International Reserves and the Global Financial Crisis

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1. Introduction

The global financial crisis wreaked havoc on world markets and has led to major economic dislocation around the world. Initially it was the developed countries that bore the brunt of the crisis, but by mid-2008 the crisis was global; financing for emerging markets dried up and credit spreads for emerging market debt rose dramatically, raising concerns about their ability to refinance their debt. Many trade-oriented countries saw exports plunge leading to sharp contractions of GDP. Countries with high levels of debt were also hard hit, with many countries forced to allow their currency to depreciate and a long list in danger of default. Some countries were hit more strongly by the crisis (especially in Central and Eastern Europe) while others, at least initially, appeared more shielded. Our study aims to understand how pre-crisis international reserve accumulations, as well as exchange rate and reserve decumulation policy decisions made during the crisis, can explain cross-country differences in post-crisis economic performance.

Our project begins with an analysis of initial conditions in order to better understand the choices countries faced when the global crisis struck. An important component of this analysis will be a focus on pre-crisis international reserve accumulation. In the years since the regional crises in the 1990s a number of countries, especially in East Asia, were thought to have built up excessive international reserve portfolios. If the main rationale for accumulating reserves was to provide precautionary self-insurance, the global financial crisis would seem to be the ultimate vindication for that strategy. Yet recent studies by Blanchard, Faruqee and Das (2010) and Aizenman and Sun (2010) find that even countries with high levels of reserves were reluctant to use (or lose) them. They find little evidence that reserves were important buffers to the crisis.

The decision by governments not to deplete reserves during the crisis does not provide evidence against the positive role for reserves in self-insurance. Indeed high reserve stocks prior to the crisis may have protected countries against speculative attacks which would have otherwise occurred. Reserves in this context may be analogous to the lender of last resort facilities in central banks.

The derivation of optimal reserve levels has long been contentious. Recent experience suggests that models have underestimated the threshold level of reserves after which risk perceptions about a country rise dramatically. Further, the widely differing initial levels of reserve stocks held by emerging countries indicates significant heterogeneity in desired threshold levels (perhaps based on past experience during crises as Hashimoto and Ito (2007) emphasize). More importantly, recent evidence suggests that once reserves fall below the threshold, net new capital inflows abruptly end leading to debt rollover problems and capital flight. These capital flow reversals can, in turn, increase the pace of decumulation of reserves. South Korea through

the current crisis is a case in point. In 2008 there was concern that Korea's total external debt maturing over the coming year would exceed its level of international reserves. In addition to depleting some of its reserves, Korean authorities opted to draw on their swap line with the Fed in the midst of the crisis in order not to breach their perceived threshold level of reserves.

Our approach will focus on all the resources that might matter (e.g. a country with a SWF and reserves, and/or swap lines, is likely to be perceived differently than one with only reserves) in order to gauge how (and whether) these resources influenced the economic and financial performance of countries during and after the global crisis.

2. Why Do Countries Hold International Reserves?

International reserves held by monetary authorities (typically in the Central Bank, Treasury, or Ministry of Finance) are part of national wealth, and were originally important for countries with fixed exchange rates that wanted to avoid costly adjustments to disturbances in the external sector of the economy. For example, if a country ran a current account deficit and/or experienced private-sector capital outflows, reserves could be used by the government to forestall an exchange rate depreciation that might otherwise occur. However, in this view of reserves, as a country's level of wealth increases over time, or if a country moves away from a fixed exchange rate regime, it is less clear how much of a share of the national wealth should be devoted to international reserve assets. It is worth noting that when a central bank acquires international reserves they typically sterilize the effect of these purchases on the domestic monetary base by incurring domestic-currency liabilities (often termed "sterilization bonds").[1] Likewise, reserves held by the fiscal authority are typically financed with domestic government bills. Hence, international reserves in most countries are not *net* national assets. Countries with large stocks of international reserves and a high domestic interest rate may inadvertently be counter-parties to the carry trade. While carry-traders borrow in low interest currencies and invest in high interest currencies, most reserve building countries invest in low interest foreign currencies and borrow at the (relatively higher) domestic interest rate.[2]

Heller (1966) provides one of the first attempts at calculating an optimal country specific level of international reserves based on what he termed the precautionary motive. The three parameters he thought important to this calculation include: (1) the cost of adjusting to an

[1] If the central bank does not sterilize its foreign reserve purchases it increases its domestic liabilities when its foreign assets increase. If the central bank sterilizes, it effectively reduces its net assets. In both cases the net worth of the central bank is unchanged.

[2] A conspicuous exception to this is the case of Japan, and possibly China. The interest rate of Japan's fiscal bills that have been issued to maintain foreign reserves is markedly lower than the US Treasury interest rate. The special account of the foreign exchange fund managed by the Japanese Ministry of Finance has recorded net interest gains in the last 20 years. See Ito (2003, 2007a) for details of the balance sheet of the account, and interest income. This suggests that Japanese foreign reserve operations are essentially engaged in carry-trade, pursuing net interest income with exposure to currency risk.

external imbalance (measured as the propensity to import); (2) the cost of holding liquid international reserves (measured as the difference between the return on the reserves relative to a benchmark return on domestic bonds); and (3) the probability that there will actually be a need for reserves of a given magnitude (based on the history of past external imbalances).

In the period following the 1971 break down of the Bretton Woods system, while many industrial countries moved away from fixed exchange rate systems toward more flexible regimes, countries continued to hold reserves despite the disappearance of their original purpose which was to help finance current account imbalances. In practice there seem to have evolved a number of "rules of thumb" to determine optimal reserve levels loosely based on Heller's precautionary motive. These rules included maintaining reserves equivalent to: (1) three months of imports (to offset current account shocks); (2) 5-20 percent of M2 (to be able to shore up confidence in the value of the domestic currency in the event of a currency crisis); and (3) the value of all debt obligations falling due within the following 12 months (in the event of a sudden disappearance of short-term capital inflows)[3.]

All of these rules of thumb imply a desire on the part of governments to acquire reserves to serve as a cushion against adverse economic shocks of one form or another, and as such can be categorized as satisfying Heller's precautionary motive. Frenkel and Jovanovic (1981) provide a more formal approach to modeling the precautionary motive for holding reserves using a stochastic inventory-theoretic framework. Their model indicates that optimal reserve holdings increase with the volatility of reserves (which are presumably influenced by current account shocks, the value of the domestic currency, and capital inflows) subject to a fixed cost of reserve accumulation and the opportunity cost of holding reserves. Ben-Bassat and Gottlieb (1992) follow in this buffer stock modeling tradition while also linking international reserves with sovereign risk.

An alternative view of reserve accumulation is that it is the byproduct of a government strategy to keep the international value of the domestic currency low in order to boost export growth. In this view purchases of international reserves are not motivated by a desire to smooth consumption in the face of external shocks, but rather they are the consequence of sterilized interventions in the foreign exchange market.[4] This rationale for reserve accumulation, typically labeled the mercantilist motive, has been advanced by Dooley, Folkerts-Landau and Garber (2003) as a description of the export-led development strategy followed by many East Asian

[3] This is often referred to as the "Greenspan-Guidotti rule".

[4] There is a large literature exploring the motivation for and efficacy of sterilized intervention policy in developed countries (see, for example, Dominguez and Frankel (1993), Dominguez (2006b), Ito (2003, 2004, 2005 and 2007b) and Ito and Yabu (2007)). The efficacy of sterilized intervention policies in developing countries has been less widely studied, in large part because governments have been reluctant to provide detailed data on their operations. Reinhart and Reinhart (2008) document the extent to which the accumulation of foreign exchange reserves has been sterilized by developing countries since 1990.

countries, particularly China. Alternatively, it may be that reserve acquisition is motivated by a desire to keep the exchange rate stable, not for mercantilist reasons, but in order to provide a stable economic environment for foreign investment and domestic economic activity.

There have been a number of recent empirical studies attempting to measure whether the precautionary or exchange rate stability motive better explains international reserve accumulations by both industrialized and developing countries. These studies generally find evidence in support of both motivations (see, for example, Aizenman and Lee (2007)), while at the same time finding that neither motivation fully explains the upsurge in reserve accumulations by developing countries starting in 2000 (Jeanne (2007) and Jeanne and Ranciere (2007)). Three recent studies that come to the conclusion that reserve accumulations through 2007 were not excessive include: Obstfeld, Shambaugh and Taylor (2010) who gauge reserve adequacy against the size of the banking sector, Hashimoto and Ito (2007) who focus on the adequacy of reserves to maintain exchange rate stability, and Dominguez (2010) who focuses on the role for reserves in countries with underdeveloped financial markets.

There are also a few studies that examine reserve policy during the most recent global crisis. Aizenman and Sun (2010) document that many emerging market countries chose not to deplete their international reserves as part of the adjustment mechanism. Further, they find that the main factor distinguishing countries that did rely on reserves was their heavy trade orientation (measured as openness, oil export share and commodity export ratio). They suggest that countries which accumulated reserves for mercantilist reasons prior to the crisis were less wary of depleting reserves when export markets collapsed, while those countries that accumulated reserves for precautionary reasons opted for adjustment via exchange rate depreciation rather than reserve depletion.[5] Obstfeld, Shambaugh and Taylor (2009) and Aizenman, Jinjarak and Park (2011) document the heavy reliance on swap lines of inter-governmental credit during the crisis, especially by developed countries that did not have large reserve accumulations. They suggest that swap lines may substitute for reserves for some countries.[6]

Precautionary and exchange rate stability motives for reserve accumulation may have been importantly connected for some countries in the pre-global crisis period, and may have

[5] This interpretation is puzzling given our understanding of the mercantilist and precautionary motivations. As a mercantilist, a country should prefer depreciation over foreign reserve depletion. Indeed the motivation to accumulate reserves for mercantilists is to prevent appreciation when experiencing capital inflows. At the same time, mercantilist countries should be delighted to allow the exchange rate to depreciate when experiencing capital outflows. On the other hand, a country motivated by precaution should prefer to deplete foreign reserves in the face of capital outflows in order to preserve exchange rate stability. The precautionary motive should lead countries to accumulate reserves during times of capital inflows in order that they are available for use during times of capital outflow.

[6] As we will describe in more detail in section 3, it is important to recognize that swap lines that are drawn upon are part of a country's international reserves.

contributed to the global imbalances that are often cited as playing a causal role in the global crisis. Countries that experienced crises and decumulation of reserves in the late 1990s were in the process of rebuilding reserves in the years prior to the global crisis. Reserve accumulation by these countries will have put downward pressure on their own currencies and contributed to external surpluses.

3. Measurement of International Reserves

The definition of international reserves has evolved over time. Conceptually reserves should be denominated in foreign currency, owned by the government, and should be highly liquid.[7] Reserves held at the IMF, both a country's "reserve tranche" as well as IMF loans are included[8], as are certain assets held in special purpose government funds (often termed Sovereign Wealth funds, SWFs)[9] and assets created under reciprocal facilities (swap arrangements)[10]. There is an interesting historical progression between how countries measured reserves in the 1990s (before and during crises) and how the IMF responded with new restrictions on these funds. Appendix A provides some of these country-specific examples.

In response to concerns in both the financial markets and by creditor governments to perceived problems with international reserve measurement as well as the reliability of other key macroeconomic variables, the IMF launched the Special Data Dissemination Standard (SDDS) in

[7] According to the sixth edition of the IMF *Balance of Payments Manual* (*BPM*6), a country's international reserve assets refer to "those external assets that are readily available to and controlled by monetary authorities for meeting balance of payments financing needs, for intervention in exchange rate, and for other related purposes (such as maintaining confidence in the currency and the economy, and serving as a basis for foreign borrowing). Reserve assets must be foreign currency assets and assets that actually exist." (Chapter 6, 6.64; p.111)

[8] A country's "reserve position in the IMF is the sum of (a) the "reserve tranche," that is, the foreign currency (including SDRs) amounts that a member country may draw from the IMF at short notice; and (b) any indebtedness of the IMF (under a loan agreement) in the General Resources Account that is readily available to the member country, including the reporting country's lending to the IMF under the General Arrangements to Borrow (GAB) and the New Arrangements to Borrow (NAB). While a member country must present a declaration of balance of payments–related need to make a purchase in the reserve tranche (reduction in reserve position), the IMF does not challenge a member's request for reserve tranche purchases" *BPM6* (Chapter 6, 6.85; pp. 114).

[9] "Assets held in special purpose government funds that meet the definition of reserve assets are classified within reserve assets depending on their nature. So, if the special purpose government funds hold deposits, securities, and other reserve assets, these are classified as such within reserve assets. Assets held in a resident special purpose government fund that are claims on nonresidents but do not meet the criteria to be classified as reserve assets are classified in the financial account and IIP under the appropriate instrument and functional category. If special purpose government funds own direct investment equity and debt securities that could be classified in either direct investment or reserves assets, as general guidance, in the hierarchy of the balance of payments and IIP between direct investment and reserve assets, the equity securities should be classified as direct investment ahead of reserve assets, and debt securities should be classified as reserve assets ahead of direct investment" *BPM6* (Chapter 6, 6.98; pp. 116).

