INTERNATIONAL RESERVES AND THE GLOBAL FINANCIAL CRISIS

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ABSTRACT

This study examines whether pre-crisis international reserve accumulations, as well as exchange rate and reserve policy decisions made during the global financial crisis, can help to explain cross-country differences in post-crisis economic performance. Our approach focuses not only on the total stock of official reserves held by countries, but also on the decisions by governments to purchase or sell reserve assets during the crisis period. We introduce new data made available through the IMF Special Data Dissemination Standard (SDDS) Reserve Template, which allow us to distinguish interest income and valuation changes in the stock of official reserves from the actively managed component of reserves. We use this novel data to gauge how (and whether) reserve accumulation policies influenced the economic and financial performance of countries during and after the global crisis. Our findings support the'view that higher reserve accumulations prior to the crisis are associated with higher post-crisis GDP'growth.

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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. After the Lehman Brother's collapse in September 2008, 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/or draw down their foreign currency reserves. The governments of countries with exceptionally large banking sectors took over their liquidity-strapped banks, converting private sector debts to public sector debts. Some countries were hit more strongly by the crisis (especially in Central and Eastern Europe) while others, at least initially, appeared more shielded. Many of these emerging market countries had accumulated impressive stocks of international reserves prior to the global crisis. Our study aims to understand whether these pre-crisis international reserve accumulations, as well as exchange rate and reserve policy decisions made during the crisis, can help to 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.

Our analysis reexamines the findings and interpretations in the literature about the role of reserves during crises. First, we argue that the decision by governments not to deplete reserves during the crisis does not necessarily 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 require drawing down reserves, and which would have otherwise occurred. Reserves in this context may be analogous to the lender of last resort facilities in central banks. Second, our graphical analysis of country-by-country reserve changes suggests that one has to be careful in defining the timing of crises, which are likely to differ across countries. The range of currency and reserve defense strategies used by countries is lost in

the regressions reported in the current literature which generally use the same crisis timing for all countries.

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 non-linearly and dramatically. Further, the widely differing 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 reserve depletion. 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. Korean officials were also concerned about their losses due to the unwinding of currency hedges for cancelled export orders. 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 not only on the total stock of official reserves held by countries, but also on the decisions by governments to purchase or sell reserve assets during the crisis period. We introduce new data made available through the IMF Special Data Dissemination Standard (SDDS) Reserve Template, which allow us to distinguish interest income and valuation changes in the stock of official reserves from the actively managed component of reserves. We use this novel data to gauge how (and whether) reserve accumulation policies 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 a country with fixed exchange rates, international reserves are a necessary buffer to maintain the regime. However, in this view of reserves, 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 monetary authorities acquire international reserves they typically sterilize the effect of these purchases on the domestic monetary base by incurring domestic-currency liabilities (often

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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. If the interest rate of the reserve assets is lower than the domestic interest rate, holding reserves incurs quasi-fiscal costs. 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] Countries with domestic interest rates that are lower than the interest rate on reserve assets (e.g., Japan) benefit from net interest income on reserves; in this case reserve accumulation can be regarded as a form of public carry-trade. Holding reserves also exposes the country to currency risk. If the domestic currency appreciates vis-à-vis the currencies denominating the reserve assets, the domestic currency value of reserves drops. These valuation risks can, at least in theory, be mitigated if the reserve assets are diversified.

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 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 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 include 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.]

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

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[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.

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

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 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 with trade-openness, oil export share and commodity export ratios). They suggest that these countries were less wary of depleting reserves when export markets collapsed, while most other countries 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

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[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.

[5] In the context of the mercantilist versus precautionary motives, we should expect a mercantilist country to 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.

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 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 term "international reserves" is not used consistently in the literature. The assets held by governments for reserve purposes are interchangeably called "foreign reserves," "official reserves," or "international reserves;" even government publications often use different labels to describe the same category of assets. In this paper we use the reserve category names defined in the IMF's Special Data Dissemination Standard (SDDS) Reserve template.

Total official reserves (IR) are the broadest definition of international reserves. This concept consists of foreign currency reserves (Forex), and non-currency reserves, which include monetary gold (Gold), Special Drawing Rights (SDRs), the reserve position at the International Monetary Fund (IMF) and other reserve assets (Other). Foreign currency reserves (Forex), in turn, consist of financial assets, which include securities (SEC) and currencies and deposits (DEPO). In equations:

(3.1) $\text{IR} = \text{Forex} + \text{Gold} + \text{SDR} + \text{IMF} + \text{Other}$

(3.2) $\text{Forex} = \text{SEC} + \text{DEPO}$

The securities (SEC) and currencies and deposits (DEPO) component of official reserves reflect foreign reserve policy actions, including interventions and reserve portfolio management (involving shifts between currency denomination and asset maturities). The details of foreign reserve policy actions reflected in changes in Forex will be the subject of our analysis in the next section. Other reserve assets (Other) consist of financial derivatives, loans to nonbank nonresidents and others, which generally make up a very small share of official reserves.

Most researchers use the "international reserves minus gold" variable available from the International Financial Statistics (IFS_IR) to examine cross-country reserve behavior because

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[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.

this data it is available for a wide sample of countries over a long time series. But IFS_IR includes SDRs, IMF reserves, and other components of official reserves which may not be relevant to foreign reserve policy, particularly to the self-insurance motive for reserve accumulation. Cross-country data are also available for Gold, SDRs, IMF reserves, and Other, so that it is possible to measure each component in equation (3.1). The one reserve component that is not available is the breakdown of SEC and DEPO in Forex. In this study we therefore focus on a new source of data provided through the SDDS in the Reserve Template which provides data on all these categories of reserves, including the breakdown of SEC and DEPO.

While the definition of official reserves seems straight forward, the details regarding what assets should be included or excluded has evolved over time. Conceptually international 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

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[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).

perceived problems with international reserve measurement as well as the reliability of other key macroeconomic variables, the IMF launched the SDDS in 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.

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[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.

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 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 IMF (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.

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[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.

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 are regarded as emerging market economies, rather than advanced countries. The arrangement allowed Mexico and Korea to temporarily replenish their foreign reserve stocks. 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 (which include 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. The details of the Federal Reserve swap lines and their usage are summarized in Table 2. Not all central banks used the established swap lines.

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

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[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))

1979-81, and in 2009.[22] The most recent allocation was made to help mitigate the effects of the 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 specific components of international reserves: Figure 1a shows the 2009 SDR allocation for the U.S. Reserve Template and Figure 1b shows the impact of IMF loans in 2008 and 2009 for the Iceland Reserve Template.

Figure 1a: United States International Reserve Assets, 2008-10
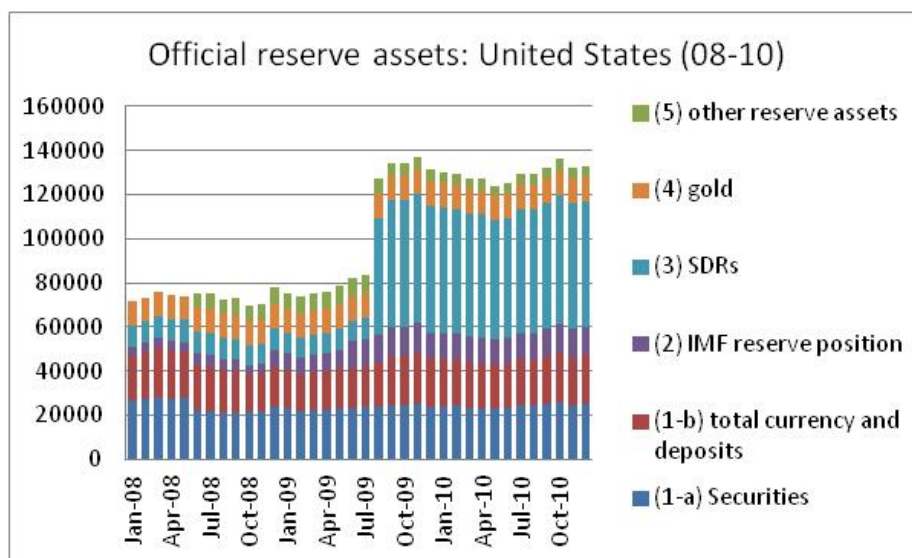
Figure 1b: Iceland International Reserve Assets, 2008-10
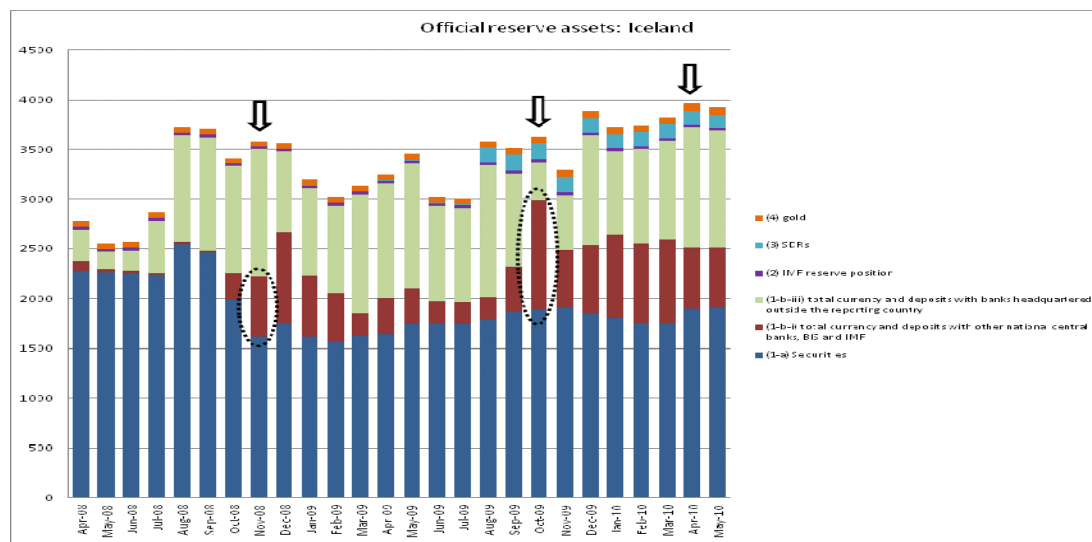
Source: IFS, arrows in Figure1b show where IMF loans appear in the reserve data.

4. Alternative Measures of Reserve Changes

Worldwide international reserves rose dramatically in the five years prior to the onset of the global financial crisis. Figure 2 indicates that rapid reserve accumulation was 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 holding countries are China, Japan, Saudi Arabia, and Russia.

Figure 2: World International Reserves (USD million)

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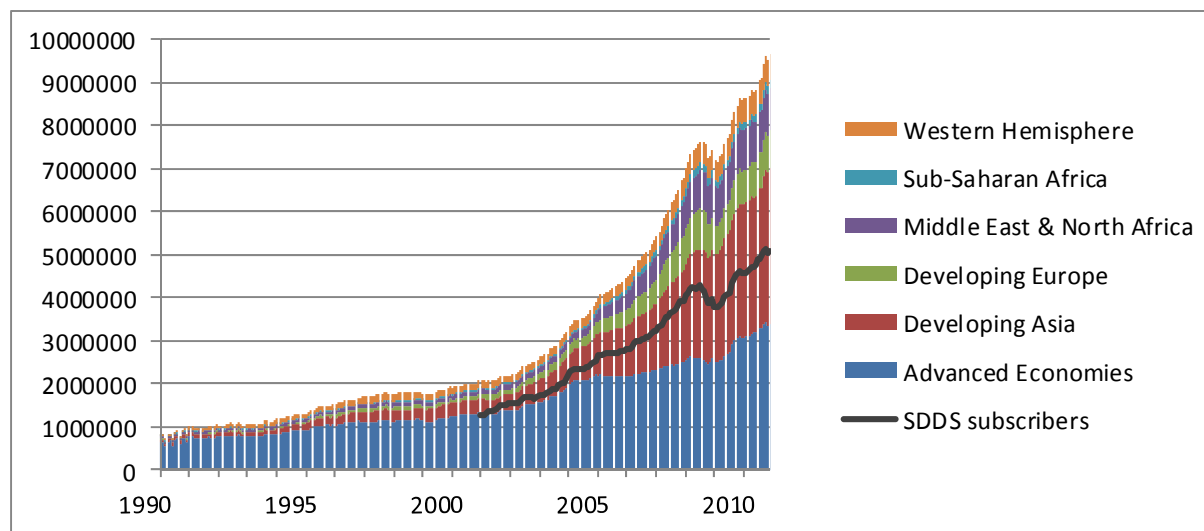
4.1. Active management

Official stocks of reserves change for three main reasons: (1) due to purchases or sales of foreign currency reserve assets, (2) due to the receipt of interest income on existing assets, (3) due to valuation changes in existing assets. Recall from equation (3.1) that Official Reserve Assets (IR) are composed of foreign currency reserves (Forex); the reserve position in the IMF (this is the "reserve tranche", the foreign currency amounts that a member country can draw from the IMF on short notice); SDRs; monetary Gold, and Other reserve assets. Foreign currency reserves, Forex, is further divided into securities (SEC) and currency and deposits (DEPO).