[10] "Assets created under reciprocal facilities (swap arrangements) for the temporary exchange of deposits between the central banks of two economies warrant mention. Deposits (in foreign exchange) acquired by the central bank initiating the arrangement are treated as reserve assets because the exchange provides the central bank with assets that can be used to meet the economy's balance of payments financing needs and other related purposes. Reciprocal deposits acquired by the partner central bank also are considered reserve assets, as long as they meet the general criteria for being reserve assets, if they are denominated and settled in a convertible currency. Lines of credit that could be drawn on and foreign exchange resources that could be obtained under swap agreements are not reserve assets because they do not constitute existing claims" *BPM6* (Chapter 6, 6.102*;* pp. 117).

April 1996 in an effort to guide countries in the collection and timely publication of economic and financial data, including international reserves data. In 1997 the IMF announced a second set of more generalized standards, the General Data Dissemination System (GDDS). [11]

During the Asian financial crisis proper disclosure of international reserves became an issue for the affected governments. By June 1997 forty-one countries, including all of the crisis-hit Asian countries—Thailand, Malaysia, Indonesia, and Korea—had subscribed to the SDDS.[12] However, governments in the midst of crisis were reluctant to fully disclose financial information. Complicated questions arose over the composition and location of international reserve assets, as well as timeliness of data publication. The selective dissemination of data, which did not deviate from any standards at the time, seems to have been motivated by a desire on the part of governments to exaggerate usable, net (spot-forward consolidated) international reserves. (See Appendix A for details on the relationship between the Mexican and Asian currency crisis and data transparency promoted by the IMF.)

In response to the post-Asia crisis data issues, particularly the need for more transparent reserve data, the Data Template on International Reserves and Foreign Currency Liquidity (known as the Reserve Template) was approved at the Executive Board Meeting in 1998.[13] Initially the SDDS only required countries to provide international reserve information on a gross basis, information on reserve-related liabilities was also encouraged. When the Reserve Template became effective, SDDS subscribers were required to provide detailed monthly reserve data by asset class (gold, SDRs, currency and deposits, securities, financial derivatives)[14] and location (reserves held in other national banks, BIS, IMF, or domestic and foreign commercial banks)[15] as well as detailed information on reserve-related liabilities.

It is worth noting that outside of crisis periods countries with large reserve accumulations may have incentives to "understate" reserves, in an attempt to deflect criticism of mercantilist

[11] The SDDS is one of the IMF's Data Dissemination Standards initiatives and subscription is voluntary. It prescribes the coverage, periodicity (frequency), and timeliness of 18 data categories for the four sectors (real, financial, fiscal, and external sectors) of the economy. The data dissemination practice of the SDDS subscribers is monitored by the IMF and the countries receive a monthly report (which is not published) and an annual report (which is posted on the IMF website).

[12] The first few years, April 1996 through December 31, 1998, were regarded as a formal transition period for the implementation of the SDDS, and a member "could subscribe to the SDDS even if its dissemination practices were not fully in line with the SDDS at that time" (Alexander 2008, p.10).

[13] During the Asian crisis, it was recognized that "the available data on the international reserves at that time did not give a complete or timely picture of the liquidity constraints some countries faced during 1997." (Footnote 6 of page 11, Second Review).

[14] In economies in which extensive reserve assets are held outside of the central bank, supplementary information is required on the institutional sector of holdings of those reserve assets (only external claims actually owned by the monetary authorities can be classified as reserves assets).

[15] The Reserve Template has four parts: I. Official Reserve Assets and Other Foreign Currency Assets; II. Predetermined Short-term Net Drains on Foreign Currency Assets; III Contingent Short-Term net Drains on Foreign Currency Assets; and IV. Memorandum Items. Part I of the Reserve Template, Official reserve assets, shows the total amount of official reserve assets disaggregated into (1) foreign currency reserves, (2) IMF reserve position, (3) SDRs, (4) gold, and (5) other reserve assets. Data on Official reserve assets and the Reserve Template for the SDDS subscribers are publicly available at the IMF's website, http://dsbb.imf.org/Pages/SDDS/ReserveTemplates.aspx.

motives and excessive reserves. Another consequence of the large accumulations of reserves in emerging countries is a new consciousness among monetary authorities of the risk of international reserve valuation losses[16] as well as criticism from the US concerning excessive official holdings of dollar-denominated assets. In order to avoid these economic and political costs a number of countries with large reserve stocks have begun to pursue strategies that diversify their reserve holdings[17] and create new fund categories. Although these funds are often not officially defined as international reserves under BPM6 rules[18], nonetheless they could be used in times of crisis. Table 1 provides information on selected sovereign wealth funds (SWFs), detailing which countries with SWFs subscribe to the SDDS or participate in the GDDS, and whether SWF data are in BOP/IIP as of 2007 or 2010.

Swap arrangements between central banks are included in the Reserve Template (they are recorded as financial derivatives in Section II.2 of the Reserve Template, and if they are re-lent to commercial banks they are recorded in Section I.B). One of the U.S. Federal Reserve policy responses to the global financial crisis was to provide liquidity to the interbank dollar market in December 2007. The Fed simultaneously established the Term Auction Facility (TAF), which provided funding to US banks, and reciprocal currency arrangements (known as "swap lines"), which provided funding to the European Central Bank (ECB) and the Swiss National Bank (SNB). Through these swap arrangements foreign central banks can obtain US dollars in exchange for their own currency with an agreement to reverse the transaction at a future date. These swap arrangements then allowed the ECB and the SNB to provide dollar liquidity to commercial banks in Europe (see Fleming and Klagge (2010) and Goldberg, Kennedy, and Miu (2011) for more details on the Fed swap facilities established in 2007-2010).[19] The swap lines to the ECB ($20 billion) and the SNB ($4 billion) were originally set to expire in six months, but were later not only extended but expanded in size in several steps, and became unlimited on October 13. The list of central banks with which the Federal Reserve established swap lines included Japan, UK, Canada, Australia, Denmark, Sweden and Norway shortly after the failure of Lehman Brothers in September 2008. The Reserve Bank of New Zealand was added to the list on October 28.

On October 29, Fed swap lines were extended to Brazil, Mexico, Korea, and Singapore, with authorization through April 30, 2009. This was an unusual move in that these four countries

[16] Dominguez, Fatum and Vacek (2010) examine the implications of systematic reserve decumulation (intended to mitigate valuation losses) on domestic currency movements.

[17] The dollar remains the dominate currency denomination for reserves, though there is some evidence that countries have begun to diversify into euro and yen, see Dominguez (1999, 2006a)

[18] SWFs could be defined as reserves if they allow "the monetary authorities control over the disposition of funds" *BPM*6 (Chapter 6, 6.95; pp. 115-116).

[19] Initially, the Fed funded the dollar swap lines by reducing its holdings of Treasury securities, though as its various liquidity facilities grew, the Fed eventually allowed its liabilities to increase. In December 2008 there were $580 billion in swaps outstanding, which accounted for over 25 percent of the Fed's total assets.

are regarded as emerging market economies, rather than advanced countries. The arrangement allowed Mexico and Korea to temporarily replenish their foreign reserve stocks, a use of swap funding that is non-conventional. It is interesting that it was the Federal Reserve, and not the IMF, that provided dollar liquidity to these four countries. It might also be considered controversial that only these four emerging market countries were offered swap lines.[20]

In order to understand the role of swap lines in the reserve data it is instructive to consider the case of South Korea. The Bank of Korea faced severe exchange market (outflow) pressure in the fall of 2008. News reports indicate that the Fed swap line (up to $30 billion) helped to calm investor concerns with Korea, especially when the swap line expiration date was extended (from April 30 to October 30, 2009) in February 2008. Later, on June 25, it was announced that the expiration date was further pushed back to February 1, 2010. Consequently, for countries like Korea who had access to Fed swap lines from October 2008 to February 2010, stocks of foreign reserves (including swap lines which are actually drawn[21]) were temporarily inflated.

The European Central Bank and the People's Bank of China also provided swap lines during the global financial crisis, though there is less evidence that these sources of funding were as effective as the Fed swap lines in providing liquidity to commercial banks. Table 2 provides information on the size of these swaps (in USD, Euros and RMB) as well as the countries involved.

Country holdings of Special Drawing Rights (SDRs) are also included in international reserves. For many countries, especially advanced countries with relatively small international reserve positions, SDR fluctuations can be quite important. A nation's IMF quota, the maximum amount of financial resources that it is obligated to contribute to the fund, determines its allotment of SDRs. The SDR is neither a currency, nor a claim on the IMF, it is a potential claim on the freely usable currencies of IMF members. Holders of SDRs can obtain these currencies in exchange for their SDRs either through the arrangement of voluntary exchanges between members or, in some cases, by the IMF designating members with strong external positions to purchase SDRs from members with weak external positions. It is in this way that SDRs are transferred among IMF countries. General allocations of SDRs are based on long-term global needs to supplement existing reserve assets and have been made only three times, in 1970-72, in 1979-81, and in 2009.[22] The most recent allocation was made to help mitigate the effects of the

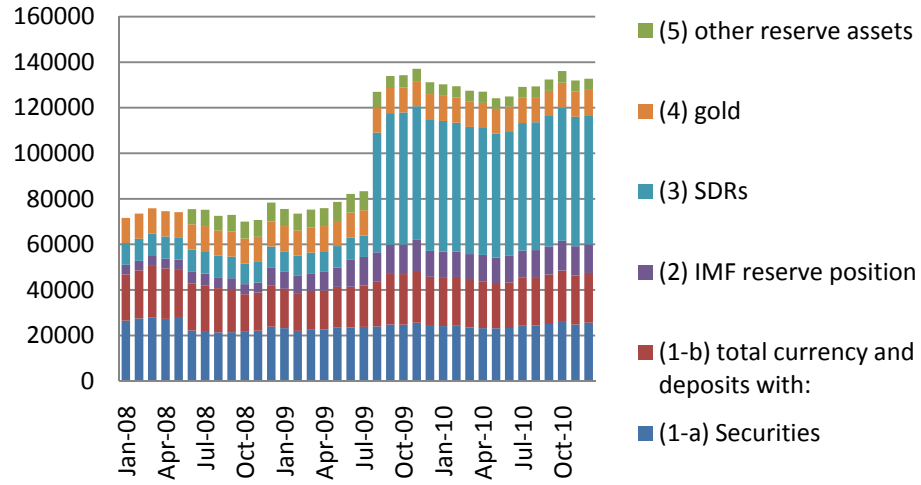
[20] At least one other Asian country requested, but was denied, a swap line with the Federal Reserve.

[21] The following central banks did not draw on the swap arrangements: Reserve Bank of New Zealand, Bank of Canada, Banco de Brasil, and the Monetary Authority of Singapore (Goldberg, et a. (2011, p. 11))

[22] Further information on SDRs and the 2009 General and Special SDR allocations is at http://www.imf.org/external/np/exr/facts/sdr.htm

financial crisis and to enable all members of the IMF to participate in the SDR system on an equitable basis. The 2009 allocation corrected for the fact that countries that joined the IMF after 1981—more than one fifth of the current IMF membership— had never received an SDR allocation. Figure 1 shows the importance of the 2009 SDR allocation for the U.S. Reserve Template.

Figure 1: United States International Reserve Assets, 2008-10

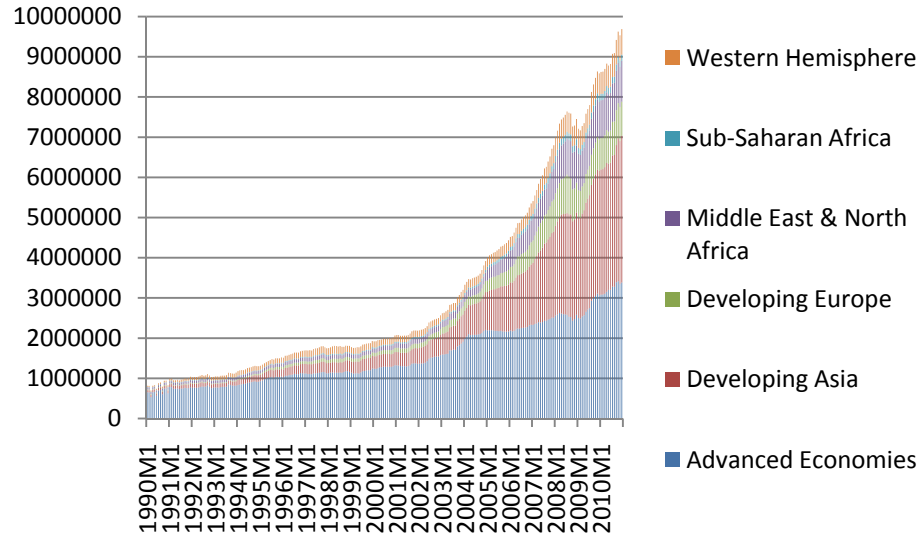


Source: IFS

4. Alternative Measures of Reserve Changes

Worldwide international reserves accumulation rose dramatically in the years before the global financial crisis. Figure 2 indicates that increases in reserve accumulation were most dramatic in the economies of developing Asia, and to a lesser extent developing Europe, the Middle East and North Africa. As of the end 2010, the top four reserve accumulating countries are China, Japan, Saudi Arabia, and Russia.

Figure 2: World International Reserves (USD million)



Source: IFS

International reserves are recorded in the balance of payments (BOP) accounts. The BOP is an accounting record of all monetary transactions between a country and the rest of the world. In theory, for each country, when all components of the BOP account are included it must sum to zero with no overall surplus or deficit. Specifically, the BOP identity is as follows:

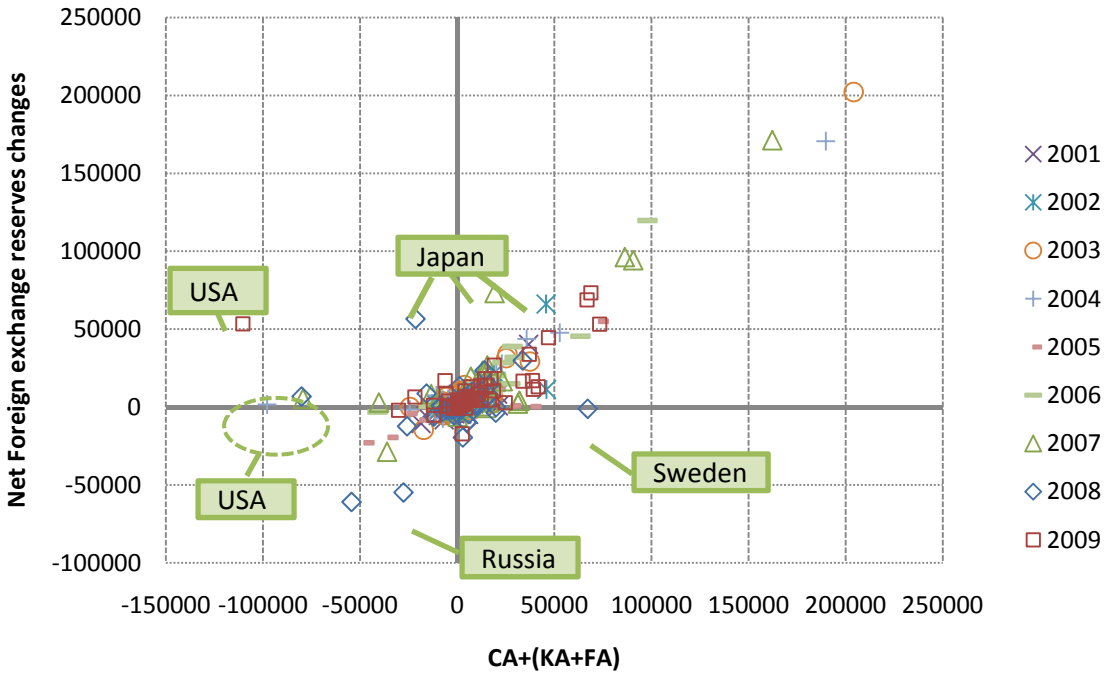
Current Account (CA) + Capital Account (KA) + Financial Account (FA)
+ net errors and omissions + Net foreign reserves changes (NFR) = 0.

If we for abstract from statistical discrepancies and net errors and omissions, the BOP identity can be expressed as:

CA + (KA+FA) = -NFR

In other words, using the BOP identity we can measure net foreign reserves (NFR) as the (negative) sum of a country's current, capital and financial accounts. Figure 3 shows the actual relationship between these BOP components for the countries that subscribe to the IMF's SDDS over the time period 2001 to 2009. The net foreign reserves (NFR) data include securities, currency and deposits, the IMF position, gold, SDRs, swaps, and other assets. If the BOP identity held perfectly, the data points in this figure should lie on the 45 degree line.

Figure 3: Current/financial account and the net reserves changes

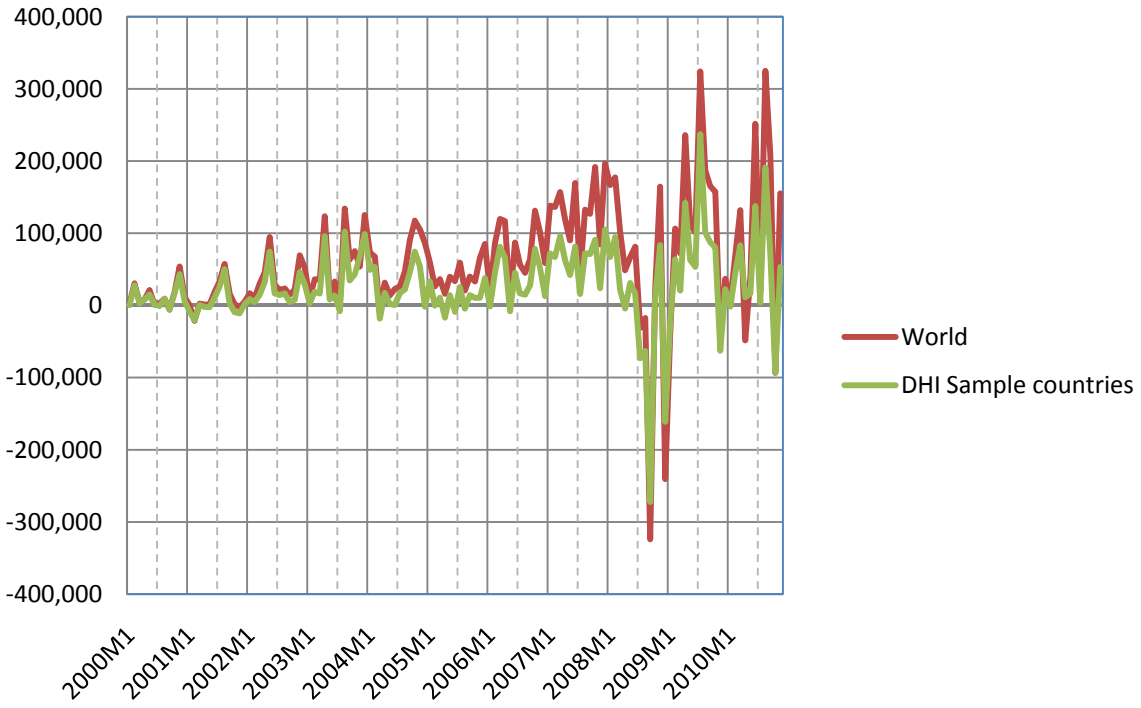


Source: IFS

It is interesting to note that the two countries that lie the farthest from the 45-degree line are the US and Japan, with the most recent 2009 US data showing up as an important outlier. These data indicate that while in theory we could measure international reserves using the current and financial accounts data, in practice this approach would provide a significantly different calculation of reserve holdings.

While the BOP identity should hold on a country-by-country basis, it is also the case that the identity should hold in the worldwide aggregate. Figure 4 shows the sum of worldwide international reserves changes. The figure indicates that the worldwide sum of net international reserves changes have on occasion been close to zero; prior to the global financial crisis they were generally positive and small (summing to less than $100,000 million). This pattern changed dramatically in late 2008, when worldwide net international reserves plunged dramatically and then quickly recovered to their pre-crisis levels by mid-2009. This figure provides our first indication from the data that at least some countries depleted their international reserves during the financial crisis.

Figure 4: Sum of World International Reserves Changes (USD millions)



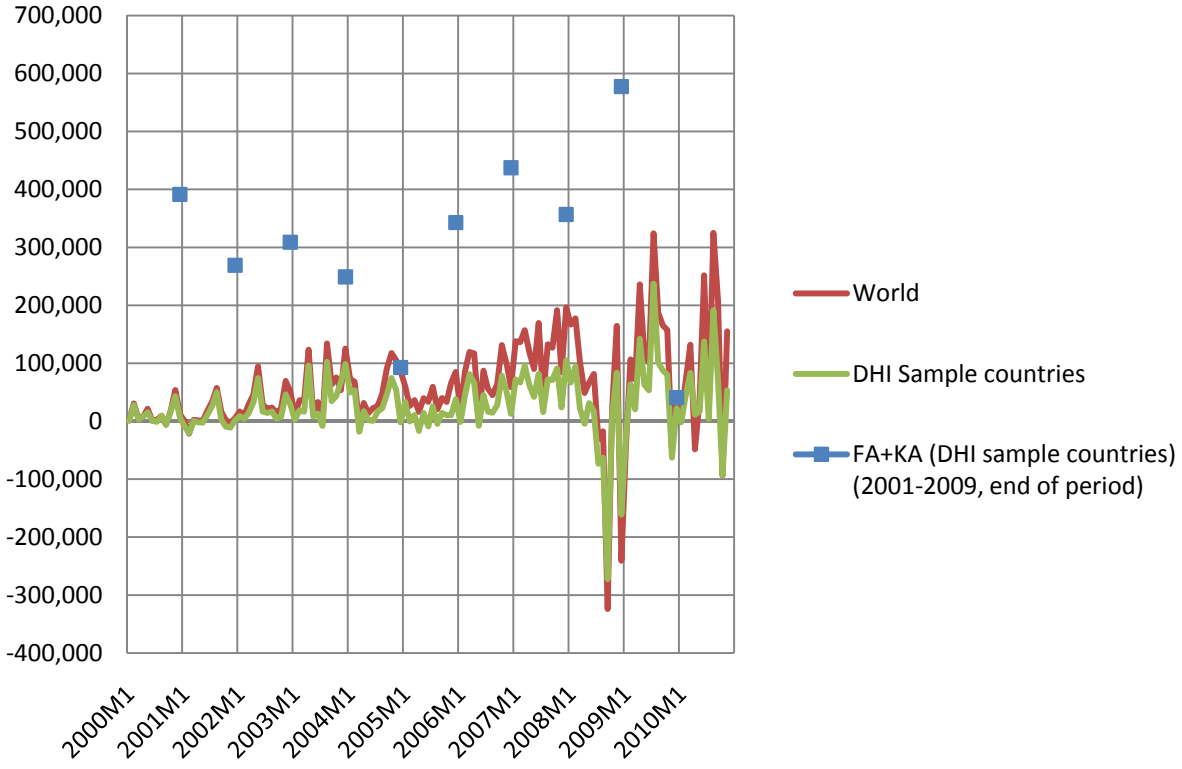
Source: IFS

Figure 5 explores the worldwide relationship between components of the BOP account in more detail. The figure shows the world sum of international reserve changes (NFR) together with the world sum of the capital and financial accounts (KA+FA). In theory, the worldwide sum of current accounts should equal zero, ignoring the measurement basis difference (f.o.b and c.i.f).[23] The current account balance in each country measures the excess of national income over total absorption. If we sum current account deficits and surpluses across all countries these should offset each other (world income should equal world absorption). Moreover, if the worldwide current account balance is zero, this implies that the sum of international reserve changes (NFR) is equal to the worldwide financial account balance (KA+FA). The data in figure 5 indicate a huge discrepancy in the BOP identity; the worldwide financial account positions in all the years prior to 2010 (indicated by the blue squares in the figure) are far larger than the worldwide change in international reserves.[24] It is only in 2010 that the worldwide financial account and worldwide changes in foreign reserves are approximately equal to zero.

[23] The Balance of Payments statistics published from the IFS uses the f.o.b basis for both exports and imports.

[24] The measurement problems inherent in the financial account data have been widely discussed in the literature.

Figure 5: Sum of World International Reserves changes (USD millions)



Source: IFS

These explorations of the BOP data indicate that using alternative measures of international reserves based on capital and financial account data are likely to be problematic. The disadvantage of the Reserve Template data is that it is only available from the 68 SDDS subscribers, and 2000 is the earliest year data are available (for more recent subscribers the time series is even shorter).[25] The advantage of the Reserve Template data is that it is available at a monthly frequency, and provides specific asset and liability information. In the next section, we will take advantage of this detailed data to better understand the changes in reserve management that occurred across our sample of countries before, during, and after the global financial crisis.

[25] These are the countries included in the "DHI sample" indicated in the figures.

5. Active versus Passive Reserve Management

While all SDDS compliant countries report detailed, marked-to-market,[26] and timely international reserve data, they (unfortunately) do not provide information about whether changes in reserves are due to *passive* valuation changes in the underlying assets held, or *actively managed* additions or subtractions to the reserve portfolio. One of the objectives of this project is to understand whether reserves can serve as important buffers for countries during times of crisis. In order to fully understand the role of reserves in times of crisis, however, it is important to distinguish between active and passive reserve changes. If the values of most reserve assets are declining, which was roughly the case during the global financial crisis, it follows that the value of all country's reserves should have declined in the absence of active reserve accumulation. So that recent studies that find limited evidence of reserve depletion during the crisis may be misinterpreting the data.[27] Stable reserve levels during the crisis may in fact indicate that countries were actively accumulating reserves.