(3.1) IR= Forex + Gold + SDR + Gold + IMF + Other

      = (SEC + DEPO) + Gold + SDR + Gold + IMF + Other

The change in official reserve assets from period t to $t+1$, $\triangle$IR, is the sum of the changes in outstanding balances of each of its components:

(4.1) $\triangle$IR = r^s*SEC + r^d*DEPO + $\triangle$SEC + $\triangle$DEPO + $\triangle$Gold + $\triangle$SDR + $\triangle$IMF + $\triangle$Other

where r^s is the interest rate on securities and r^d is the interest rate on deposits. Define the sum of changes in Gold, SDRs, IMF reserves, and Other, as Non-Currency Reserves (NonCR). Then,

(4.2)   IR = SEC + DEPO + NonCR.   And,

(4.3) $\triangle$IR = r^s*SEC + r^d*DEPO + $\triangle$SEC + $\triangle$DEPO + $\triangle$NonCR

The $\triangle$SEC + $\triangle$DEPO from period t to $t+1$ are the sum of the purchases and sales ($\triangle^{PS}$) of reserve assets and valuation changes ($\triangle^{val}$). We define the valuation changes as the *passive* component of foreign currency reserve management, while purchases and sales are the *active* component. These transactions involve "active management" because they are made at the discretion of authorities; they may be made for investment purposes, or for the purpose of influencing exchange rates, otherwise known as foreign exchange market interventions. In equations:

(4.4) $\triangle$IR = r^s*SEC + r^d*DEPO + $\triangle$SEC + $\triangle$DEPO + $\triangle$NonCR

$\quad$ = r^s*SEC + r^d*DEPO + $\triangle^{ps}$SEC + $\triangle^{ps}$DEPO + $\triangle^{val}$SEC + $\triangle^{val}$DEPO + $\triangle$NonCR

$\quad\quad\quad$ Interest income $\quad\quad$ active management $\quad$ passive management

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ (including intervention) $\quad$ (=valuation changes)

Few countries disclose their foreign exchange intervention operations, so researchers often use changes in official reserves, $\triangle$IR, as a proxy for interventions. However, as equation (4.4) shows, $\triangle$IR includes components that have nothing to do with intervention (or active management). In particular, $\triangle$IR will be a poor proxy for intervention when interest income or valuation changes are large. ($\triangle$NonCR does not change frequently and available data allow these changes to be easily stripped from IR.) The conceptual problem inherent in using $\triangle$IR as a proxy for interventions is due to the nondisclosure of the composition of foreign currency reserves (Forex). Ideally, researchers would like data on the types of securities (by currency; by maturity; by risk-class), and types of deposits (by currency; by type of financial institution taking deposits, domestic or foreign) held in Forex, in order to analyze portfolio management of foreign currency reserves and intervention policy. However, in most countries this kind of detailed information is kept secret.

The SDDS Reserve Template, which requires reporting countries to break down Forex into SEC and DEPO, goes some way toward allowing researchers to estimate interest income. Unfortunately, details such as the currency composition of foreign currency reserves are not provided in the Reserve Template. The method we use to estimate interest income is explained in detail in section 5.

4.2. Balance of Payments

An alternative approach to isolating the purchases and sales of foreign currency assets is to use "flow variables." The Balance of Payments (BOP) data set is a collection of such flow variables. The BOP is an accounting record of all monetary transactions between a country and the rest of the world. There are two potential ways to back out the "active management" component of IR using the BOP statistics. First, using the Current Account, Capital Account, and Financial Account data, foreign reserves changes can be inferred. In theory, for each country, when all components of the BOP account are included, the sum should be zero with no overall surplus or deficit. Specifically, the BOP identity is as follows:

(4.5) $\quad$ Current Account (CA) + Capital Account (KA) + Financial Account (FA)

$\quad\quad\quad$ + net errors and omissions + Net foreign reserves changes (NFR) = 0.

13

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

(4.6)   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 reserve position in the IMF, 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. The biggest problem for this approach is that CA and (KA+FA) come from different statistical inferences and aggregations, and hence, net errors and omissions are huge. Conceptually, NFR roughly corresponds to the change in IFS_IR, but it is far from the concept of active management of foreign currency reserves.

Figure 3: BOP Current/Financial Accounts and Net Foreign Reserves
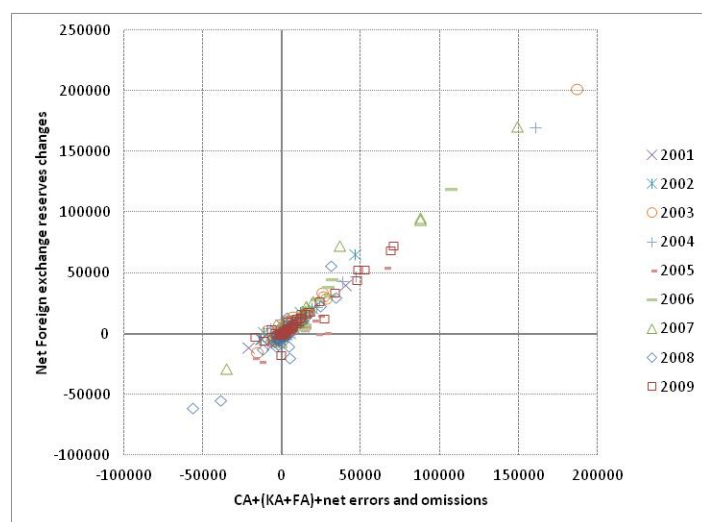
Source: IFS

A second approach to measuring "active management" involves using the Reserve and Related items category of the BOP. (Hereafter, we will refer to Reserve and Related items as the "BOPline"). The BOPline records the market valued purchases and sales of reserve assets. These data come directly from the balance sheet of the authorities. The BOPline is supposed to

represent the real transactions (at market value) because these data are compiled by authorities based on their transaction records. The BOPline also includes transactions of gold, SDRs, the reserve position in the IMF, and other assets.

Using the notation of the $\triangle$IR equation, the BOPline can be expressed as follows:

(4.7) BOPline = r^s*SEC + r^d*DEPO + $\triangle^{ps}$SEC + $\triangle^{ps}$DEPO + $\triangle$NonCR

$$\underbrace{}_{\text{Interest income}} \quad \underbrace{\phantom{\triangle^{ps}SEC + \triangle^{ps}DEPO}}_{\substack{\text{active management} \\ \text{(=part of intervention)}}}$$

If we subtract the BOPline from changes in official reserves, $\triangle$IR, we can isolate valuation changes in foreign currency reserves. (Note that the actual entry of the BOPline has the opposite sign to $\triangle$IR, so that to derive the difference, the two series have to be added.)

(4.8) $\triangle$IR – BOPline = $\triangle^{val}$SEC + $\triangle^{val}$DEP

Unfortunately the BOPline also includes interest income and changes in NonCR (the transactions involving gold, reserves at the IMF, SDRs, and other assets). As a consequence, the BOPline is not a good proxy for interventions, as it includes interest income (which can be substantial for countries with large stocks of reserves). Or, put another way, using the BOPline to proxy for "active management" is only a minor improvement over the change in official reserves, $\triangle$IR.

5. Active versus Passive Reserve Accumulation

While all SDDS compliant countries report detailed, marked-to-market,[23] and timely international reserve data at end-of-month values, they (unfortunately) do not provide information about whether changes in reserves from the preceding month are due to *passive*

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[23] 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)."

valuation changes in the underlying assets held, or *actively managed* purchases or sales of reserves.[24] 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 country's reserve stocks 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.[25] Stable reserve levels during the crisis may in fact indicate that countries were actively accumulating reserves (in order to offset valuation losses).

In order to be able to distinguish between valuation changes and active accumulation or depletion of reserves we attempt to adjust the reserves data for changes in underlying asset values. The SDDS Reserve Template data do not provide details on each asset held in the foreign currency (Forex) component of official reserves but it does provide information on the broad composition of these reserves, specifically the share of these reserves held in securities (SEC) versus the share in currency and deposits (DEPO). Information on the currency denomination 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[26]. We use the monthly SDDS Reserve Template foreign currency reserve (Forex) composition data (SEC and DEPO), together with proxies for returns to securities (10-year government bond yields) and deposits (3-month inter-bank yields)[27], and the quarterly COFER approximations of currency denomination[28], to strip out *passive* valuation changes and interest income. Figure 4 presents the underlying security and deposit data that we use in these calculations. Although the long-term

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[24] While we know of no countries that provide detailed accounts of the assets in their reserve portfolios, some central banks provide general information regarding their reserve management strategies, which are often published in annual reports. De Gregorio (2011) provides a discussion of the motives for reserve accumulation in emerging economies with a special focus on the Chilean approach.

[25] 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 timing used to measure reserve changes, especially during the global financial crisis, matters.

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

[27] 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 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.

[28] 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.

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 4: Yields used in reserve valuation exercise

10-year Government bond yields   3-month inter-bank yields
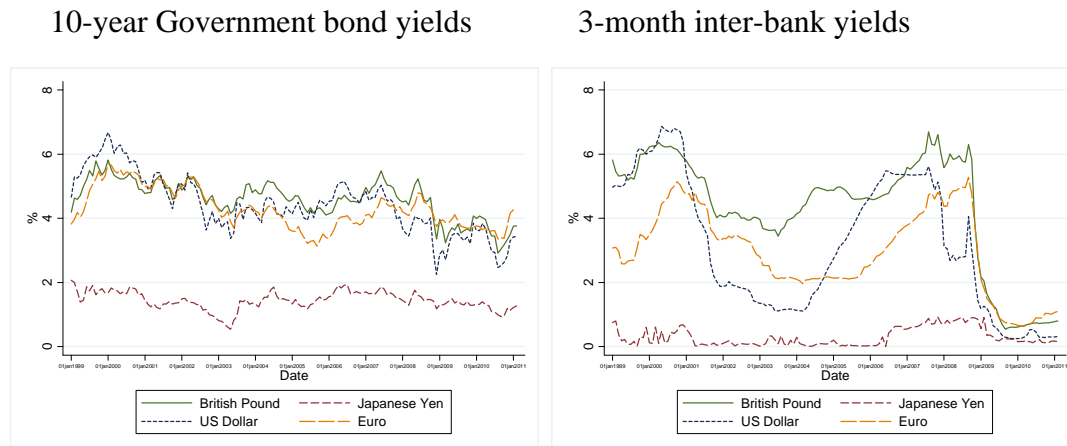
Source: Haver

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

The equations to follow describe our approach. Recall the basic definition of the change in reserves:

$\Delta\text{IR} = \Delta\text{Forex} + \Delta\text{NonCR}$

$\Delta\text{Forex} = r^s*\text{SEC} + r^d*\text{DEPO} + \Delta^{ps}\text{SEC} + \Delta^{ps}\text{DEPO} + \Delta^{val}\text{SEC} + \Delta^{val}\text{DEPO}$

| Interest income | Active management | Passive management |

If we decompose the level of foreign currency reserves at *t+1* into the level that would have been achieved without active management together with the active management component:

(5.1) $\text{Forex}(t+1) = \text{Forex}^{\text{sim}}(t+1) + \triangle^{\text{ps}}\text{Sec} + \triangle^{\text{ps}}\text{Dep}$

Active management

where simulated Forex in *t+1* is:

(5.2) $\text{Forex}^{\text{sim}}(t+1) = \text{Forex}(t) + r^{\text{s}}*\text{SEC} + r^{\text{d}}*\text{DEPO} + \triangle^{\text{val}}\text{SEC} + \triangle^{\text{val}}\text{DEPO}$

Interest income, estimated	Passive management, estimated

    Figures 5 to 9 present selected country level plots of actual foreign currency reserves (the solid black lines) and our "simulated" Forex series (the dashed orange lines) over the period 2000-2010. (Appendix B contains these graphs for all the countries in our sample.) These figures also include a trend forecast (the dashed black line) based on foreign currency 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 foreign currency 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 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 country plots indicate wide variation in foreign currency reserve accumulation patterns, for many countries actual foreign currency reserves exceed our "simulated" series (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 again actively accumulating reserves (Russia provides a good example of this pattern).

Figure 5: Estimates of Bulgaria's Foreign Reserve Management
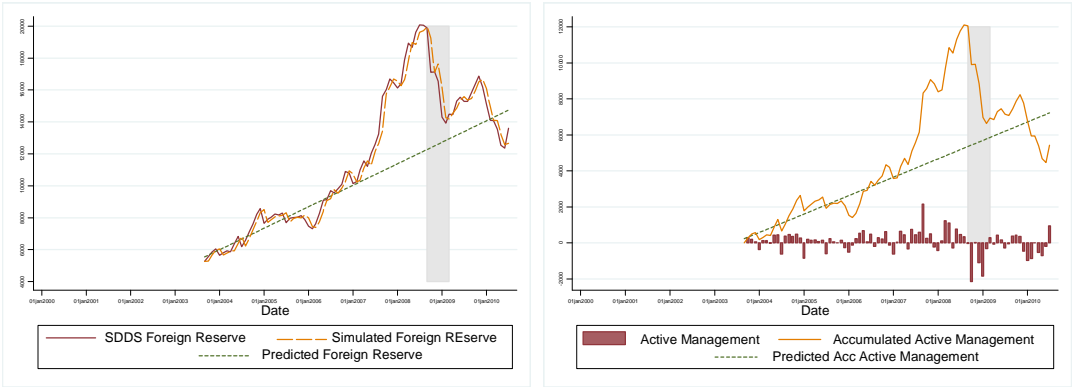
Figure 6: Estimates of Japan's Foreign Reserve Management
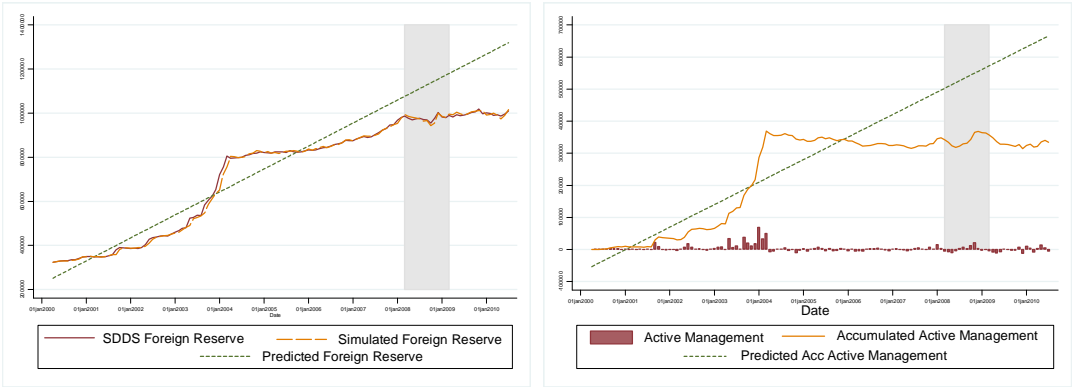
Figure 7: Estimates of Russia's Foreign Reserve Management
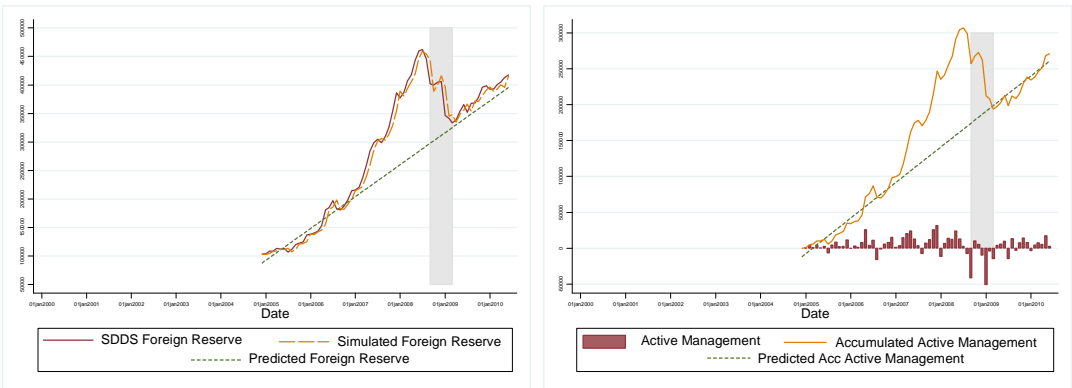
Figure 8: Estimates of South Korea's Foreign Reserve Management
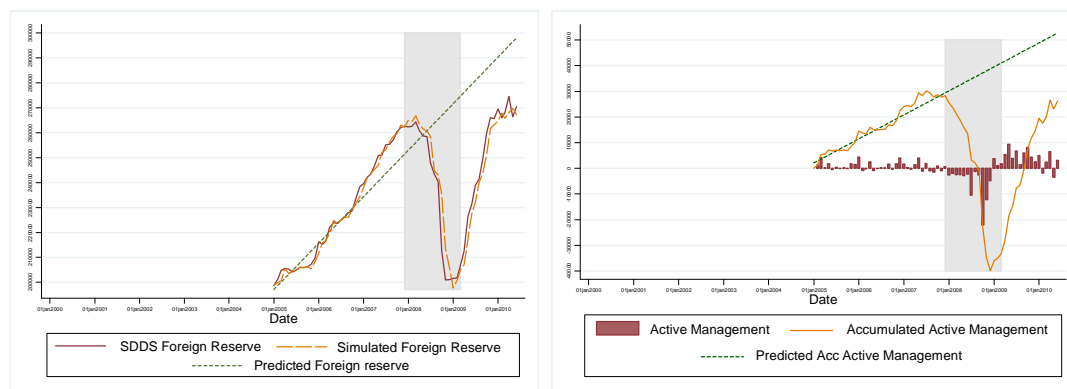
Figure 9: Estimates of Singapore's Foreign Reserve Management
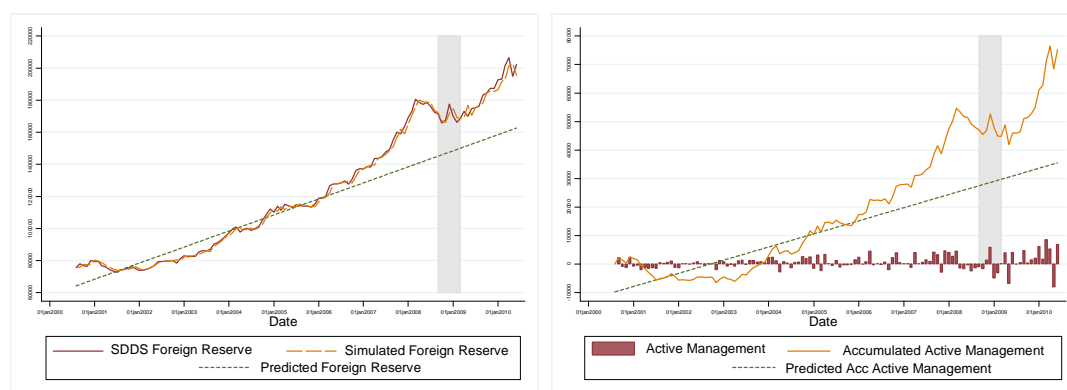
Foreign currency reserve data for developed countries generally show little evidence of active reserve accumulation (indeed a number of Euro-zone members were actively depleting reserves well before the global financial crisis).[29] Japan in 2003-4 and Switzerland in 2009-2010 are two interesting exceptions. 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).[30] These intervention operations are reflected in the large increases in actual foreign currency reserves as well as active

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[29] 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.

[30] 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.

reserve accumulation in figure 6. 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 10 and 11 present aggregated versions of the country-level "simulated" and "actual" SDDS foreign currency reserve data, as well as the accumulated "actively managed" series. Figure 10 aggregates across countries that did not actively increase their stock of foreign currency reserves over this time period; this group includes many of the developed countries in our sample. Figure 11 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 11 are foreign currency reserve accumulating countries which depleted reserves during the crisis period (for example, Argentina, Brazil, Bulgaria, Croatia, Czech Republic, Denmark, Korea, Latvia, Lithuania, Malaysia, Mexico, Netherlands, Norway, Peru, Poland, Russia, Singapore, South Africa) as well as those countries that continued to accumulate throughout this time period (Chile, Colombia, Hong Kong, Estonia).

Figure 10: Estimates of Aggregated Reserve Management by Non-accumulating Countries
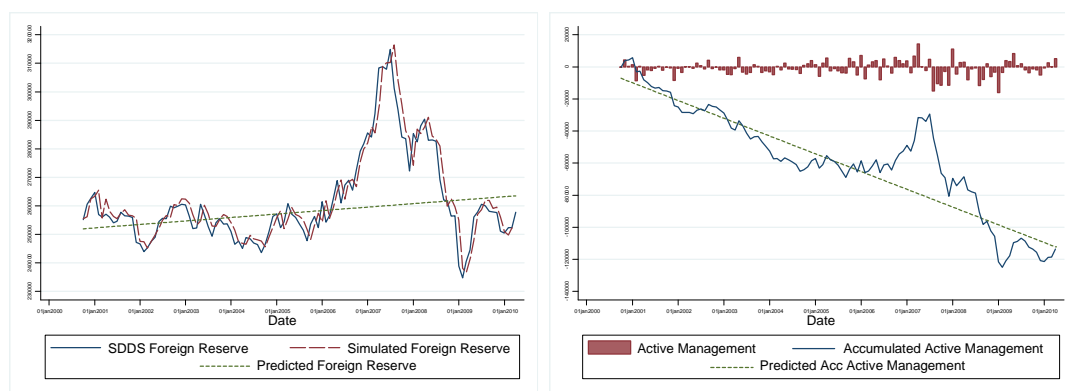
Notes: includes Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Portugal, Spain, UK, US

Figure 11: Estimates of Aggregated Reserve Management by Accumulating Countries
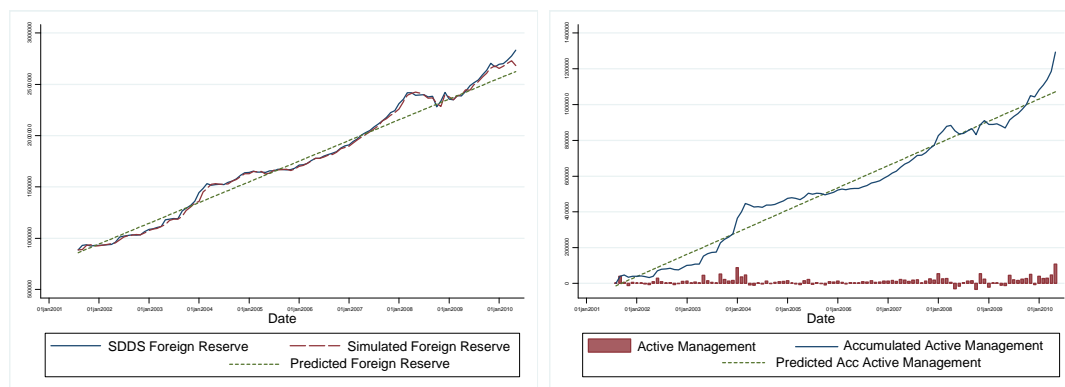
Notes: includes all SDDS countries not included in figure 10, except as noted in Table 3.

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.[31]

In order to measure the strength of exchange rate market pressure (EMP) during the global financial crisis we calculate changes in the exchange rate during the country-specific crisis periods. Figure 12 shows combinations of exchange rate changes and active additions or subtractions to foreign currency reserves, as measured by our "actively managed" reserves series, for the SDDS compliant countries during the global financial crisis. The exchange rate and

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[31] 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).

reserve changes for each country are measured during the country-specific crisis period (as shown in the shaded portions of figures 5-9; based on a peak-to-trough real GDP calculation after 2007). If a group of countries suffer from the same amount of exchange market pressure (EMP), but with differing degrees of depreciation and foreign currency reserve depletion, those countries should scatter on the upward sloping line. Since the euro-zone 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 euro-zone 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.