In order to be able to distinguish between valuation changes and active management of reserves we attempt to adjust the reserves data for changes in underlying asset values. The SDDS data does not provide details on each asset held in the "foreign reserves" component (which excludes IMF reserves, SDRs, gold, swaps, and other assets) of international reserves but it does provide information on the broad composition of these reserves, specifically the share of reserves held in "securities" versus the share in "deposits". Information on the currency composition of these assets, in turn, is available on an aggregated basis (the data are available for two groups: "advanced" and "emerging and developing" countries) from the Currency Composition of Official Foreign Exchange Reserves (COFER) database[28]. We use the monthly SDDS foreign reserve composition data, together with proxies for returns to securities (10-year government bond yields) and deposits (3-month inter-bank yields)[29], and the quarterly COFER

[26] The SDDS reserve template guidebook says, "values of foreign currency resources are to reflect what could be obtained for them in the market if they were liquidated; that is, at market prices on the reference date. In cases where determining market value on a frequent basis is impractical, approximate market values can be substituted during the intervening periods... The stock of equity securities of companies listed on stock exchanges can be revalued based on transaction prices on the revaluation date. If such transaction prices are not available, the midpoint of the quoted buy and sell prices of the shares on their main stock exchange on the reference date should provide a useful approximation... For debt securities, the market price is the traded price on the reference date and includes accrued interest. If that value is not available, other methods of approximation include yield to maturity, discounted present value, face value less (plus) written value of discount (premium), and issue price plus amortization of discount (premium)."

[27] Another issue that arises in characterizing reserve losses is that large-reserve-loss countries during the crisis are mainly countries whose reserves first rose and then fell, so that they both *gained* and lost reserves during the crisis. This suggests that the precise way in which reserve changes are measured, especially during the crisis, matters.

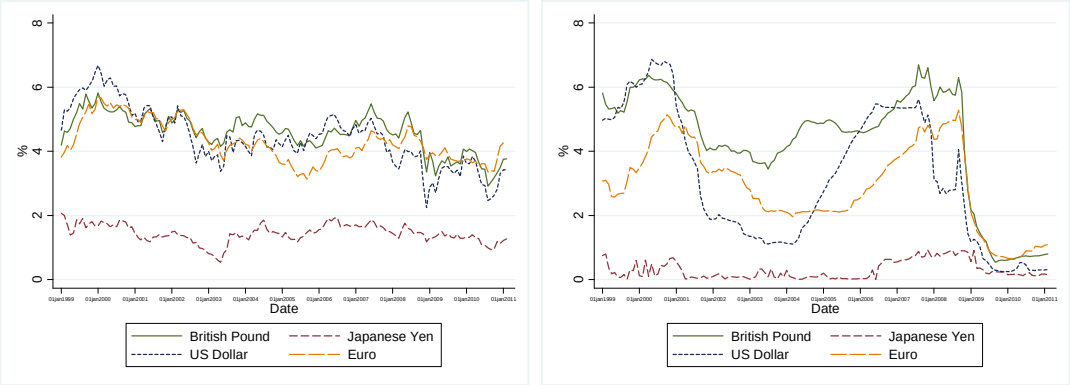
[28] These data are available at http://www.imf.org/external/np/sta/cofer/eng/index.htm.

[29] These monthly data are from HAVER (http://www.haver.com/our_data.html). The long-term securities used include: Japanese 10-year benchmarked government bond yields EOP, UK Government Bonds 10-Year Nominal par yield EOP, US 10-Year Treasury Bond yields at constant maturity EOP, and Euro-area 10-year benchmark government bond yields EOP. The short-term deposits used include: Euro-area 11-17 3-month

approximations of currency denomination[30], to strip out *passive* valuation changes. Figure 6 presents the underlying security and deposit data that we use in these calculations. Although the long-term government bond yields are relatively stable (though diminishing) over this time period, the short-term bank yields are more volatile, and fall dramatically in the wake of the global crisis

Figure 6: Yields used in reserve valuation exercise

10-year Government bond yields 3-month inter-bank yields



Source: Haver

An important assumption we must make for this "simulated" reserve calculation is that each country's shares of reserve assets in securities and deposits are not adjusted over the month; re-valued reserves in period 1 are based on shares of securities and deposits in various currency denominations reported in period 0 (and returns to securities and deposits are calculated between period 0 and period 1).

Figures 7 to 11 present selected country level plots of actual foreign reserves (the solid black lines) and our "simulated" reserves series (the dashed orange lines) over the period 2000-2010. These figures also include a trend forecast (the dashed black line) based on foreign reserve data prior to the global financial crisis (this trend is based on the earliest data available, in most cases starting in 2000, through 2006Q4). The second plot in each figure shows the difference between actual and simulated reserves (the red bars), which we term "actively managed reserves", the accumulation of actively managed reserves (the solid orange line) and the linear trend forecast of accumulated-actively-managed reserves (again based on data through 2006Q4). In each of these

EURIBOR Rate EOP, UK 3-Month London Interbank offered Rate EOP, US 3-Month London Interbank offered Rate EOP, and the Japan Call Rate uncollateralized 3-Month EOP.

[30] COFER information is only available quarterly (so that in our calculations monthly shares are the same within the quarter) and at an aggregated level. We use the COFER information in such a way that issuing countries are not allocated shares of their own currency. For example, Euro assets are only included in the portfolios of countries not in the euro-zone.

figures we also shade the country-specific crisis period (based on a peak-to-trough real GDP calculation after 2007). While the full set of SDDS country plots indicate wide variation in reserve accumulation patterns, for many countries actual reserves exceed "simulated" reserves (indicating active reserve accumulation) prior to the crisis period. During the crisis period many countries experienced active reserve depletion (Bulgaria, South Korea and Russia all show this pattern), while in the post-crisis period, many countries are back on their pre-crisis trend lines and are actively accumulating reserves (Russia provides a good example of this pattern).

Figure 7: Estimates of Bulgaria's Foreign Reserve Management

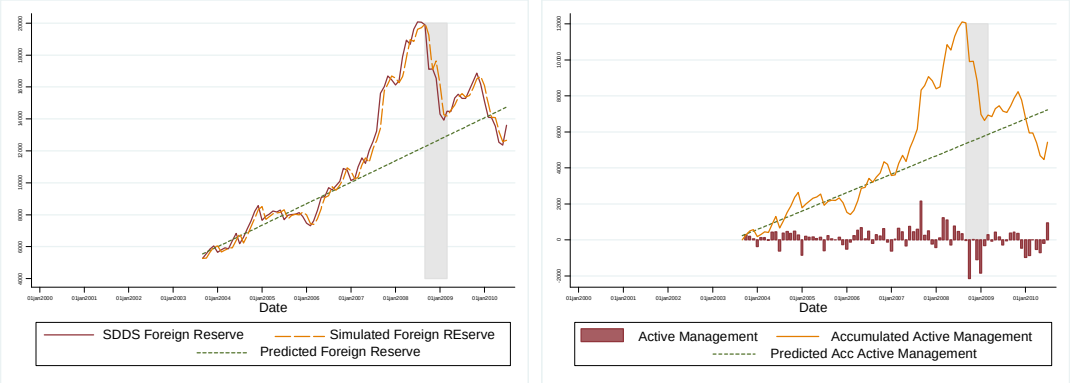


Figure 8: Estimates of Japan's Foreign Reserve Management

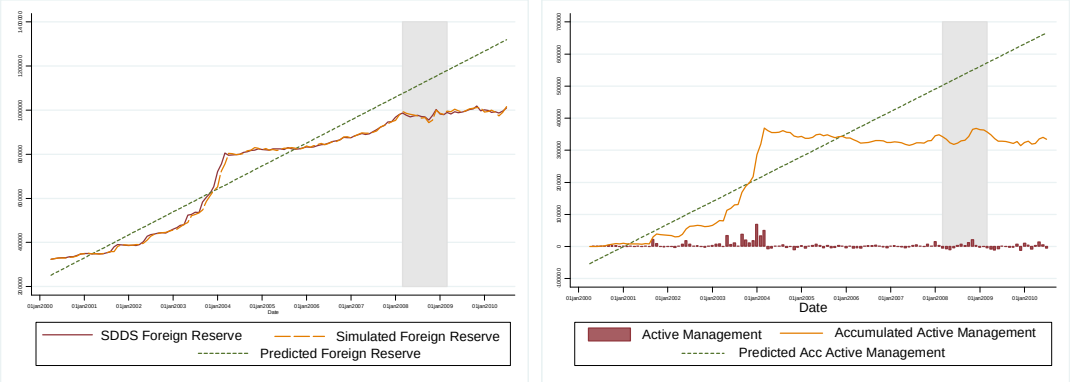


Figure 9: Estimates of Russia's Foreign Reserve Management

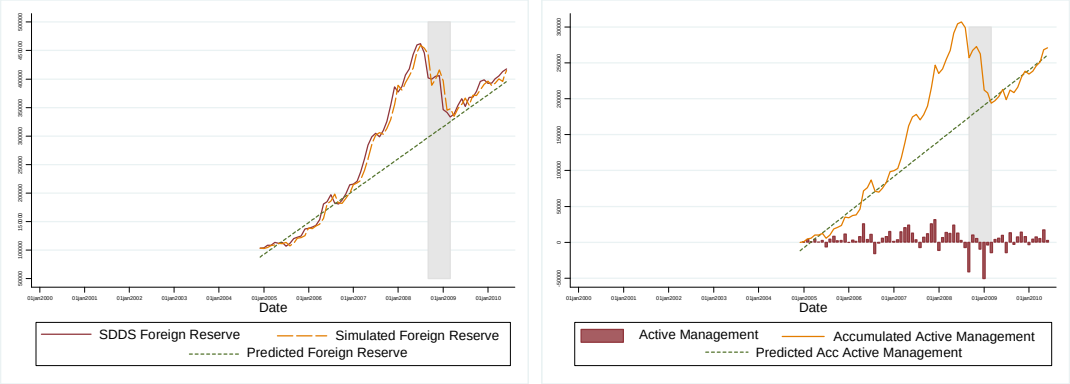


Figure 10: Estimates of South Korea's Foreign Reserve Management

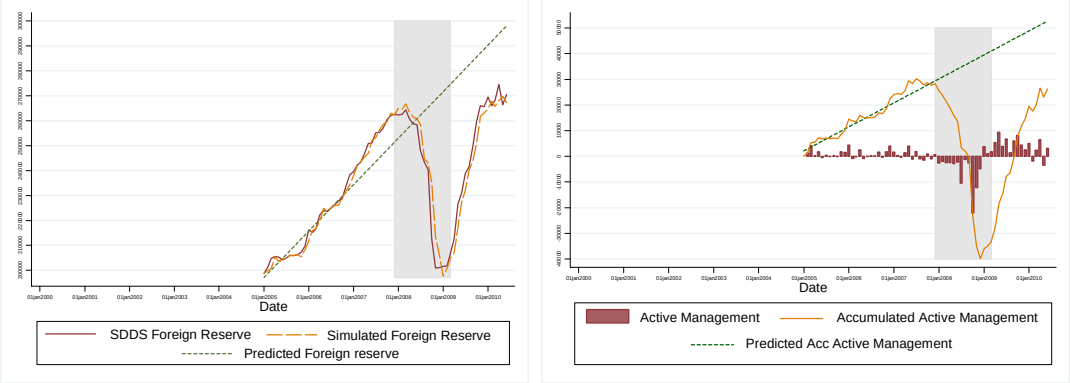
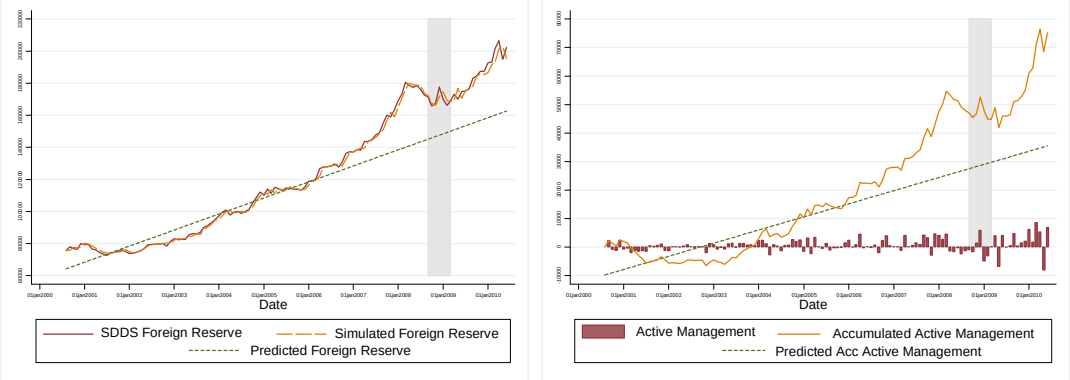