Figure 12 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 currency reserve and exchange rate changes was mildly negative during this time period, and when we exclude the developed countries the negative slope is less steep. 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 12: Reserve Changes and Exchange Market Pressure
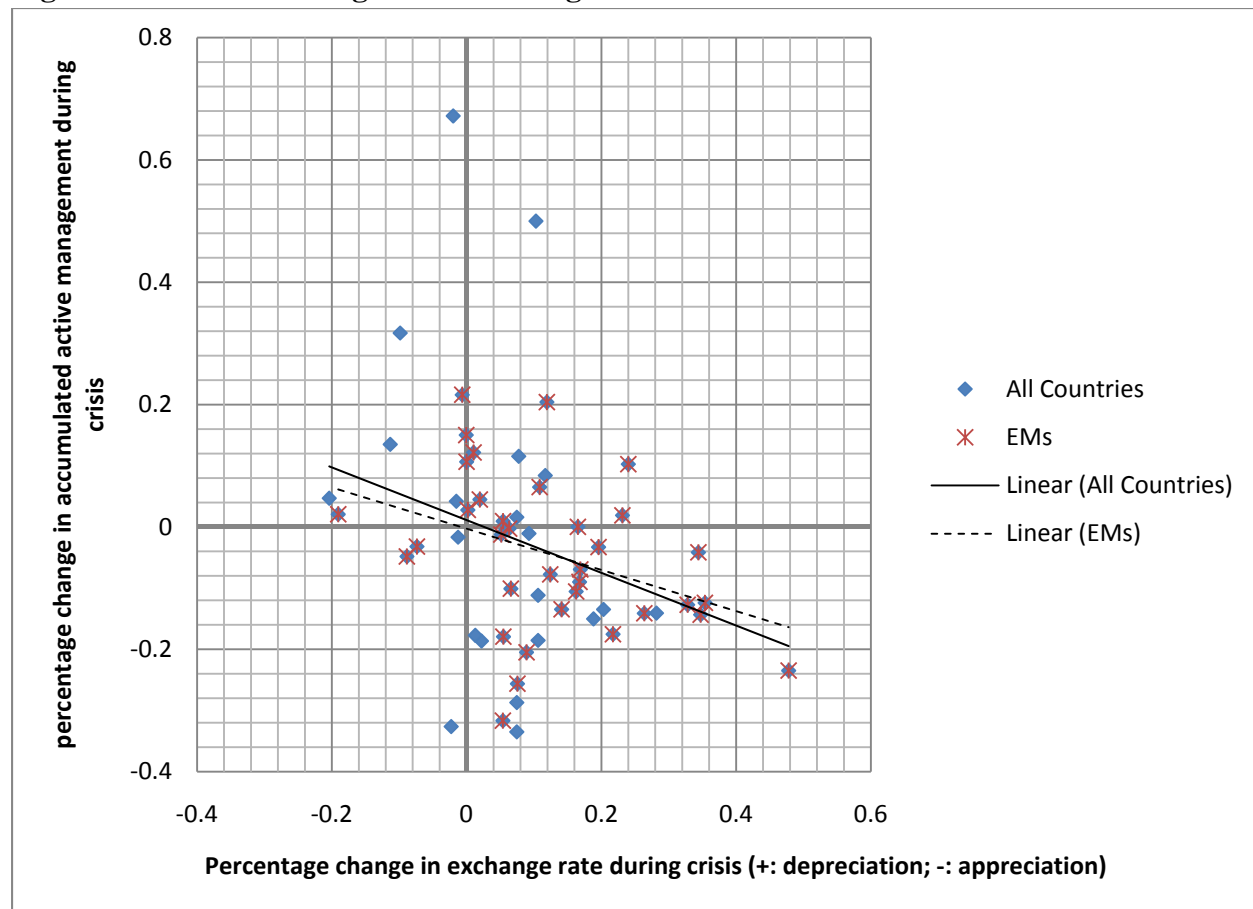
7. Determinants of Pre- and Post-Crisis Reserve Accumulation

The countries that drew down their reserves during the global financial crisis were often the same countries that had actively accumulated reserves prior to the crisis. In order to understand what motivates countries to build up their foreign currency 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 through 2010Q2 for pooled and panel specifications using quarterly data. The dependent variable is the log of official reserves measured using: (1) IFS_IR data (which allow the widest cross-section and time-series, available for 177 countries, includes interest income and valuation changes in the underlying reserve assets, excludes gold, includes SDRs, IMF loans, SWFs, and swaps)[32], (2) the

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[32] 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

accumulated *actively managed* SDDS foreign currency reserves series (available for 68 countries, most starting in 2001, excludes passive changes in reserves due to interest income and valuation changes in the underlying reserve assets, also excludes gold, SDRs, IMF loans, SWFs, and swaps), or (3) the accumulated "Reserves and Related items" line in the BOP, (available for 113 countries, excludes valuation changes in the underlying reserve assets but includes interest income, gold, SDRs, IMF loans, SWFs, and swaps). The explanatory variables we include in the various regression specifications include: country size (GDP), measures of trade openness, measures of primary export ratios (from Comtrade), the oil export ratio (net oil export volume over GDP, EIA), export growth and volatility, capital account openness (Chinn-Ito index), exchange rate growth and volatility, the real exchange rate, short-term debt ratios (from JEDH), the current account to GDP ratio, the interest rate differential between domestic and US deposits, the share of M2 to GDP [33], a crisis dummy variable (based on Reinhart (2010), countries are considered "in crisis" during the year in which they experience an external or domestic debt default, a banking crisis, or a hyperinflation), a dummy variable indicating the country-specific peak to trough GDP during the global financial crisis, a dummy variable indicating countries which received IMF loans (equal to 1 during the time the loan was outstanding), a dummy variable indicating that the country has a SWF (starting the year the SWF was established), and a dummy variable indicating that the country drew on Fed Swap lines during the crisis.[34]

Tables 4a and b present the regression results of a representative specification (many of the potential explanatory variables are only available for select countries in our sample, or on an annual basis, the specification reported in the tables attempts to maximize included variables while still keeping our country and time coverage as wide as possible) using our three measures of official reserves and, in table 4b, excluding the developed countries in our sample. Analysis of these tables provides evidence that both precautionary and exchange rate stability factors were important drivers of reserve accumulation for this sample of countries. The reported coefficient estimates, across the various specifications, suggest that there are multiple reasons that countries accumulate reserves; no one explanatory variable seems to be driving reserve behavior across these countries. Interestingly, the influence of the explanatory variables is not qualitatively different depending on whether we use the traditional IFS_IR measure, the actively managed SDDS foreign currency reserves series, or the BOP "Reserves and Related Items" data. The

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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.

[33] Including M2/GDP as an explanatory variable in the regressions reduces our cross-country panel by 20 countries due to their lack of M2 data. These (dropped) countries include: Australia, Austria, Belgium, Canada, Croatia, Finland, France, Germany, Greece, India, Ireland, Italy, Netherlands, Peru, Philippines, Portugal, Spain, Thailand, Tunisia, and UK. Excluding M2/GDP, however, does not qualitatively change the regression results; these estimates are available upon request.

[34] We are grateful to Joshua Aizenman and Yi Sun for providing us with data on a number of the included explanatory variables.

coefficient signs on the last five explanatory variables in the table, which are all (1,0), are intuitive indicating that reserve accumulation was higher in countries that experienced crises prior to the GFC (denoted as Reinhart-Crisis in the table), lower during the GFC, lower for countries that required IMF loans, higher for countries with SWFs, and lower for countries that drew on Fed swap lines.

Our time-series graphs of the country-by-country reserve data in section 5 and Appendix B suggest that the same country may well change their approach to reserve accumulation in reaction to global economic circumstances. Many of the graphs show rapid reserve accumulation in the pre-crisis period, indicating that many emerging market countries actively increased their foreign currency 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 indicate that many of these same countries reverted to their pre-crisis accumulation trends by 2010. (Recall that the linear trends shown in the figures are based on pre-crisis reserve accumulation.) This "reserve bounce back" is apparent in the full sample of countries as shown in Figure 13, and 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 accumulation strategies to their subsequent GDP growth in the next section.

Figure 13: International Reserve Bounce-back (Decumulation and Recovery)
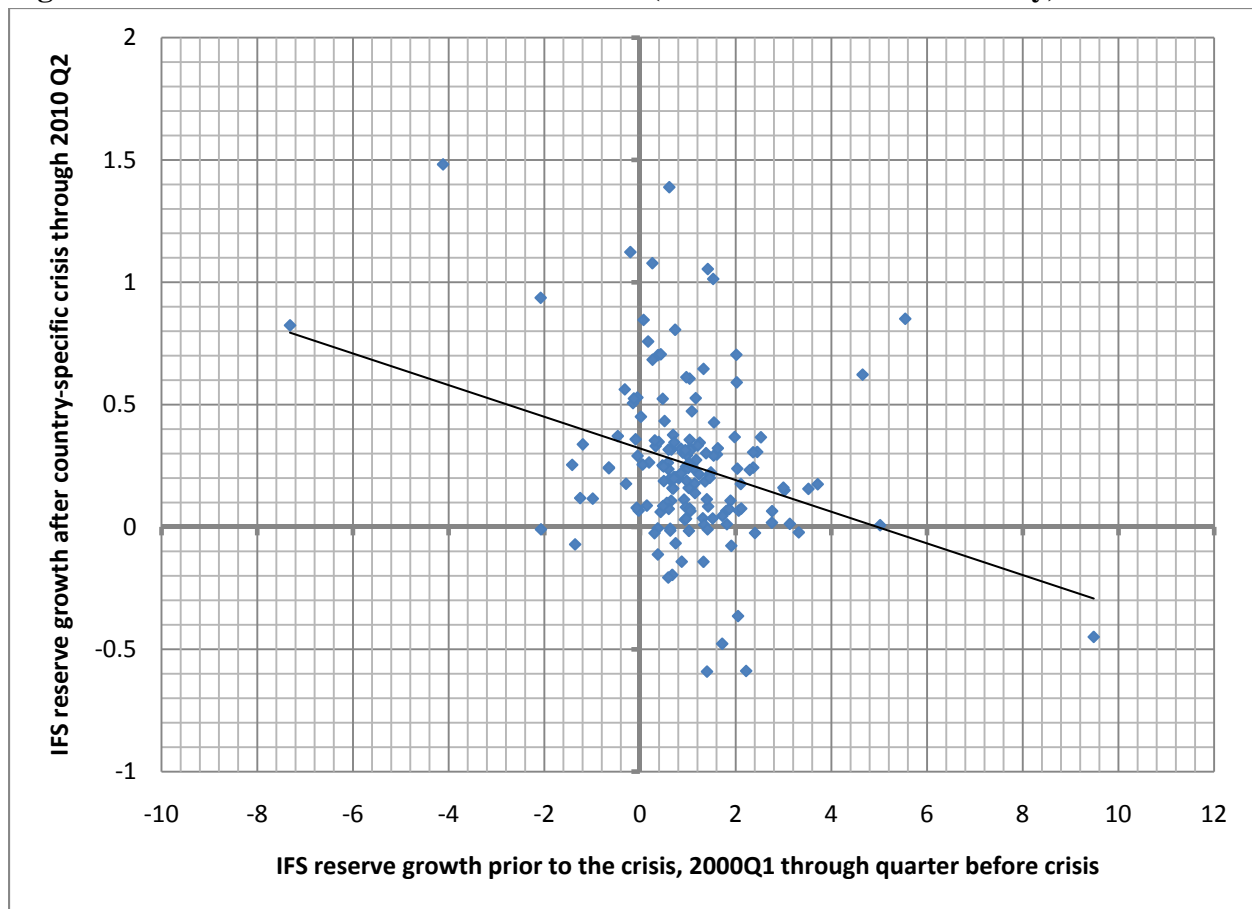
Source: IFS

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 active reserve management, suggest that foreign currency 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 accumulation 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 crisis 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. Likewise, Frankel and Saravelos (2010) find that the level of reserves in 2007 is a significant (negative) leading indicator of the cross-country incidence of the global financial crisis.[35] We explore this relationship for our larger sample of countries using the relevant country-specific crisis period to measure output declines in Figure 14. We find evidence of a positive relationship between *active* accumulation of foreign currency reserves and output during the crisis, which is stronger (more positive) when we exclude the developed countries in our sample.

Figure 14: International Reserve Changes and Country-Specific Output Declines

IFS reserve growth based on country specific peak to trough GDP change after 2007

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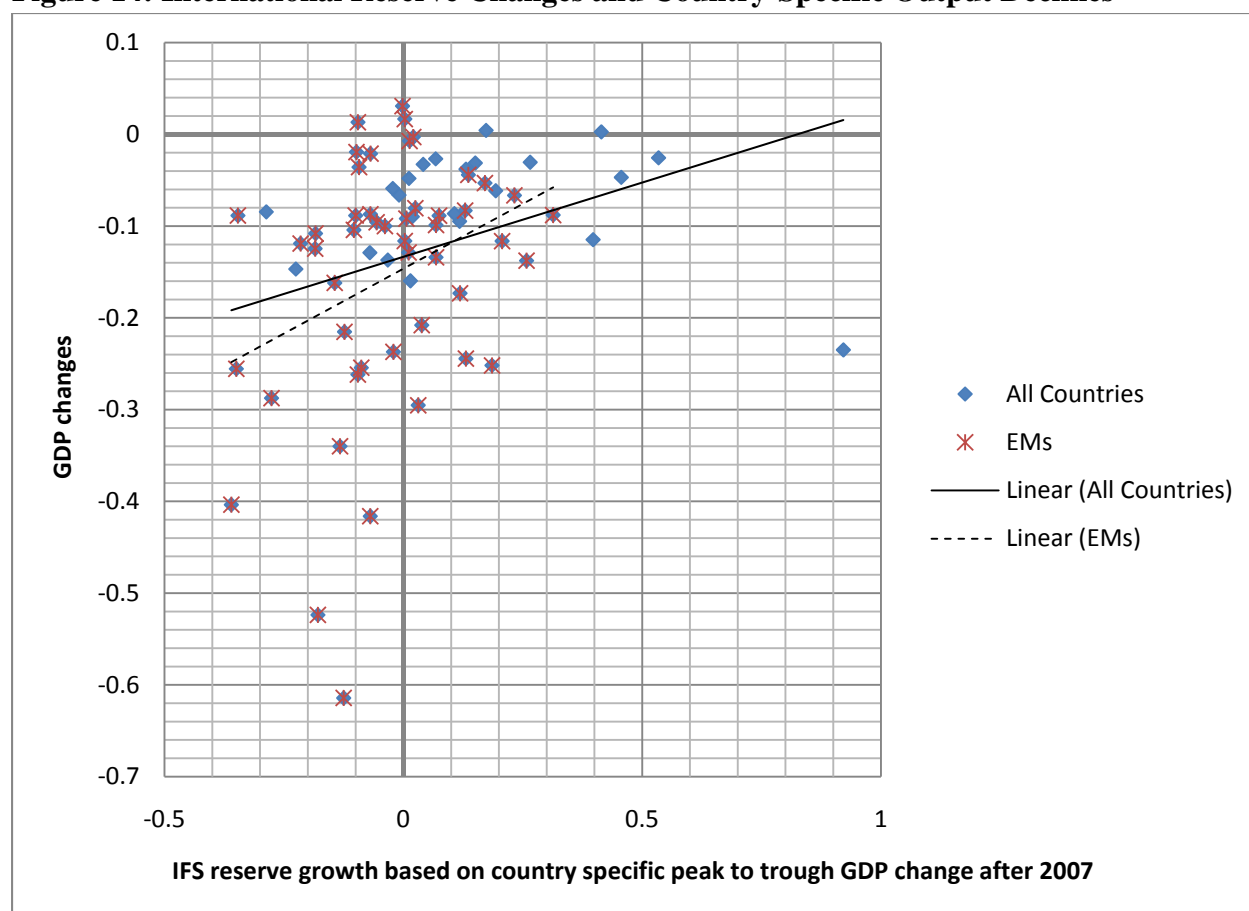
[35] Frankel and Saravelos (2010) are focused on finding leading indicators rather than causes of the crisis, but the authors conclude that their results "lend credence to the usefulness of reserve accumulations policies as insurance during periods of crisis" (page 27). Rose and Spiegal (2010) also examine cross-country indicators of the crisis but do not find robust links between various potential causes of the crisis, including the pre-crisis level of reserves (and various measures of reserve adequacy), and its incidence across 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 15 we examine the relationship between a measure of reserve adequacy (IFS_IR reserves measured against the current account in 2006Q4) and output changes during the crisis. In this case, we also find a *positive* relationship, indicating that countries with higher reserve adequacy prior to the crisis experienced less dramatic output declines.[36]

Figure 15: International Reserve Adequacy and Country-Specific Output Declines

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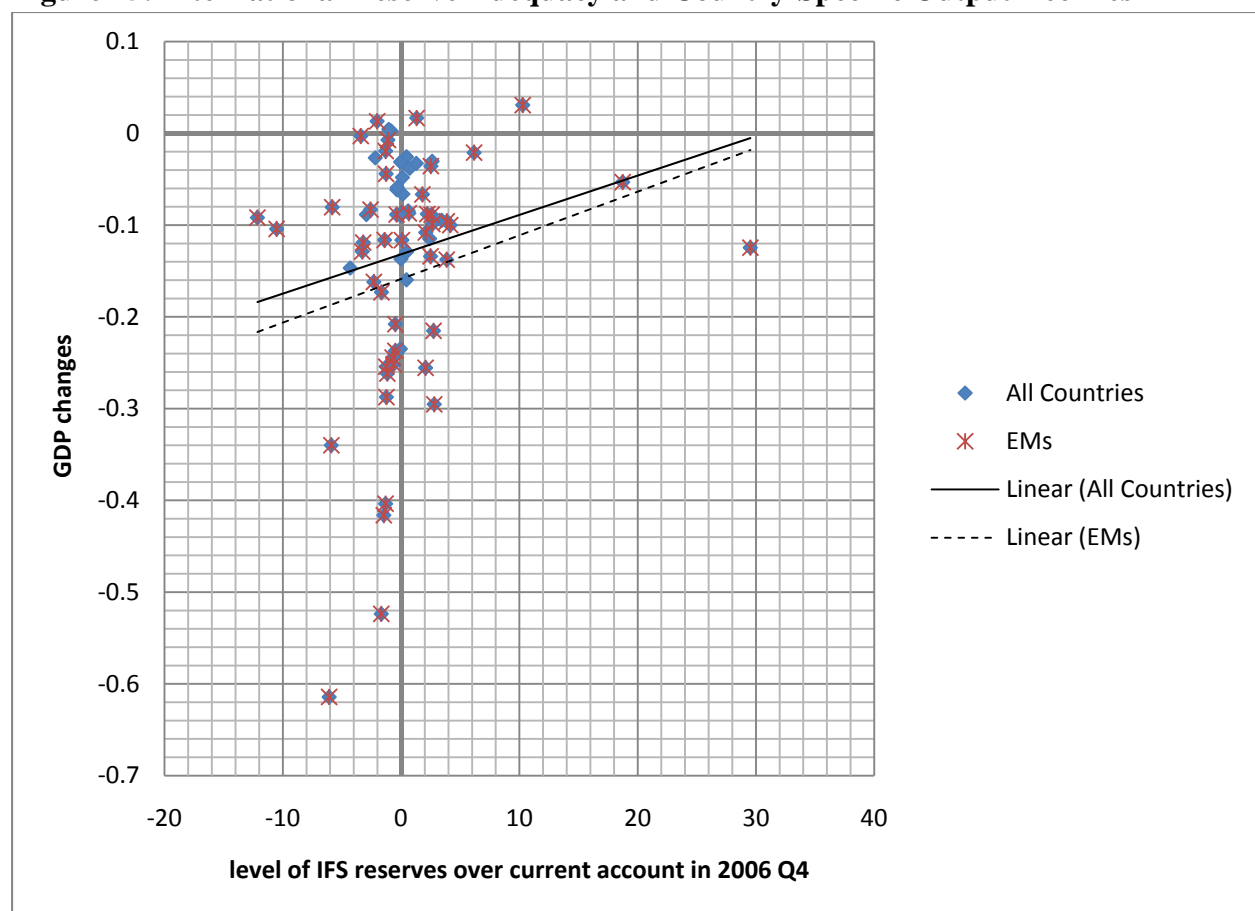
[36] We also measure "reserve adequacy" using short-term debt and imports in 2006Q4, and find similar patterns to those reported. In order to fully understand what is driving this positive relationship between reserve adequacy and output performance for the emerging market countries in our sample, it 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 currency reserve accumulation and *post*-crisis economic performance. Did the countries that used their reserves during the global financial crisis experience faster GDP bounce-back after the crisis? Figure 16 indicates that *active* foreign currency reserve depletion during the country-specific crisis periods is positively associated with post-crisis (through 2010Q2) GDP recovery.

Figure 16: Foreign Reserve Accumulation and Post-Crisis GDP Recovery
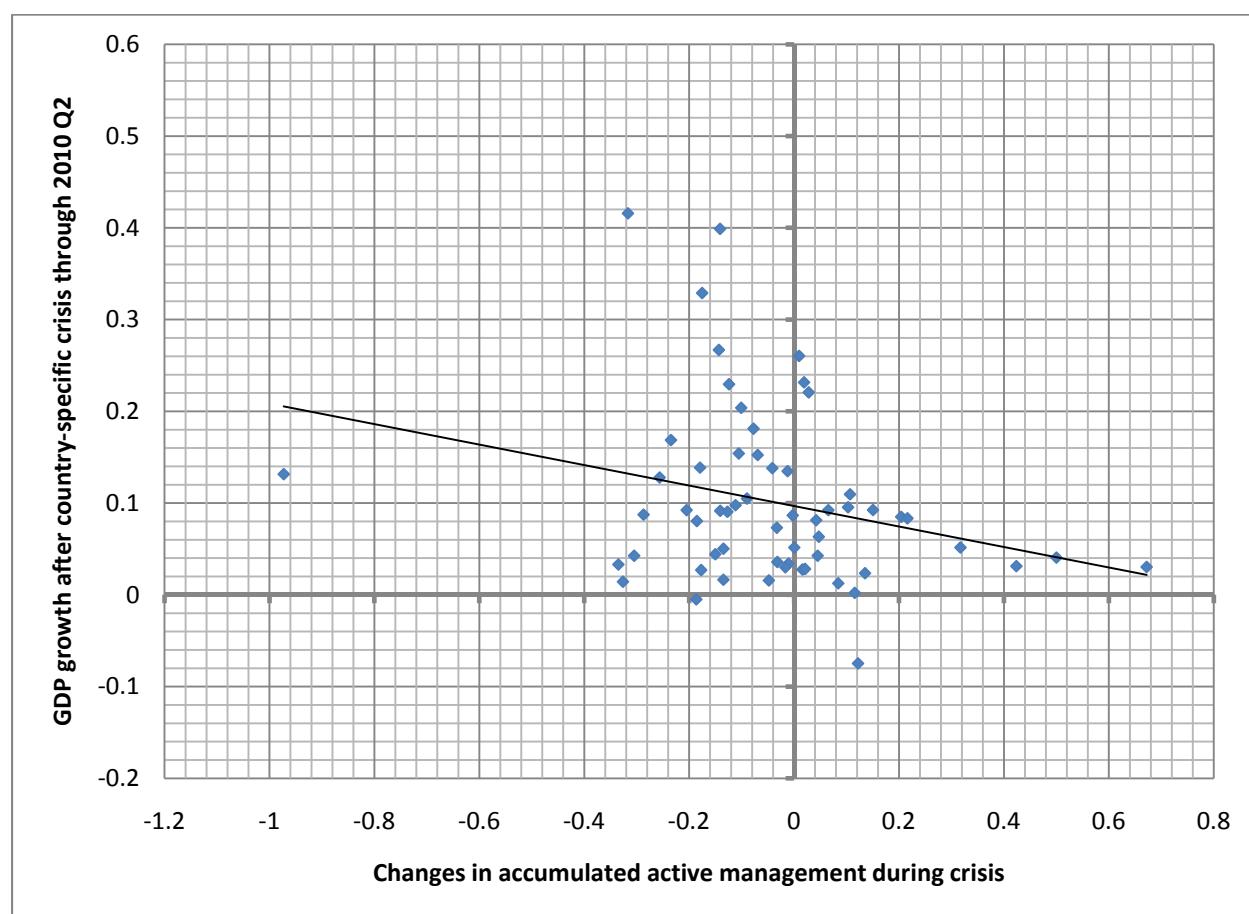
The relationship between reserve accumulation and post-crisis output growth is consistent with the reserve bounce-back pattern we found earlier (shown in Figure 13). It suggests that those countries that *used* their reserves during the crisis, and replenished their reserve accumulations after the crisis, were also the countries that experienced higher GDP bounce-back by mid-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.