Figure 11: Estimates of Singapore's Foreign Reserve Management



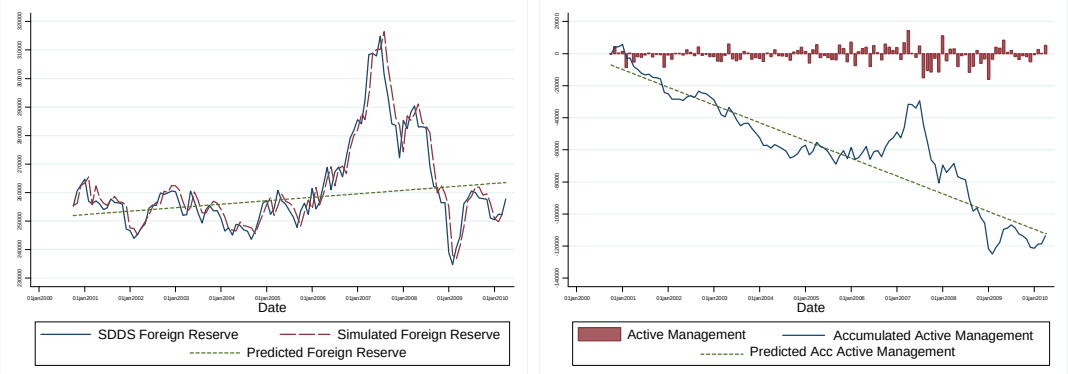
Foreign reserve data for developed countries generally show little evidence of active reserve accumulation (indeed a number of Euro-zone members were actively depleting reserves well before the global financial crisis).[31] Japan in 2003-4 and Switzerland in 2009-2010 are two

[31] It is worth noting that when countries join the Euro-zone we typically see a dramatic fall in foreign reserves, which reflects the fact that Euro-denominated assets are no longer considered foreign reserves for these countries. This pattern is very apparent in the time series for the Slovak Republic and Slovenia.

interesting exceptions. Both countries actively intervened to stop excessive appreciation of their domestic currencies over this time period. In the case of Japan, active interventions involving yen sales (and usd purchases), 35 trillion yen in total, occurred in 2003 through the first quarter of 2004. In addition, Japan intervened once on September 15, 2010 to sell 2.1249 trillion yen (a purchase of USD 250 billion at that day's exchange rate).[32] These intervention operations are reflected in the large increases in actual foreign reserves as well as active reserve accumulation in figure 8. Likewise, the plots for Switzerland show the dramatic accumulation of dollar and euro-denominated assets that occurred in March 2009 through May 2010 as a result of interventions to stop the appreciation of the swiss franc.

Figures 12 and 13 present aggregated versions of the country-level "simulated" and "actual" SDDS foreign reserve data as well as the accumulated "actively managed" series. Figure 12 aggregates across countries that did not actively increase their stock of foreign reserves over this time period; this group includes most of the developed countries in our sample. Figure 13 aggregates across the rest of the countries in our sample, all of which actively accumulated reserves over this period. Included in the aggregated data in figure 13 are foreign reserve accumulating countries which depleted reserves during the crisis period (Argentina, Brazil, Croatia, Czech Republic, Denmark, Latvia, Lithuania, Malaysia, Mexico, Netherlands, Norway, Peru, Poland, Singapore, South Africa) as well as those countries that continued to accumulate throughout this time period (Chile, Colombia, Hong Kong, Estonia, Hungary).

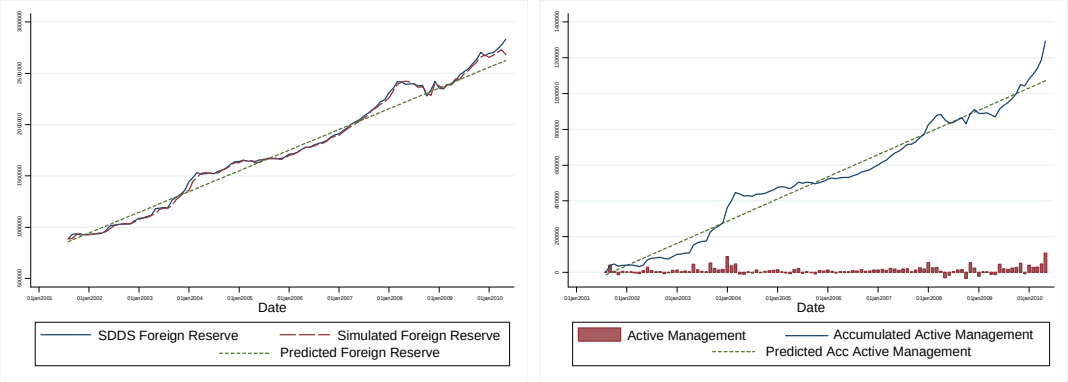
Figure 12: Estimates of Aggregated Reserve Management by Non-accumulating Countries



Notes: includes Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Portugal, Spain, UK, US

[32] The Ministry of Finance in Japan discloses the daily intervention numbers (with a time delay). Prior to this intervention, there had not been an intervention for six and half years. After this intervention, there was one intervention on March 18, 2011, one week after the mega Earthquake in Japan to calm the yen market, as a part of a concerted intervention operation by the G7.

Figure 13: Estimates of Aggregated Reserve Management by Accumulating Countries



Notes: includes Argentina, Brazil, Chile, Colombia, Croatia, Czech Republic, Denmark, Hong Kong, Estonia, Hungary, Japan, Latvia, Lithuania, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Singapore, South Africa, Sweden, Switzerland, Thailand, Tunisia, Turkey

6. Reserve Accumulation and Exchange Rate Market Pressure

When a country faces sudden capital outflows, there tends to be enormous pressure to depreciate the currency. Monetary authorities have a limited set of policy choices to counter this pressure; they can (1) allow the exchange rate to depreciate, (2) use foreign reserves to defend the exchange rate, (3) raise the interest rate in the hope that a higher interest rate will discourage capital outflows, or (4) use a combination of all of the above. If the pressure against the domestic currency is moderate, authorities often allow the exchange rate to depreciate. However, in cases where the pressure is strong, concerns typically arise that depreciation will be too precipitous and may encourage further capital outflows, which could rapidly result in a systemic crisis in the country's financial institutions. It is in these circumstances that authorities typically resort to the use of foreign reserves to absorb capital outflow pressure. This will also be the case for countries that especially value exchange rate stability. The third approach, raising the domestic interest rate to make domestic assets more attractive, has the disadvantage of dampening domestic demand and adversely affecting domestic investment, especially if capital outflow pressure is strong.[33]

In order to measure the strength of exchange rate market pressure (EMP) during the global financial crisis we calculate a weighted average of changes in the exchange rate and foreign reserves. Figure 12 shows combinations of exchange rate and foreign reserve changes for our sample countries. The exchange rate change for a country is defined as its change from peak (highest level in 2007-08) to trough (lowest level in 2008-09). The foreign reserves change for a

[33] A number of recent studies have analyzed the policies available to countries experiencing capital outflows based on their explicit preferences toward exchange rate stability and monetary independence within a Trilemma framework. See, for example, Obstfeld, Shambaugh and Taylor (2010) and Aizenman, Chinn and Ito (2010).

country is likewise defined as its change from peak (highest level in 2007-08) to trough (lowest level in 2008-09). If a group of countries suffer from the same amount of exchange market pressure (EMP), but with differing degrees of depreciation and foreign reserve depletion, those countries should scatter on the upward sloping line. Since the euro-area countries share the same degree of exchange rate depreciation (vis-à-vis the US dollar), they scatter vertically depending on the severity of exchange market pressure. Some countries experienced accumulation of reserves, while others, like Greece and Portugal, experienced large losses. The figure shows that the Japanese yen appreciated most among the currencies of sample countries, followed next by Egypt.

Figure 14 indicates that the majority of countries in our sample experienced both a loss of reserves and a depreciation of their currency during the financial crisis. The regression line suggests that the relationship between foreign reserve and exchange rate changes was mildly negative during this time period, and when we exclude the euro-area countries the negative slope is steeper. While in past financial crises authorities typically either allowed their currency to lose value *or* depleted reserves, these data suggest that during the global financial crisis authorities were forced to do both.

Figure 14: Reserve Changes and Exchange Market Pressure



7. Determinants of Pre- and Post-Crisis Reserve Accumulation

The countries that drew down their reserves during the global financial crisis were often the same countries that had actively accumulated reserves after 2006. In order to understand what motivates countries to build up their foreign reserve stocks we examine cross-country panel and pooled regressions of reserve accumulation, similar to those used in Hashimoto and Ito (2007) and Dominguez (2010), which allow for both self-insurance and exchange rate stability motives. The regressions are estimated over the pre-crisis period (through 2006Q4) over two data frequencies (annual and quarterly). The dependent variable is international reserves measured either using SDDS data (68 countries, most starting in 2001) or IFS data (which allow a wider panel)[34] and explanatory variables include: country size (GDP), measures of trade openness (exports plus imports over GDP), measures of primary export ratios (from Comtrade), the oil export ratio (net oil export volume over GDP, EIA), export volatility (the standard deviation of monthly export growth), capital account openness (Chinn-Ito index), exchange rate volatility (standard deviation of monthly exchange rate growth), short-term debt ratios (JEDH), the current account to GDP ratio (IFS), changes in interest rates (IFS), and the share of M2 to GDP (IFS).[35]

Analysis of tables 4 and 5 provides evidence that both precautionary and exchange rate stability factors were important drivers of reserve accumulation in the pre-crisis period for this sample of countries.[36] Also included in the tables are specifications using the actively managed reserves series described in section 5. The reported estimates suggest that there are multiple reasons that countries accumulate reserves in normal times; no one explanatory variable seems to be driving reserve behavior across these countries. Moreover, our analyses of the country-by-country reserve data in section 5 suggest that the same country may well change their approach to reserve accumulation in reaction to global economic circumstances. The country-specific linear trend forecasts of reserve accumulation during the crisis, based on pre-crisis behavior,

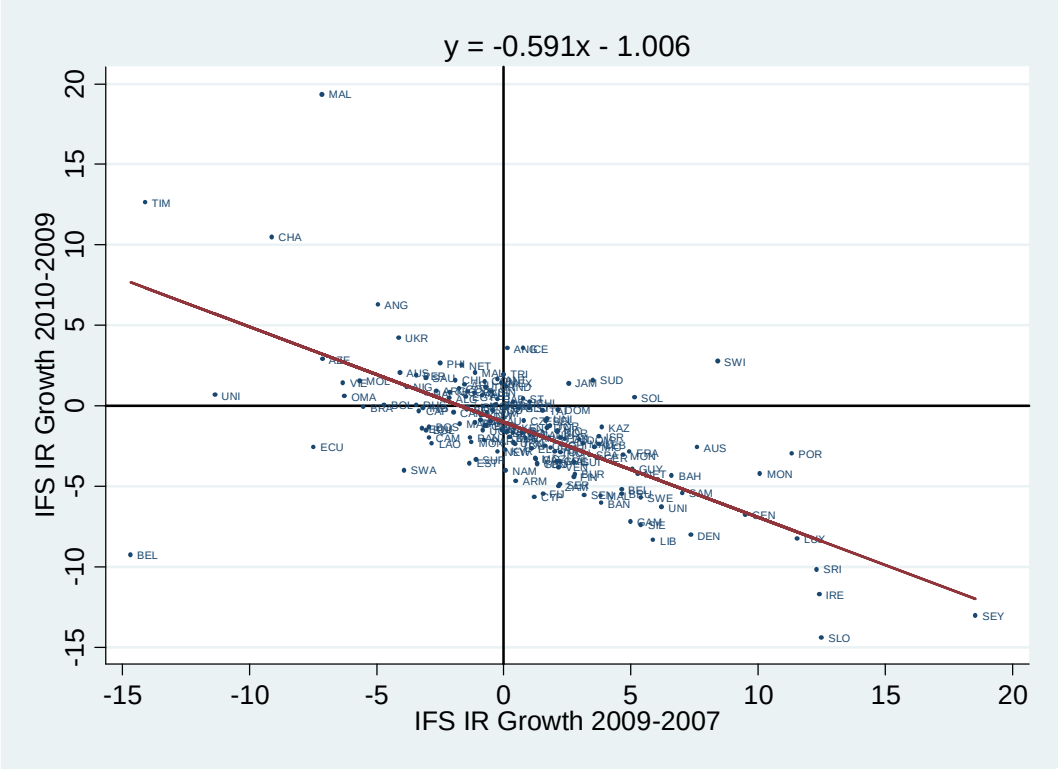
[34] The IFS's "total reserves minus gold" *should* be consistent with "official reserve assets minus gold" in the SDDS templates. However, the valuation of the IMF account data ("reserve position in the Fund" and "SDRs") differs between the IFS and the SDDS. In the IFS these data are taken from the IMF's Treasury records while the data for the SDDS templates on reserve positions and SDRs are reported by SDDS countries and posted on the web as reported. It is also the case that gold in the IFS is calculated at national valuation, whereas in the SDDS gold is at market value.

[35] We are grateful to Joshua Aizenman and Yi Sun for providing us with data on a number of the included explanatory variables. Tables 4 and 5 report regression specifications that allow the widest possible country coverage and therefore exclude some of the listed explanatory variables that are not widely available across our sample. For example, M2 is not available for the Euro-zone countries after 1999. Results using the full set of explanatory variables are available upon request. In order to test whether reserve accumulation is influenced by: (1) previous IMF loan programs (perhaps motivating countries to build reserves in order to avoid dependence on the IMF in the future), and (2) the presence of SWFs (which might act as either a compliment or substitute for official reserves), we also included dummy variables to proxy for these in the regressions. Neither of these variables is statistically significant in either the panel or pooled regressions. Standard errors in the tables are clustered by country when appropriate.

[36] Reserves and a number of the explanatory variables in these regressions are likely to be non-stationary variables, potentially leading to spurious results using OLS; the next version of this draft will report estimates using an error correction approach.

suggests that many emerging market countries actively increased their foreign reserve stocks in the 2007-8 period (when many of the advanced countries were already in crisis) and only began to deplete reserves in late 2008 and 2009. Our data also suggest that many of these countries reverted to their pre-crisis accumulation trends by 2010. The "reserve bounce back" that is apparent in figure 15 is similar to the "GDP bounce-back" documented in Didier, Hevia and Schmukler (2010). Focusing on GDP growth over this period, they find a bounce-back effect in economic activity: countries that suffered greater collapses in the global financial crisis tend to be those that enjoyed larger growth recoveries. We will attempt to relate what we know about country's reserve management strategies to their subsequent GDP growth in the next section.

Figure 15: International Reserve Bounce-back (Decumulation and Recovery)



Source: IFS

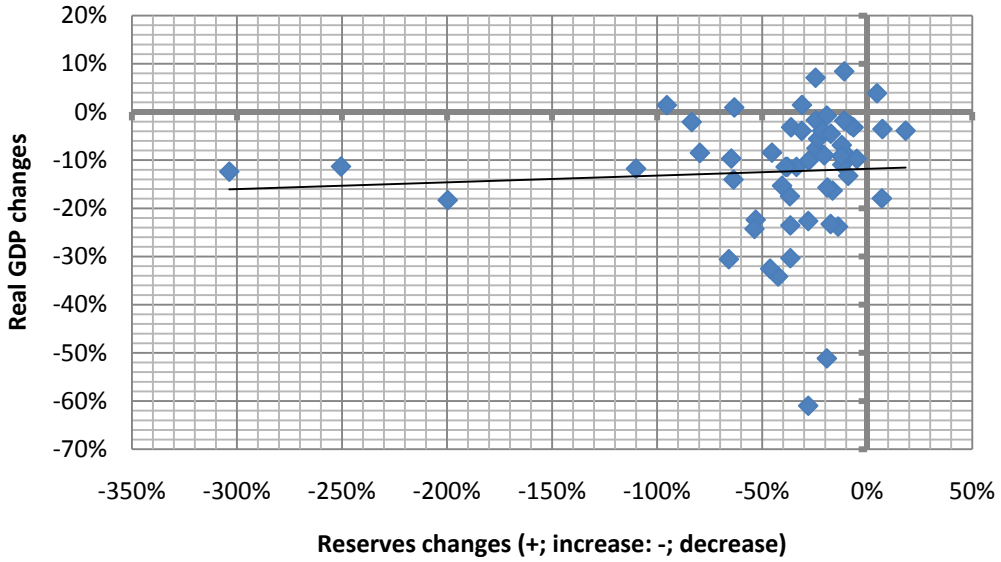
8. Reserves and Economic Performance

Our analysis of reserve accumulation trends prior to the crisis, and the decisions made by countries regarding exchange rate depreciation and reserve depletion, suggest that international reserves were considered a counter-cyclical policy tool, at least in some countries, during the global financial crisis. A close inspection of the data also suggests that the timing of the crisis in

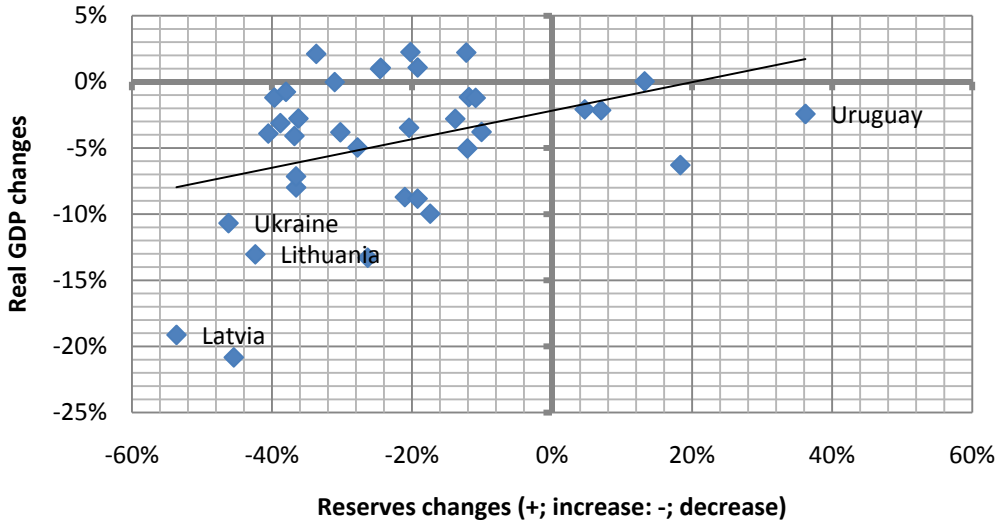
different countries matters in terms of understanding active reserve management patterns. While the global financial crisis may have officially started in late fall of 2007 for the advanced countries (the NBER dates the US recession from December 2007 through June 2009), for many emerging market countries the crisis started much later (these country-specific dates are listed in table 3). The data indicate that emerging market countries were generally continuing to accumulate reserves up to the point at which their own output levels began to decline.

Did these reserve management strategies result in less drastic output declines during the crisis period? A recent study by Llaudes, Salman and Chivakul (2010) finds evidence among the emerging market countries that pre-crisis reserve holdings were associated with a positive (though diminishing at very high levels of reserves) moderating impact on output collapse. We explore this relationship for our larger sample of countries using the relevant country-specific crisis period to measure output declines in Figure 16. The lower panel of the figure includes only the emerging market countries in our sample and finds a stronger (more positive) relationship between changes in reserves and output during the crisis.

Figure 16: International Reserve Changes and Country-Specific Output Declines



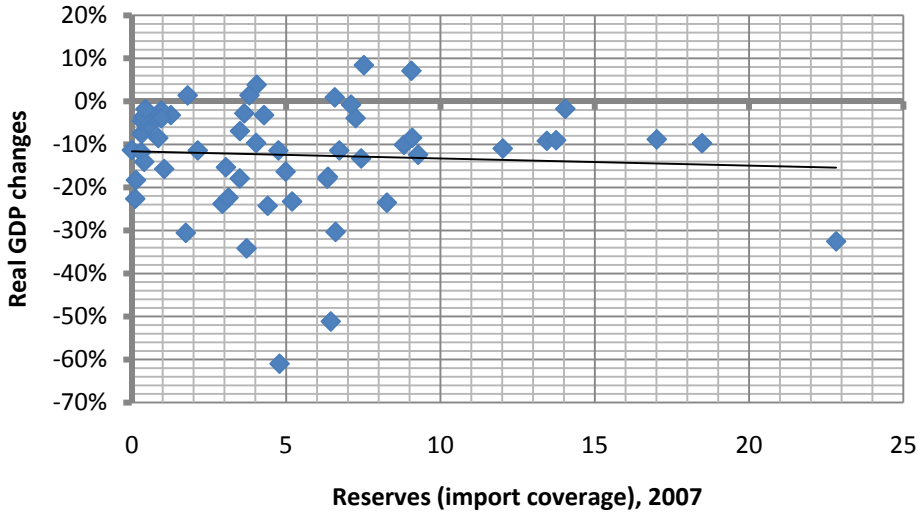
Emerging Market Countries



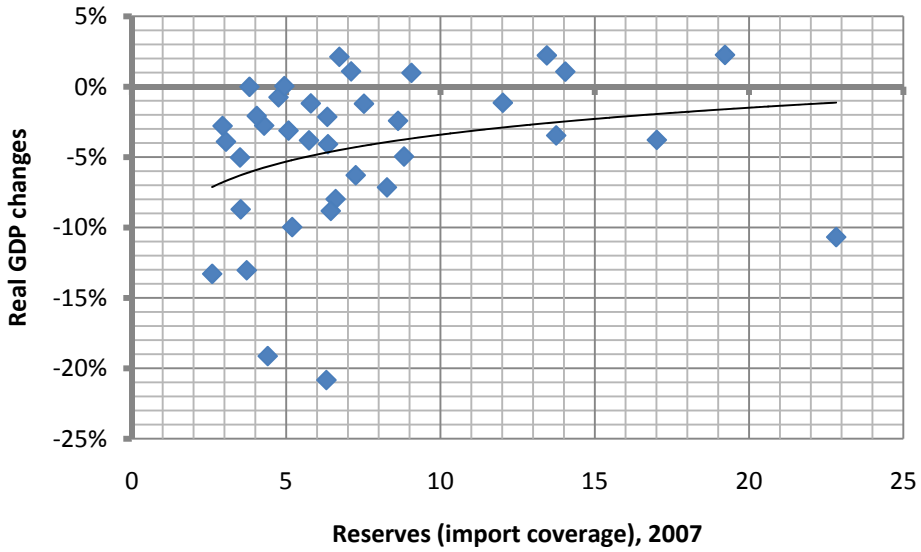
It may be that the counter-cyclical value of reserves should not be measured in absolute terms, but rather relative to a precautionary motive benchmark which reflects "reserve adequacy". The same dollar value of reserves might protect countries differently, depending on specific country characteristics. In figure 17 we examine the relationship between a measure of reserve adequacy (reserves measured against import levels) and output changes during the crisis. In this case, when we include our full sample of countries, the relationship is weakly negative; higher reserve adequacy is negatively associated with output growth. However, when we focus

only on the emerging market economies (the lower panel) we find a non-linear but *positive* relationship, indicating that EM countries with higher reserve adequacy experienced less dramatic output declines.[37]

Figure 17: International Reserve Adequacy and Country-Specific Output Declines



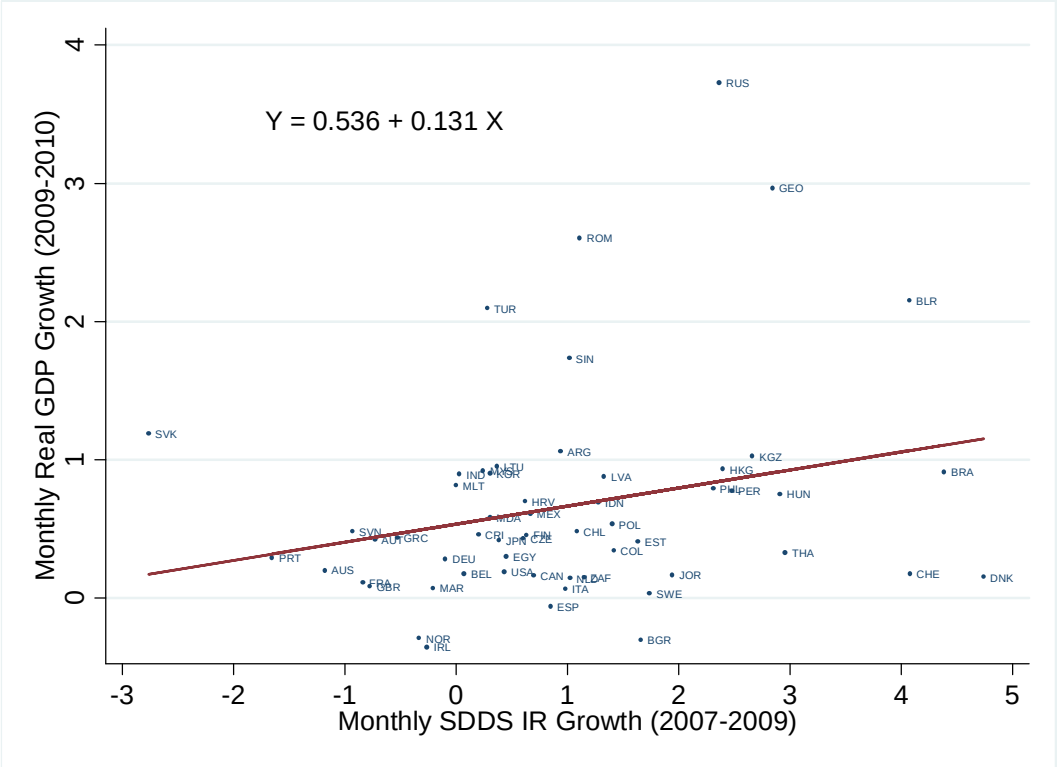
Emerging Market Countries



[37] We also measure "reserve adequacy" using short-term debt and the current account deficit, and find similar patterns to those reported. In order to fully understand what is driving this positive relationship between reserve adequacy and output performance for the emerging market countries in our sample, it will be important to control for cross-country internal conditions. Figure 17 is implicitly assuming that all the included countries are subject to the same exchange market pressure and have the same growth potential. If these assumptions hold, which may be more likely to be the case in the emerging market country sample then we can interpret the graph as indicating that countries with greater reserve adequacy fared better during the global financial crisis.