In order to more formally investigate the relationship between reserve stocks prior to and during the crisis, and real GDP growth after the crisis, we examine a cross-section regression which allows us to include additional macro controls. Table 5 presents these regression results. The dependent variable is real GDP growth *after* the country-specific crisis through 2010Q2. The explanatory variables include real GDP, exchange rate and reserve growth *during* the crisis and the reserves-to-GDP ratio prior to the crisis (in 2006Q4). The first column in table 5 presents results for our full sample of countries and subsequent columns restrict our sample in various ways. The second column excludes the developed countries, the third column excludes countries that are major commodity exporters, the fourth column includes countries with low reserves-to-debt ratios, and columns 5 through 7 restrict the sample to those countries with high interest differentials relative to the US, which we label as "carry-trade counterparty countries".

In columns 1 through 5 of Table 5 we measure reserve growth during the GFC using the IFS_IR series (which includes interest income and valuation changes), in column 6 we measure reserve growth during the GFC using the actively managed SDDS foreign currency reserve series (which excludes valuation changes and interest income), and in column 7 we use the "reserves and related items" BOP series (which excludes valuation changes but includes interest income). The one specification in which we find that a deeper drop in real GDP during the (country-specific) crisis did not influence post-crisis recovery (the GDP bounce-back effect described earlier) is reported in column 4 which includes only those countries with low reserve adequacy relative to short-term debt. In all the country samples we find that the larger were reserve stocks before the GFC started, the higher was post-crisis growth. The statistical significance of the coefficient on exchange rate growth and reserve growth during the crisis is less consistent across the columns, but the estimates often indicate that countries which experienced larger depreciations during the crisis has better post-crisis recovery (most likely through higher exports) . Likewise, depletion of reserve stocks during the crisis, conditional on having accumulated reserves prior to the crisis, improved post-crisis growth.

We restrict our sample of countries in column 3 of the table to exclude countries that are primary commodity exporters, which include a number of the top reserve accumulating countries. These countries may behave differently than the rest of the sample, in that reserve accumulation is more likely driven by commodity price movements, than the precautionary or exchange rate stability motives. Indeed, in tables 4a and 4b we find that our primary commodity exporter indicator variable is a statistically significant (and positive) determinant of reserve accumulation. The sample of primary commodity exporter countries is too small (12) to consider separately, but it is interesting to note that when we exclude these countries from our sample, pre-crisis reserve stocks are still found to be positively associated with post-crisis recovery. However, when primary exporters are excluded from the sample, the exchange rate

and reserve growth variables during the crisis are no longer statistically significant, in turn suggesting that many of the countries that benefited from depreciations and reserve depletion are primary commodity exporters.

The role of short-term debt both in motivating countries to build up reserves as well as its role during the global financial crisis has been the subject of a number of recent studies, including Blanchard, Faruqee and Das (2010), Frankel and Saravelos (2010) and Rose and Spiegal (2010). We find, as most studies do, that countries with higher short-term debt to GDP ratios accumulate larger stocks of reserves, reflecting the precautionary motive. The relationship between debt and reserves during the crisis is less well understood. One of the hallmarks of the global financial crisis was the inability of countries to refinance their debt obligations. They faced a sudden reversal of capital flows, and deleveraging ensued. In this circumstance we might expect that countries with large debt obligations would tap into their reserves to smooth the deleveraging process. Yet a number of countries, with Korea being a prime example, opted to draw on their Fed Swap lines rather than fully deplete their reserves. In column 4 of table 5 we consider whether countries with relatively low reserves-to-short-term-debt ratios (below the median for the full sample of countries) behaved differently than other countries in the sample. This is the only sample of countries in which we do not find evidence of GDP bounce-back. One interpretation is that countries with low pre-crisis reserve adequacy had limited choices during the crisis. Capital outflows caused undesired depreciation, which in turn damaged financial institutions and corporations. The damage lingered after the crisis, hindering growth and cancelling the boost from depreciation for exports. We do find that larger reserve stocks prior to the crisis increased GDP recovery for these countries, but reserve depletion during the crisis did not make a difference.

Another of the explanatory variables that we found to be important in our reserve accumulation regressions is the interest differential; countries with interest rates that are higher than those in the US tend to accumulate more reserves. These countries accumulate reserves, despite their higher fiscal costs of maintaining their reserve stock. These same countries may inadvertently be counter-parties to the carry trade. Carry-traders borrow in low interest currencies and invest in high interest currencies, while most reserve building countries invest in low interest foreign currencies (mostly the US dollar) and borrow at the (relatively higher) domestic interest rate. In other words, this sample of countries is likely to experience the largest valuation losses, yet the regressions in table 4 indicate they are large reserve accumulators. One explanation for why these carry-trade counterparty countries accumulate reserves (even as they lose money on the reserve stocks) is that they may be concerned about the stability of their domestic banking system, which is likely financing the carry trade (see Shin (2010)). In table 5 we consider the role of reserves in post-crisis GDP recovery for the sample of countries with the

highest interest differentials (defined as differentials that are higher than the median differential for the full sample). The regression results for this sample of "carry-trade counterparty countries" (in columns 4 to 6) indeed suggest that reserve stocks prior to the crisis, and reserve depletion during the crisis (made possible by those large pre-crisis reserve stocks) improved post-crisis recovery. Interestingly, exchange rate depreciation did not play an important role, in terms of GDP recovery, for these countries.

9. Conclusions

The contribution of this paper is four-fold. First, we make use of the SDDS Reserve Template data which provides a breakdown of the types of assets (securities and deposits) included in the foreign currency reserve component of official reserves. This data, along with assumptions on currency composition and the applicable interest rate on these assets, make it possible to estimate the *passive* interest income and valuation changes which are included in measures of official reserves. Second, we derive the *actively* managed component of foreign currency reserves by subtracting the interest income and valuation changes from the official reserve data. As a consequence, we have much better estimates of actual purchases and sales of reserve assets, which are conceptually similar to foreign exchange intervention. Third, we find that emerging market economies did deplete foreign currency reserves during the global financial crisis. Many countries that were reserve accumulators before the crisis used their reserves and allowed their currencies to depreciate during the crisis. We also find evidence of "reserve bounce back"; after the crisis many emerging market countries went back to their pre-crisis reserve accumulation trends. Fourth, we find that real GDP growth recovery after the crisis was stronger for countries with large pre-crisis accumulations of foreign currency reserves. The influence of currency depreciation and reserve depletion during the crisis on GDP growth after the crisis differed depending on which countries are included in the sample. Perhaps ironically, the group of countries that benefitted the most from reserve depletion during the crisis is the carry-trade counterparty countries (who are also the countries that suffered the highest valuation losses on their reserve stocks).

Official reserve accumulation among emerging market economies is a contentious topic. Trading partners often accuse reserve accumulators of having mercantilist motives, and domestically large reserve stocks are sometimes criticized as wasteful resource allocation. Emerging market economies often rebut these criticisms by citing the self-insurance value of reserves. They argue that reserves reduce the probability of falling into a crisis, and that the value of self-insurance exceeds the costs. Our findings support the view that higher reserve

33

accumulations prior to the global financial crisis are associated with higher post-crisis GDP growth.

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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

Central banks	Line size ($ billion)	Starting	Net Outstanding Positions ($ billion)	
			31-Dec-08	30-Jun-09
European Central Banks	Full allotment	13-Oct	291.35	59.9
Swiss National Bank	Full allotment	13-Oct	25.18	0.37
Bank of England	Full allotment	13-Oct	33.08	2.5
Resreve Bank of Australia	30	29-Sep	22.83	0.24
Reserve Bank of New Zealand	15	28-Oct		
Bank of Japan	Full allotment	29-Sep	122.72	17.92
Bank of Canada	30	29-Sep		
Danmarks Nationalbank	15	29-Sep	15	3.93
Sveriges Riksbank	30	29-Sep	25	11.5
Norges Bank	15	29-Sep	8.23	5
Bank of Korea	30	29-Oct	10.35	10
Banco do Brasil	30	29-Oct		
Banko de Mexico	30	29-Oct	0	3.22
Monetary Authority of Singapore	30	29-Oct		

Details on Dollar Auctions (swaps) by Central Banks with Federal Reserve Bank, October 2008-February 1, 2010

Source: Authors' summary from Goldberg, et al. (2011)Tables 2 and 3

Table 3: Data Sources and Coverage

Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		BOP line (Annual) Start date	BOP line (Quarterly) Start date		GFC start date		GFC end date	
		Date	Start date	Year	M	Year	Year	Q	Year	Q	Year	Q
Afghanistan, I.R. of	EM			1963	9	1979			2007	4	2009	1
Albania	EM			1993	12	1980	1995	1	2007	4	2009	1
Algeria	EM			1968	1	1977			2007	4	2009	1
Angola	EM			1995	12	1985			2007	4	2009	1
Anguilla	EM			1990	12	1990			2007	4	2009	1
Antigua and Barbuda	EM			1979	1	1977			2007	4	2009	1
Argentina	EM	1-Nov-99	Sep-00	1957	1	1976	1976	1	2008	2	2009	1
Armenia	EM	7-Nov-03	Nov-03	1992	12	1993	1993	1	2008	3	2009	1
Aruba	EM			1986	1	1986	1986	1	2007	4	2009	1
Australia	AE	23-Jul-01	Mar-00	1957	1	1960	1959	3	2008	3	2009	2
Austria	AE	5-Jul-01	Jun-00	1957	1	1967	1970	1	2008	4	2009	1
Azerbaijan, Rep. of	EM			1992	12	1995	1999	1	2008	3	2009	1
Bahamas, The	EM			1968	12	1976	1976	1	2007	4	2009	1
Bahrain, Kingdom of	EM					1975			2007	4	2009	1
Bangladesh	EM			1973	3	1976	1976	1	2007	4	2009	1
Barbados	EM			1968	6	1970			2007	4	2009	1
Belarus	EM	22-Dec-04	November-04	1994	12	1993	1996	1	2008	3	2009	1
Belgium	AE	26-Jan-01	Jul-00	1957	1	2002	2002	1	2008	3	2009	1
Belize	EM			1976	12	1984	2001	1	2007	4	2009	1
Benin	EM			1962	9	1974			2007	4	2009	1
Bhutan	EM			1983	12	2006			2007	4	2009	1
Bolivia	EM			1957	1	1976	1977	1	2008	3	2008	4
Bosnia & Herzegovina	EM			1997	8	1998	2001	1	2007	4	2009	1
Botswana	EM			1976	9	1975			2008	3	2009	1
Brazil	EM	14-Mar-01	February-01	1957	1	1975	1975	1	2008	3	2009	1
Brunei Darussalam	EM			1999	12	2001	2001	1	2008	3	2009	2
Bulgaria	EM	1-Dec-03	September-03	1991	12	1980	1991	1	2008	3	2009	1
Burkina Faso	EM			1962	7	1974			2007	4	2009	1
Burundi	EM			1967	1	1985			2007	4	2009	1
Cote d'Ivoire	EM			1993	12	1992	1994	1	2007	4	2009	1
Cambodia	EM			1965	1	1977	1979	2	2007	4	2008	1
Cameroon	EM			1957	1	1945	1950	1	2007	4	2009	1
Canada	AE	19-Feb-99	Apr-00	1978	3	1977	1998	1	2008	3	2009	2
Cape Verde	EM			1965	1	1977			2007	4	2009	1
Central African Rep.	EM			1965	1	1977			2007	4	2009	1
Chad	EM			1959	1	1975	1991	1	2007	4	2009	1
Chile	EM	30-Mar-00	Aug-00	1980	7	1982	2010	1	2008	2	2009	1
China, P.R.: Mainland	EM			1990	12	1998	1999	1	2008	4	2009	1
China, P.R.:Hong Kong	EM	12-Jul-00		1984	6	2002			2007	4	2009	1
China, P.R.:Macao	EM			1957	1	1968	1996	1	2007	4	2009	2
Colombia	EM	9-May-00	Apr-00	1980	12	1980			2008	4	2009	1
Comoros	EM			1965	1	1978			2007	4	2009	1
Congo, Dem. Rep. of	EM			1957	1	1977	1987	1	2007	4	2009	1
Congo, Republic of	EM			1962	7	1975			2007	4	2009	1
Costa Rica	EM	28-Nov-01	Apr-00	1992	12	1993	1993	1	2009	1	2009	2
Croatia	EM	30-Mar-01	Mar-00	1964	1	1976	1978	2	2008	3	2009	1
Cyprus	AE	1-Dec-09	Jan-10	1993	1	1993	1993	1	2008	2	2009	1
Czech Republic	EM	4-Jun-99	Mar-00						2008	4	2009	1
Denmark	AE	1-Sep-00	Dec-99	1957	1	1975	1975	1	2007	4	2009	1