It is also useful to examine the relationship between foreign reserve management strategies and *post*-crisis economic performance. Did the countries that increased their stocks of reserves during the global financial crisis bounce-back, in terms of GDP growth, faster? Figure 18 indicates that foreign reserve growth during the full crisis period, from 2007 through 2009, is positively associated with post-crisis (2009-10) GDP recovery.

Figure 18: Foreign Reserve Accumulation and Post-Crisis GDP Recovery



The relationship between reserve accumulations and post-crisis output growth is consistent with the reserve bounce-back pattern we found earlier (shown in Figure 15). It suggests that those countries that were able to replenish their reserve accumulations by the end of 2009 were also the countries that experienced the highest GDP bounce-back in 2010. This does not suggest that building reserve stocks leads to higher economic performance, but it does indicate a positive association, at least for this sample of countries in this time period.

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Appendix A: The Evolution of the SDDS guidelines

When Mexico announced its devaluation on December 20, 1994, investors were surprised to realize that Mexican international reserves had not been disclosed in a timely manner.[38] For example, Mexico did not disclose its reserve position in the month (November) prior to the devaluation. The IMF was criticized for its perceived lack of surveillance and responded by increasing its emphasis on transparency and disclosure of international reserves and other data.[39] Quick calculations from trade data and other statistics led investors to the realization that Mexican international reserves were most likely exhausted. Moreover, investors suddenly realized that the Mexican government had large external liabilities in the form of short-term, (de facto) dollar-denominated government bonds (tesobonos).[40] Heavy selling pressure occurred in the two days after the announcement of the devaluation, and the Mexican government was forced to allow the peso to float on December 22, the peso lost half of its pre-devaluation value in a week. It was later argued that if the Mexican government financial information, in particular the international reserves position, had been disclosed in a timely manner, market discipline would have worked: investors would have demanded a higher premium on Mexican bonds much earlier, forcing the Mexican government to take corrective actions. Thus, timely disclosure of foreign exchange data and other macroeconomic information became a focus of reform in the international financial official community.

The IMF described its motivation for the SDDS and GDDS initiatives as follows: "work on standards and codes began in the wake of the 1994–95 international financial crisis, which underscored the role that information deficiencies play in contributing to market turmoil. …financial markets, for example, relied on information that too often was incomplete and out of date and thus could adversely affect resource allocation and the pricing of country risks. In response to these circumstances, the international community asked the IMF—in line with its role in the international financial system—to set standards in the provision of economic and financial statistics to the public. In response to this request, the IMF established the SDDS in 1996 as the first of its core standards" (Alexander (2008; p.7).

When the Asian financial crisis occurred in 1997, proper disclosure of international

[38] IMF (1995; p. 56) states, "… the stock of foreign reserves remained fairly stable until the end of October. In November, selling pressures on the Mexican peso increased again, and foreign exchanges reserves in Mexico declined $4.8. This reduced the stock of reserves to $12.9 billion by the end of November. *The decline in reserves in November was not publicly announced until after the devaluation of the Mexican peso in December*" (emphasis is the authors').

[39] The Mexican team at the IMF had not closely monitored the macroeconomic and capital market situation since their Article IV visit to Mexico City in the spring of 1994.

[40] The tesobonos were peso-denominated short-term government bonds, but the interest rates were linked to the dollar-peso interest rate, making them essentially dollar denominated liabilities to the Mexican government. See IMF (1995; chapter 3).

reserves became an issue for the Asian governments. The issue was not the total amount of international reserves, but their composition and usability. By June 1997, all of the crisis-hit Asian countries—Thailand, Malaysia, Indonesia, and Korea—had subscribed to the SDDS.

When the baht was hit by waves of speculative attacks in the spring of 1997, in particular mid-May 1997, the Bank of Thailand became the counterparty of hedge funds and investment banks in the dollar-baht swap arrangements. By late May the Bank built up huge forward contracts to deliver US dollars in three to six months. Essentially, the Bank of Thailand had exhausted international reserves if the current and future positions were consolidated.

The bank of Thailand became a counterparty to huge speculations against the Thai baht and lost sizable foreign reserves in forward positions, but their statistics (which only provided current positions) showed ample reserves (this reporting was IMF-consistent at the time). On July 2, 1997, the Bank of Thailand floated the exchange rate. The market at that time had yet to realize the extent of the Bank's exposure to forward contracts. After the forward position was revealed in August 1997, at the time of IMF program approval, the market was surprised because the exposure was higher than market estimates. This episode made it clear that the "forward position" of the central bank should be included in the foreign reserve data release. After the crisis the IMF responded by requiring reporting on forward contracts.

The Korean government during November – December 1997 deposited foreign reserves into Korean commercial banks, and Korean commercial banks used them to repay chaebol firms' foreign liabilities. Thus, "usable" reserves were much lower than international reserves in official statistics (then consistent with IMF SDDS). These examples, as well as other Asian country responses to capital outflows with dwindling foreign reserves, are described in detail in Ito (2007a)). Deposits with domestic commercial banks became a source of difficulty in the interpretation of private-and official-sector external transactions and, in case of emerging market countries, a source of suspicion for adequacy of international reserves at the time of crisis.[41]

[41] Japan, along with a number of other countries, holds a portion of its official dollar deposits, which are counted as reserves, in domestic banks. The problem with this is that these deposits are not claims on a foreigner, unless commercial banks hold enough foreign assets themselves. When Japan puts together its BOP accounts it includes the increase in reserves as a financial outflow. At the same time it must remove that same amount from the outflows of its banks. But the banks may use the official dollar deposits to buy, for example, US Treasury bills. So the data show the Japanese official sector increasing dollar deposits and the U.S. thinks it sees the Japanese private sector buying or holding T-bills, while the Japanese BOP show a reduction in the private bank claims on the U.S.

Table 1: Selected Sovereign Wealth Funds[1]

Country Fund Name	SDDS/GDDS Country	Data in BOP/IIP as of 2007	Data in BOP/IIP as of 2010
Oil and Gas Exporting Countries			
Azerbaijan State Oil Fund	GDDS	Yes	Yes
Brunei Brunei Investment Authority	GDDS	No BOP/IIP dissemination	BOP dissemination SWF coverage unclear
Iran Foreign Exchange Reserve Fund	Neither	No BOP/IIP dissemination	No BOP/IIP dissemination
Kazakhstan National Fund	SDDS	Yes	Yes
Kuwait Kuwait Investment Authority	GDDS	SWF not included in IIP to STA Flows in Balance of Payments	No major change
Malaysia Khazanah Nasional BHD	SDDS	Only flows in Balance of Payments/No functional breakdown in IIP	No major change
Norway Norwegian Government Pension Fund - Global	SDDS	Yes	Yes
Oman State General Reserve Fund	GDDS	Yes, in reserves, flows only	Yes in reserves transactions, no IIP dissemination
Qatar Qatar Investment Authority	GDDS	No BOP/IIP dissemination	No BOP/IIP dissemination
Russia Oil Stabilization Fund	SDDS	Yes in reserves	Yes in reserves
Saudi Arabia Hassana Investment Co	GDDS	No IIP dissemination Flows in the balance of payments	SWF recently constituted .Unclear coverage in BOP
Trinidad and Tobago Reserve Stabilization Fund	GDDS	No	No Major Change
UAE Abu Dhabi Investment Authority	GDDS	No BOP/IIP dissemination	Included in BOP, however not broken down
Venezuela FIEM	GDDS	Yes	Yes
Other Countries			
Australia Australia Future Fund	SDDS	Not disclosed	Not clear if disclosed in BPM6
Botswana Pula Fund	GDDS	Yes, in reserve flows/no IIP production	IIP production, probably also included
Chile Economic and Social Stabilization Fund Pension Reserve Fund	SDDS	Yes	Yes
China China Investment Corporation	GDDS	Established in September 2007	SWF coverage unclear
Kiribati Revenue Equalization Fund	GDDS	No BOP/IIP dissemination	No BOP/IIP dissemination
Korea Korea Investment Corporation	SDDS	Yes in reserves	Yes in reserves
Singapore Government Investment Corporation Temasek	SDDS	Yes, but no functional category breakdown	No major change

[1] This table is based on publicly available information.

Table 2: Swap Lines

This table provides the initial swap lines provided by the U.S. Federal Reserve (billion USD), the European Central Bank (billion Euro), and the People Bank of China (billion yuan).

Country	FED_USD	ECB_EURO	PBC_CNY
Argentina			70
Australia	30		
Brazil	30		
Belarus			20
Canada	30		
Denmark	15	15	
ECB	240		
Hong Kong			200
Hungary		5	
Iceland		1.5	
Indonesia			100
Japan	120		
Korea	30		180
Mexico	30		
Malaysia			80
Norway	15		
New Zealand	15		
Poland		10	
Sweden	30		
Singapore	30		
Switzerland	60		
United Kingdom	80		

From Aizenman et al (2011), pp. 11.

Table 3: Data Sources and Coverage

SDDS Subscription Information

Country	Date of Subscription	Date Metadata were Posted on the DSBB	Date when subscriber met SDDS specifications
Argentina	16-Aug-96	19-Sep-96	1-Nov-99
Armenia	7-Nov-03	7-Nov-03	7-Nov-03
Australia	19-Apr-96	30-Sep-98	23-Jul-01
Austria	4-Sep-96	11-Jul-97	5-Jul-01
Belarus	22-Dec-04	22-Dec-04	22-Dec-04
Belgium	6-Jun-96	24-Apr-97	26-Jan-01
Brazil	14-Mar-01	14-Mar-01	14-Mar-01
Bulgaria	1-Dec-03	1-Dec-03	1-Dec-03
Canada	20-Apr-96	19-Sep-96	19-Feb-99
Chile	17-May-96	19-Feb-97	30-Mar-00
Colombia	31-May-96	25-Apr-97	9-May-00
Costa Rica	28-Nov-01	28-Nov-01	28-Nov-01
Croatia	20-May-96	26-Sep-96	30-Mar-01
Cyprus	1-Dec-09	1-Dec-09	1-Dec-09
Czech Republic	21-Apr-98	1-Oct-98	4-Jun-99
Denmark	7-Jun-96	19-Sep-96	1-Sep-00
Ecuador	27-Mar-98	14-Sep-98	14-Jul-00
Egypt	31-Jan-05	31-Jan-05	31-Jan-05
El Salvador	5-Jun-98	21-Dec-98	12-Oct-99
Estonia	30-Sep-98	27-Jan-99	30-Mar-00
Finland	3-Jun-96	19-Sep-96	2-Jun-00
France	8-Aug-96	27-Sep-96	27-Apr-01
Georgia	17-May-10	17-May-10	17-May-10
Germany	2-Dec-96	12-Sep-97	23-Mar-00
Greece	8-Nov-02	8-Nov-02	8-Nov-02
Hong Kong, SAR, PRC	28-Oct-96	23-Apr-97	12-Jul-00
Hungary	24-May-96	25-Apr-97	24-Jan-00
Iceland	21-Jun-96	16-Apr-98	30-Jun-04
India	27-Dec-96	30-Oct-97	14-Dec-01
Indonesia	24-Sep-96	21-May-97	2-Jun-00
Ireland	26-Jul-96	19-Sep-96	17-Jul-01
Israel	23-Apr-96	4-Dec-96	5-Jun-00
Italy	13-Aug-96	19-Sep-96	14-Apr-00
Japan	3-Jul-96	5-Nov-96	9-Jun-00
Jordan	28-Jan-10	28-Jan-10	28-Jan-10
Kazakhstan	24-Mar-03	24-Mar-03	24-Mar-03