41

Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		BOP line (Annual) Start date	BOP line (Quarterly) Start date		GFC start date		GFC end date	
Djibouti	EM			1984	12	1991			2007	4	2009	1
Dominica	EM			1979	1	1976			2007	4	2009	1
Dominican Republic	EM			1957	1	1968			2007	4	2009	1
Ecuador	EM	14-Jul-00		1957	1	1976	1993	1	2007	4	2009	1
Egypt	EM	31-Jan-05	Aug-09	1962	1	1977			2009	1	2009	2
El Salvador	EM	12-Oct-99	Apr-00	1957	1	1976	1999	1	2007	4	2009	1
Equatorial Guinea	EM			1982	1	1987			2007	4	2009	1
Eritrea	EM			1995	12	1992	1998	1	2007	4	2009	1
Estonia	EM	30-Mar-00	Jan-11	1992	6	1992	1992	1	2007	4	2009	1
Ethiopia	EM			1957	1	1977	1977	1	2007	4	2009	1
Fiji	EM			1975	1	1979	2000	1	2007	4	2009	1
Finland	AE	2-Jun-00	Apr-00	1957	1	1975	1975	1	2007	4	2009	1
France	AE	27-Apr-01	Aug-00	1957	1	1975	1975	1	2008	3	2009	3
Gabon	EM			1965	1	1978			2007	4	2009	1
Gambia, The	EM			1970	9	1978	2007	1	2007	4	2009	1
Georgia	EM	17-May-10	Jan-07	1995	10	1997	1997	1	2008	4	2009	1
Germany	AE	23-Mar-00	Dec-99	1957	1	1971	1971	1	2008	1	2009	1
Ghana	EM			1965	1	1975			2007	4	2009	1
Greece	AE	8-Nov-02	Jan-03	1957	1	1976	1976	1	2008	3	2009	1
Grenada	EM			1970	1	1977			2007	4	2009	1
Guatemala	EM		Aug-08	1957	1	1977	1976	3	2007	4	2009	1
Guinea	EM					1986	2008	1	2007	4	2009	1
Guinea-Bissau	EM			1986	12	1982			2007	4	2009	1
Guyana	EM			1967	1	1977			2007	4	2009	1
Haiti	EM			1958	1	1971			2007	4	2009	1
Honduras	EM		Nov-10	1957	1	1974	2004	1	2007	4	2009	1
Hungary	EM	24-Jan-00	Apr-00	1983	12	1982	1989	4	2008	4	2009	1
Iceland	EM	30-Jun-04	Oct-00	1957	1	1976	1976	1	2008	4	2009	1
India	EM	14-Dec-01	Oct-07	1957	1	1975	1975	1	2008	4	2009	1
Indonesia	EM	2-Jun-00	Dec-06	1971	1	1945	1945	1	2008	3	2008	4
Iran, I.R. of	EM			1957	1	1976			2007	2	2007	3
Iraq	EM			1957	1	2005			2007	1	2007	2
Ireland	AE	17-Jul-01	Apr-01	1958	1	1974	1981	1	2007	4	2009	4
Israel	AE	5-Jun-00	Dec-01	1957	1	1952	1972	1	2009	1	2009	4
Italy	AE	14-Apr-00	Aug-00	1957	1	1970	1970	1	2008	2	2009	2
Jamaica	EM			1962	1	1976			2008	4	2009	2
Japan	AE	9-Jun-00	Apr-00	1957	1	1977	1977	1	2007	2	2009	1
Jordan	EM	28-Jan-10	Jan-06	1958	1	1972	1977	1	2008	3	2009	1
Kazakhstan	EM	24-Mar-03	Feb-03	1993	11	1995	1995	1	2008	3	2009	1
Kenya	EM			1967	1	1975			2007	4	2009	1
Korea, Republic of	EM	1-Nov-99	Jan-05	1957	1	1976	1976	1	2007	4	2009	1
Kosovo, Republic of	EM			2007	9	2004	2009	1	2007	4	2009	1
Kuwait	EM			1964	1	1975			2007	4	2009	1
Kyrgyz Republic	EM	26-Feb-04	Feb-04	1993	12	1993	1993	1	2008	3	2009	1
Lao People's Dem Rep	EM			1987	12	1984	1994	1	2007	4	2009	1
Latvia	EM	28-Sep-99	Apr-00	1993	7	1992	1993	1	2007	4	2009	4
Lebanon	EM			1957	1	2002	2002	1	2007	4	2009	1
Lesotho	EM			1980	1	1975	1985	3	2007	4	2009	1
Liberia	EM			1974	1	1979			2007	4	2009	1
Libya	EM			1957	1	1977			2007	4	2009	1

Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		BOP line (Annual) Start date	BOP line (Quarterly) Start date		GFC start date		GFC end date	
Lithuania	EM	12-Jul-99	Apr-00	1992	12	1993	1993	1	2008	3	2009	1
Luxembourg	AE	12-May-06	Jan-06	1984	12	2002	2002	1	2008	4	2009	2
Macedonia, FYR	EM			1993	12	1996	1996	1	2007	4	2009	1
Madagascar	EM			1967	1	1974	2003	1	2007	4	2009	1
Malawi	EM			1965	6	1977			2007	4	2009	1
Malaysia	EM	1-Sep-00	Apr-00	1959	8	1974	1999	1	2008	3	2009	1
Maldives	EM			1981	1	1977			2007	4	2009	1
Mali	EM			1965	1	1975			2007	4	2009	1
Malta	EM	1-Dec-09	Dec-09	1960	1	1971	1995	1	2008	3	2009	1
Mauritania	EM			1962	7	1975			2007	4	2009	1
Mauritius	EM			1969	1	1976	2000	1	2008	4	2009	1
Mexico	EM	29-Jun-00	Jan-00	1957	1	1979	1979	1	2008	3	2009	1
Micronesia, Fed.Sts.	EM			1995	12				2007	4	2009	1
Moldova	EM	2-May-06	May-06	1991	12	1994	1994	1	2008	4	2009	1
Mongolia	EM			1992	12	1981	1999	1	2007	4	2009	1
Montenegro	EM			2002	12	2007			2007	4	2009	1
Montserrat	EM			1984	1	1986			2007	4	2009	1
Morocco	EM	15-Dec-05	Nov-05	1961	1	1975	2003	1	2009	1	2009	3
Mozambique	EM			1984	3	1980	1999	1	2007	4	2009	1
Myanmar	EM			1957	1	1976	1976	1	2007	4	2009	1
Namibia	EM			1992	1	1990	1999	1	2007	4	2009	1
Nepal	EM					1976	1977	1	2007	4	2009	1
Netherlands	AE	26-Apr-00	Apr-00	1957	1	1960	1960	1	2008	3	2009	2
Netherlands Antilles	EM			1972	1	1976	1998	1	2008	3	2009	2
New Zealand	AE		Mar-00	1967	9	1972	1980	1	2008	4	2009	2
Nicaragua	EM		Dec-10	1957	1	1977	1992	1	2007	4	2009	1
Niger	EM			1962	7	1974			2007	4	2009	1
Nigeria	EM			1963	1	1977	1990	1	2007	4	2009	1
Norway	EM	28-Apr-00	Apr-00	1957	1	1975	1975	1	2008	4	2009	2
Oman	EM			1970	4	1974			2007	4	2009	1
Pakistan	EM			1959	1	1976	1976	1	2007	4	2009	1
Panama	EM			1969	10	1977	1998	1	2007	4	2009	1
Papua New Guinea	EM			1973	11	1976	1976	1	2007	4	2009	1
Paraguay	EM			1957	1	1975	2001	1	2007	4	2009	1
Peru	EM	15-Jul-99	Jan-06	1957	1	1977	1977	1	2008	2	2009	1
Philippines	EM	17-Jan-01	Apr-00	1957	1	1977	1977	1	2008	4	2009	1
Poland	EM	2-Mar-00	Apr-00	1984	12	1976	1985	1	2008	4	2009	1
Portugal	AE	1-Dec-00	Apr-00	1957	1	1975	1975	1	2007	4	2009	1
Qatar	EM			1966	12				2007	4	2009	1
Romania	EM	4-May-05	Jan-07	1979	1	1971	1991	1	2008	4	2009	1
Russian Federation	EM	31-Jan-05	Dec-04	1993	12	1994	1994	1	2008	3	2009	1
Rwanda	EM			1967	1	1976			2007	4	2009	1
Sao Tome & Principe	EM			1995	8	1974			2007	4	2009	1
Samoa	EM			1972	12	1977	2003	3	2007	4	2009	1
San Marino	EM			1993	12				2007	4	2009	1
Saudi Arabia	EM			1964	1	1971	2006	1	2007	4	2009	1
Senegal	EM			1962	7	1974			2007	4	2009	1
Serbia, Republic of	EM			1999	12	2007	2007	1	2007	4	2009	1
Seychelles	EM			1978	12	1976	1979	1	2007	4	2009	1
Sierra Leone	EM			1966	1	1977			2007	4	2009	1

Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		BOP line (Annual) Start date	BOP line (Quarterly) Start date		GFC start date		GFC end date	
Singapore	EM	30-Jan-01	Aug-00	1969	1	1972	1995	1	2007	4	2009	1
Slovak Republic	AE	7-Oct-99	Dec-99	1993	1	1993	1993	1	2008	3	2009	1
Slovenia	AE	7-Jul-00	Mar-00	1991	12	1992	1992	1	2008	3	2009	1
Solomon Islands	EM			1977	12	1975	2006	1	2007	4	2009	1
Somalia	EM			1965	12	1977			2007	4	2009	1
South Africa	EM	18-Sep-00	Jul-00	1957	1	1946	1960	1	2009	1	2009	2
Spain	AE	21-Dec-00	Aug-00	1958	1	1975	1975	1	2008	2	2009	3
Sri Lanka	EM			1957	1	1975	1977	1	2007	4	2009	1
St. Kitts and Nevis	EM			1981	1	1980			2007	4	2009	1
St. Lucia	EM			1979	1	1976			2007	4	2009	1
St. Vincent & Grens.	EM			1979	1	1978			2007	4	2009	1
Sudan	EM			1960	7	1977	1977	1	2007	4	2009	1
Suriname	EM			1973	1	1977	1977	1	2007	4	2009	1
Swaziland	EM			1974	4	1974			2007	4	2009	1
Sweden	AE	29-Jun-00	Aug-00	1957	1	1970	1975	1	2007	4	2009	1
Switzerland	AE	18-May-01	Sep-00	1957	1	1977	1999	1	2008	3	2009	2
Syrian Arab Republic	EM			1960	1	1977			2007	4	2009	1
Taiwan Prov.of China	EM			1964	1				2007	4	2009	1
Tajikistan	EM			1997	1	2002	2002	1	2007	4	2009	1
Tanzania	EM			1966	6	1976			2007	4	2009	1
Thailand	EM	16-May-00	Apr-00	1957	1	1975	1976	1	2008	3	2009	2
Timor-Leste	EM			1957	1				2007	4	2009	1
Togo	EM			1962	7	1974			2007	4	2009	1
Tonga	EM			1977	1	1971	1977	3	2007	4	2009	1
Trinidad and Tobago	EM			1964	12	1975			2007	4	2009	1
Tunisia	EM	20-Jun-01	May-01	1964	1	1976			2007	4	2008	1
Turkey	EM	20-Jul-01	Aug-00	1957	1	1974	1984	1	2008	3	2009	1
Uganda	EM			1966	9	1996	1996	1	2007	4	2009	1
Ukraine	EM	10-Jan-03	Dec-02	1992	12	1980	1980	1	2008	3	2009	1
United Arab Emirates	EM			1973	6	1994	1994	1	2007	4	2009	1
United Kingdom	AE	6-Jul-99	Apr-00	1957	1	1970	1970	1	2008	2	2009	2
United States	AE	19-Feb-99	Jan-08	1957	1	1970	1973	1	2008	3	2009	2
Uruguay	EM	12-Feb-04	Aug-03	1958	1	1978	2000	1	2007	4	2009	1
Vanuatu	EM			1981	1	1982	1984	1	2007	4	2009	1
Venezuela, Rep. Bol.	EM			1962	1	1970	1994	1	2007	4	2009	1
Vietnam	EM			1995	1	1996	1996	1	2007	4	2009	1
Zambia	EM			1965	6	1978			2007	4	2009	1
Zimbabwe	EM					1977	1981	1	2007	4	2009	1
Total number of SDDS subscribers: 68 (as of May 2011)												

Notes: Cyprus, Malta, Slovenia and the Slovak Republic are excluded from the graphs in the paper due to their recent introduction of the Euro; New Zealand is not a SDDS subscriber but provides the detailed data and is included in the analysis and graphs. Crisis dates are based on country-specific peak to trough percent change in real GDP after 2007.