Korea	20-Sep-96	30-Mar-98	1-Nov-99
Kyrgyz Republic	26-Feb-04	26-Feb-04	26-Feb-04
Latvia	1-Nov-96	18-Dec-97	28-Sep-99
Lithuania	30-May-96	7-Apr-97	12-Jul-99
Luxembourg	12-May-06	12-May-06	12-May-06
Malaysia	21-Aug-96	19-Sep-96	1-Sep-00
Malta	1-Dec-09	1-Dec-09	1-Dec-09
Mexico	13-Aug-96	19-Sep-96	29-Jun-00
Moldova, Republic of	2-May-06	2-May-06	2-May-06
Morocco	15-Dec-05	15-Dec-05	15-Dec-05
Netherlands	11-Jun-96	19-Sep-96	26-Apr-00
Norway	18-Jun-96	19-Sep-96	28-Apr-00
Peru	7-Aug-96	19-Sep-96	15-Jul-99
Philippines	5-Aug-96	19-Sep-96	17-Jan-01
Poland	17-Apr-96	2-Oct-96	2-Mar-00
Portugal	11-Sep-97	5-Oct-98	1-Dec-00
Romania	4-May-05	4-May-05	4-May-05
Russian Federation	31-Jan-05	31-Jan-05	31-Jan-05
Singapore	1-Aug-96	19-Sep-96	30-Jan-01
Slovak Republic	10-Sep-96	5-Oct-98	7-Oct-99
Slovenia	2-Aug-96	19-Sep-96	7-Jul-00
South Africa	2-Aug-96	27-Sep-96	18-Sep-00
Spain	27-Sep-96	6-Apr-98	21-Dec-00
Sweden	31-May-96	27-Sep-96	29-Jun-00
Switzerland	11-Jun-96	19-Sep-96	18-May-01
Thailand	9-Aug-96	19-Sep-96	16-May-00
Tunisia	20-Jun-01	20-Jun-01	20-Jun-01
Turkey	8-Aug-96	2-Oct-96	20-Jul-01
Ukraine	10-Jan-03	10-Jan-03	10-Jan-03
United Kingdom	16-Apr-96	19-Sep-96	6-Jul-99
United States	6-May-96	6-Oct-96	19-Feb-99
Uruguay	12-Feb-04	12-Feb-04	12-Feb-04

Total number of SDDS subscribers: 68 (May 17, 2011)

Country-Specific Crisis Periods

Country Abv	Country Name	Crisis Start Date	Crisis End Date
ARG	Argentina	1-Jun-08	1-Mar-09
ARM	Armenia		
AUS	Australia	1-Sep-08	1-Mar-09
AUT	Austria	1-Dec-07	1-Mar-09
BLR	Belarus	1-Sep-08	1-Mar-09
BEL	Belgium	1-Jun-08	1-Mar-09
BRA	Brazil	1-Sep-08	1-Mar-09
BGR	Bulgaria	1-Sep-08	1-Mar-09
CAN	Canada	1-Dec-07	1-Jun-09
CHL	Chile	1-Jun-08	1-Sep-09
HKG	Hongkong	1-Dec-07	1-Mar-09
COL	Colombia	1-Dec-07	1-Mar-09
CRI	Costa_Rica	1-Mar-08	1-Mar-09
HRV	Croatia	1-Sep-08	1-Mar-09
CYP	Cyprus	1-Jun-08	1-Mar-09
CZE	Czech_Republic	1-Jun-08	1-Mar-09
DNK	Denmark	1-Dec-07	1-Mar-09
EGY	Egypt	1-Mar-09	1-Jun-09
SLV	El_Salvador		
EST	Estonia	1-Dec-07	1-Mar-09
FIN	Finland	1-Dec-07	1-Mar-09
FRA	France	1-Mar-08	1-Mar-09
GEO	Georgia	1-Dec-07	1-Mar-09
DEU	Germany	1-Mar-08	1-Mar-09
GRC	Greece	1-Sep-08	1-Mar-09
HUN	Hungary	1-Dec-07	1-Mar-09
IND	India	1-Dec-08	1-Mar-09
IDN	Indonesia	1-Sep-08	1-Mar-09
IRL	Ireland	1-Dec-07	1-Dec-09
ISR	Israel		
ITA	Italy	1-Mar-08	1-Jun-09
JPN	Japan	1-Mar-08	1-Mar-09
JOR	Jordan	1-Sep-08	1-Mar-09
KAZ	Kazakhstan		
KOR	Korea	1-Dec-07	1-Mar-09
KGZ	Kyrgyz_Republic	1-Sep-08	1-Mar-09
LVA	Latvia	1-Dec-07	1-Mar-09
LTU	Lithuania	1-Sep-08	1-Mar-09
LUX	Luxembourg		

MYS	Malaysia	1-Sep-08	1-Mar-09
MLT	Malta	1-Sep-08	1-Mar-09
MEX	Mexico	1-Dec-07	1-Mar-09
MOL	Moldova		
MDA	Morocco	1-Mar-09	1-Mar-09
MAR	Netherlands	1-Mar-08	1-Jun-09
NLD	New Zealand	1-Dec-07	1-Mar-09
NOR	Norway	1-Dec-07	1-Jun-09
PER	Peru	1-Jun-08	1-Mar-09
PHL	Philippines	1-Dec-08	1-Mar-09
POL	Poland	1-Dec-08	1-Mar-09
PRT	Portugal	1-Dec-07	1-Mar-09
ROM	Romania	1-Dec-08	1-Mar-09
RUS	Russia	1-Sep-08	1-Mar-09
SIN	Singapore	1-Sep-08	1-Mar-09
SVK	Slovak, Republic	1-Sep-08	1-Mar-09
SVN	Slovenia	1-Jun-08	1-Mar-09
ZAF	South Africa	1-Sep-08	1-Jun-09
ESP	Spain	1-Mar-08	1-Dec-09
SWE	Sweden	1-Dec-07	1-Sep-09
CHE	Switzerland	1-Jun-08	1-Jun-09
THA	Thailand	1-Mar-08	1-Jun-09
TUN	Tunisia	1-Dec-07	
TUR	Turkey	1-Sep-08	1-Mar-09
UKR	Ukraine		
GBR	United Kingdom	1-Mar-08	1-Sep-09
USA	United States	1-Dec-07	1-Jun-09
URU	Uruguay		

Data Used in Cross-Country Panel Regressions

Variable	Description	Frequency	Source
SDDS_IR	SDDS International Reserves	Monthly	IMF SDDS database
SDDS_FR	SDDS Foreign Reserves (Securities + Deposits only)	Monthly	IMF SDDS database
IFS_IR	IFS International Reserves (minus gold)	Monthly	IFS
gdp_weo	Annual GDP (current prices)	Annual	World Economic Outlook (WEO)
xvolatile	Standard Deviation of Monthly Export Growth over 1 year	Annual	Annual variable from Aizenman & Sun
exstdev	Standard Deviation of Monthly Exchange Rate Growth over 1 year	Annual	Annual variable from Aizenman & Sun
mkt_rate	Market Interest Rate	Monthly	IFS For EU countries after joining EU, EU market Rate from IFS For Taiwan, Central Bank of Taiwan
m2_gdp	M2(national currency) /Annual WEO GDP(national currency)	Monthly	IFS For Taiwan, Central Bank of Taiwan
ca_gdp	Currency Account(US Dollar)/Annual WEO GDP(US Dollar)	Quarterly	IFS For Taiwan, Central Bank of Taiwan
stdebt_total_gdp	[(Liabilities + Securities)/Annual WEO GDP]*100	Quarterly	WB and WEO
oilexgdp	Net Oil Export/Annual WEO GDP	Annual	EIA
prim2export	Primary Export/Total Export	Annual	Primary Export includes products in SITC 0, 1, 2, 3, 4 and 68 categories. Annual variable from Aizenman & Sun
topen	(Export as percent of GDP + Import as percent of GDP)/100	Annual	BOP
Kapoen	Chinn and Ito Index (2008)	Annual	Chinn and Ito

Table 4: Determinants of Reserve Accumulation (Annual Observations)

	Pooled Regression				Panel Regression			
VARIABLES	(1) ln(SDDS FR)	(2) ln(SDDS IR)	(3) ln(IFS IR minus gold)	(4) Active Management	(5) ln(SDDS FR)	(6) ln(SDDS IR)	(7) ln (IFS IR minus gold)	(8) Active Management
GDP	0.000446***	0.000488***	0.000401***	0.836	0.000191*	0.000194	3.19e-05	1.832
	(9.64e-05)	(9.85e-05)	(6.49e-05)	(0.709)	(0.000112)	(0.000159)	(0.000147)	(1.477)
Export+Import/GDP	0.573**	0.448*	0.0324	-1,448	1.021*	0.982*	0.790***	92.61
	(0.225)	(0.228)	(0.103)	(945.8)	(0.578)	(0.565)	(0.298)	(3,936)
Primary Export/Export	0.000442***	0.000426***	0.00038***	1.150***	-0.000162*	-0.000151*	-7.38e-05***	-4.378***
	(3.63e-05)	(3.44e-05)	(6.24e-05)	(0.314)	(8.43e-05)	(8.24e-05)	(1.43e-05)	(0.716)
SD of Export Growth	-0.0161	0.00490	-0.0433***	-41.10	0.0176	0.0196	0.000190	-63.90
	(0.0200)	(0.0203)	(0.0115)	(68.04)	(0.0280)	(0.0278)	(0.00180)	(201.4)
Kapoen	-0.270***	-0.226**	0.0108	-432.3	0.202**	0.187**	0.145*	426.4
	(0.0986)	(0.1000)	(0.0389)	(459.8)	(0.0819)	(0.0712)	(0.0795)	(735.1)
SD of Exchange Growth	0.217	0.219	0.0627**	-140.8	-0.00318	-0.0166	-0.0268***	-251.0
	(0.136)	(0.139)	(0.0248)	(355.8)	(0.0195)	(0.0167)	(0.00924)	(211.2)
Total Debt/GDP	-0.00118	0.00201	0.000200	-45.14*	-0.00888	-0.00550	0.00352	-13.38
	(0.00421)	(0.00446)	(0.00216)	(25.45)	(0.00803)	(0.00726)	(0.00424)	(27.16)
Current Account/GDP	9.515***	9.609***	8.390***	32,212**	-0.0609	0.134	-0.107	4,241
	(1.226)	(1.230)	(0.933)	(12,867)	(3.371)	(3.249)	(0.744)	(11,419)
Mkt Interest Rate	0.00411	0.00302	-0.00530	-55.41*	-0.00351*	-0.00371*	-0.0111***	-63.66***
	(0.00414)	(0.00433)	(0.00423)	(29.81)	(0.00201)	(0.00204)	(0.00231)	(10.71)
Constant	22.39***	22.37***	22.78***	5,689***	21.87***	22.12***	21.67***	2,177
	(0.562)	(0.572)	(0.190)	(2,111)	(0.816)	(0.811)	(0.302)	(4,822)
Observations	310	310	620	307	310	310	620	307
R-squared	0.243	0.241	0.408	0.058	0.038	0.037	0.207	0.007
Number of Countries	52	52	51	51	52	52	71	51

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Determinants of Reserve Accumulation (Quarterly Observations)

	Pooled Regression				Panel Regression			
VARIABLES	(1) ln(SDDS FR)	(2) ln(SDDS IR)	(3) ln(IFS IR minus gold)	(4) Active Management	(5) ln(SDDS FR)	(6) ln(SDDS IR	(7) ln(IFS IR minus gold)	(8) Active Management
GDP	0.000323***	0.000373***	0.000387***	0.254	0.000203*	0.000235	0.000113	0.638
	(3.42e-05)	(3.56e-05)	(3.14e-05)	(0.181)	(0.000117)	(0.000166)	(0.000157)	(0.443)
Export Growth	-0.00408	-0.00167	-0.00733***	8.584	0.00205	0.00216*	0.000246	1.410
	(0.00462)	(0.00468)	(0.00230)	(8.450)	(0.00131)	(0.00123)	(0.000788)	(3.743)
Exchange Rate Growth	-0.000350	-0.00560	0.00670	-98.00	-0.00227	-0.00326	-0.00446	-140.6
	(0.00948)	(0.00910)	(0.00806)	(62.93)	(0.00319)	(0.00234)	(0.00373)	(110.1)
Total Debt/GDP	-0.00589***	-0.00421***	-0.00731***	-8.437***	-0.00673	-0.00388	-0.00196	6.957
	(0.00124)	(0.00150)	(0.000296)	(3.196)	(0.00813)	(0.00748)	(0.00153)	(6.921)
Current Account/GDP	37.79***	36.18***	37.19***	22,936***	0.665	0.338	-1.978	6,097
	(2.084)	(1.962)	(1.630)	(7,362)	(4.296)	(4.101)	(1.756)	(6,616)
Mkt Interest Rate	0.0176***	0.0142***	-0.0105***	-13.50	-0.00841***	-0.00863***	-0.0166***	-26.38***
	(0.00586)	(0.00500)	(0.00319)	(8.765)	(0.00287)	(0.00311)	(0.00331)	(7.583)
Constant	23.02***	23.22***	22.80***	586.8***	23.26***	23.44***	22.74***	-8.438
	(0.101)	(0.103)	(0.0443)	(143.1)	(0.202)	(0.197)	(0.0931)	(379.0)
Observations	1,160	1,160	1,999	1,149	1,160	1,160	1,999	1,149
R-squared	0.163	0.171	0.386	0.018	0.011	0.011	0.137	0.009
Number of Countries	52	52	65	51	52	52	65	51

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1