Data Used in Regressions Analyses

Variable	Description	Frequency	Source
IFS_IR	IFS International Reserves (minus gold)	Monthly	IFS
SDDS_FR	SDDS Foreign Reserves (Securities + Deposits only)	Monthy	IMF SDDS database
Accumulated Active Management	Accumulated "simulated" SDDS-FR series	Monthly	author calculations
BOP line	Reserves and Related Items	Quarterly	IFS
Accumulated BOP line	Accumulated "Reserves and Related Items"	Quarterly	IFS
GDP_WEO	Annual GDP (current prices)	Annual	World Economic Outlook (WEO)
GDP	Quarterly GDP (national currency)	Quarterly	IFS
GDP deflator	GDP deflator or CPI deflator if not available	Quarterly	
Export Growth	Quarterly Export Growth	Annual	Annual variable from Aizenman & Sun
Exchange Rate Growth	Quartely Exchange Rate Growth	Annual	Annual variable from Aizenman & Sun
Interest Differential	Domestic minus US interest rate	Monthly	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
Current Account/GDP	Currency Account/GDP	Quarterly	IFS
			For Taiwan, Central Bank of Taiwan
ST Debt/GDP	[(Liabilities + Securities)/Annual WEO GDP]*100	Quarterly	WB and WEO
Oil Export/GDP	Net Oil Export/Annual WEO GDP	Annual	EIA
Primary Export/Export	Primary Export/Total Export	Annual	Primary Export includes products in SITC 0, 1, 2, 3, 4 and 68 categories. Annual variable from Aizenman & Sun
Primary Exporter Indicator	Dummy for countries in the top 25% of primary exporters	Quarterly	IFS
Export+Import/GDP	(Export as percent of GDP + Import as percent of GDP)/100	Annual	BOP
Chinn-Ito	Chinn and Ito Index (2008)	Annual	Chinn and Ito
Reinhart-Crisis	Dummy for countries which experience external or domestic debt default, banking crisis or hyperinflation	Annual	Reinhart (2010)
IMF Loan Outstanding	Dummy for years in which country has IMF loans outstanding	Annual	IFS
SWF	Dummy for countries with SWF starting in year fund is established	Annual	Table 1
Fed Swap Line	Dummy for countries which drew on Fed Swap Lines	Monthly	Fed
GFC-Crisis	Dummy indicating country-specific peak to trough GDP during the GFC	Quarterly	author calculations
REER	Real Exchange Rate	Quarterly	IFS

Table 4a: Determinants of Reserve Accumulation for Full Sample of Countries (Quarterly Observations through 2010Q2)

VARIABLES	Pooled Regression			Panel Regression		
	ln(IFS-IR minus gold)	ln(Accum Active Management)	ln(Accumulated BOPline)	ln(IFS-IR minus gold)	ln(Accum Active Management)	ln(Accumulated BOPline)
GDP	0.281***	0.200***	0.625***	0.867***	0.576***	0.179
	(0.0108)	(0.0268)	(0.0349)	(0.0989)	(0.155)	(0.121)
Exchange Rate Growth	-0.00695	-0.00299	-0.000699	-0.00221	-0.00935	-0.00262
	(0.00783)	(0.0144)	(0.0220)	(0.00242)	(0.00792)	(0.00252)
Export Growth	0.00272	0.0147***	-0.00229	0.000156	0.00599**	9.84e-05
	(0.00210)	(0.00530)	(0.00580)	(0.000789)	(0.00239)	(0.000408)
Primary Exporter Indicator	0.0258	0.357**	0.426***	-1.368*	-0.595	1.943***
	(0.0696)	(0.152)	(0.133)	(0.739)	(0.978)	(0.703)
ST Debt/GDP	0.0690***	0.699***	0.839***	0.0235	0.435***	0.0162
	(0.0203)	(0.0548)	(0.0898)	(0.0265)	(0.159)	(0.0347)
Current Account/GDP	2.154***	6.562***	7.569***	0.0819	0.742*	-0.185
	(0.274)	(0.989)	(1.468)	(0.136)	(0.421)	(0.371)
Interest Differential	-0.00159	0.0180***	0.0421***	-0.000944	-0.000777	0.00375
	(0.00270)	(0.00488)	(0.00751)	(0.00159)	(0.00455)	(0.00287)
M2/GDP	0.161***	-0.0177	0.453***	0.363**	0.423***	0.124
	(0.00800)	(0.0285)	(0.0310)	(0.148)	(0.0701)	(0.115)
Reinhart-Crisis	-0.0742	1.316***	1.029***	0.118	0.434**	-0.0184
	(0.116)	(0.182)	(0.274)	(0.142)	(0.179)	(0.0545)
GDC indicator	0.373***	0.0570	-0.779*	0.0287	0.0151	-0.0545
	(0.109)	(0.204)	(0.405)	(0.0365)	(0.125)	(0.0684)
IMF loan outstanding	-1.679***	-1.054***	1.107***	-0.754***	1.200	0.155
	(0.0800)	(0.147)	(0.264)	(0.0964)	(0.890)	(0.108)
SWF	0.667***	-0.178	1.494***	0.137	-0.134	-0.137
	(0.0607)	(0.127)	(0.155)	(0.105)	(0.163)	(0.0841)
Fed Swap Line	0.204	-0.130	-2.009***	0.0453	0.0346	0.107
	(0.132)	(0.190)	(0.559)	(0.0835)	(0.181)	(0.143)
Constant	15.13***	3.037***	1.420	-0.301	-7.892*	14.51***
	(0.289)	(0.721)	(1.071)	(2.403)	(4.168)	(3.846)
Observations	1,456	809	1,435	1,456	809	1,435
R squared	0.639	0.297	0.396			
Number of Countries	41	32	39	41	32	39

Robust standard errors in parenthesis; ***p<0.01, **p<0.05, *p<0.1, "IFS-IR" (includes interest income, valuation changes, IMF loans, SDRs, SWFs, drawn swap lines, excludes gold), "Accumulated Active Management" is calculated from SDDS reserve template data (excludes interest income, valuation changes, gold, IMF loans, SDRs, SWFs, and swap lines), "Accumulated BOPline" calculated from "Reserves and Related Items" in the BOP data (includes interest income, gold, IMF loans, SDRs, SWFs, drawn swap lines, excludes valuation changes). Slovenia and the Slovak Republic are excluded due to their recent introduction of the Euro. Variable definitions are provided in section 7 of the paper.

Table 4b: Determinants of Reserve Accumulation for Emerging Market Countries (Quarterly Observations through 2010Q2)

VARIABLES	Pooled Regression			Panel Regression		
	ln(IFS-IR minus gold)	ln(Accum Active Management)	ln(Accumulated BOPline)	ln(IFS-IR minus gold)	ln(Accum Active Management)	ln(Accumulated BOPline)
GDP	0.192***	0.0655	0.373***	0.900***	0.620***	0.135
	(0.00898)	(0.0405)	(0.0368)	(0.110)	(0.185)	(0.109)
Exchange Rate Growth	0.0117	0.00764	0.000873	0.000725	0.00481	0.00250
	(0.00795)	(0.0168)	(0.0195)	(0.00310)	(0.00676)	(0.00262)
Export Growth	-0.000499	0.0132**	-0.000233	0.000303	0.00807***	0.000232
	(0.00235)	(0.00667)	(0.00613)	(0.000867)	(0.00302)	(0.000363)
Primary Exporter Indicator	0.244***	0.594***	0.353**	-1.696**	-0.837	2.415***
	(0.0756)	(0.191)	(0.153)	(0.825)	(1.121)	(0.862)
ST Debt/GDP	0.492***	0.648***	-1.354***	0.529***	0.669***	0.859**
	(0.0858)	(0.213)	(0.414)	(0.167)	(0.122)	(0.421)
Current Account/GDP	1.802***	8.066***	12.26***	0.115	1.063*	-0.415
	(0.360)	(1.299)	(2.171)	(0.269)	(0.576)	(0.711)
Interest Differential	4.49e-05	0.0225***	0.0457***	-0.00257	-0.00125	0.00292
	(0.00354)	(0.00596)	(0.00813)	(0.00176)	(0.00470)	(0.00262)
M2/GDP	0.149***	-0.0266	0.426***	0.313**	0.410***	0.0858
	(0.00949)	(0.0317)	(0.0264)	(0.145)	(0.0768)	(0.100)
Reinhart-Crisis	0.0916	1.380***	0.965***	0.156	0.447**	-0.0364
	(0.112)	(0.186)	(0.241)	(0.147)	(0.182)	(0.0492)
GDC indicator	0.170	-0.169	-0.654*	-0.0123	-0.0622	-0.112
	(0.115)	(0.249)	(0.338)	(0.0420)	(0.152)	(0.104)
IMF loan outstanding	-1.927***	-1.413***	-0.582**	-0.783***	1.445	0.0645
	(0.0883)	(0.198)	(0.261)	(0.0987)	(1.021)	(0.0795)
SWF	0.783***	-0.0658	1.448***	0.136	-0.191	-0.0808
	(0.0858)	(0.253)	(0.235)	(0.156)	(0.251)	(0.0691)
Fed Swap Line	0.229**	-0.372	-1.211***	-0.106	-0.340	-0.0455
	(0.0923)	(0.326)	(0.368)	(0.0816)	(0.411)	(0.0374)
Constant	17.39***	6.537***	8.792***	-1.007	-9.123*	15.38***
	(0.259)	(1.100)	(1.117)	(2.653)	(4.945)	(3.648)
Observations	1,113	597	1,092	1,113	597	1,092
R-squared	0.651	0.240	0.451			
Number of Countries	31	26	29	31	26	29

Robust standard errors in parenthesis; ***p<0.01, **p<0.05, *p<0.1; "IFS-IR" (includes interest income, valuation changes, IMF loans, SDRs, SWFs, drawn swap lines, excludes gold), "Accumulated Active Management" is calculated from SDDS reserve template data (excludes interest income, valuation changes, gold, IMF loans, SDRs, SWFs, and swap lines), "Accumulated BOPline" calculated from "Reserves and Related Items" in the BOP data (includes interest income, gold, IMF loans, SDRs, SWFs, drawn swap lines, excludes valuation changes). Regressions include only Emerging Market countries as defined in Table 3. Variable definitions are provided in section 7 of the paper.

Table 5: Determinants of Real GDP Growth After the GFC (based on Quarterly Observations through 2010Q2)

VARIABLES	(1) Full Sample	(2) Emerging Market Countries	(3) Excludes Commodity Exporters	(4) Low Reserves to Short-Term Debt	(5) Carry-trade Counterparty Countries	(6) Carry-trade Counterparty Countries	(7) Carry-trade Counterparty Countries
GDP growth during GFC	-0.373***	-0.360***	-0.329***	-0.0909	-0.409***	-0.280**	-0.369***
	(0.104)	(0.115)	(0.108)	(0.136)	(0.123)	(0.125)	(0.121)
Reserves/GDP (2006Q4)	0.240***	0.236***	0.259***	0.245***	0.281***	0.576**	0.312**
	(0.0627)	(0.0810)	(0.0616)	(0.0886)	(0.0845)	(0.241)	(0.126)
EMP during GFC	0.142*	0.192*	0.115	0.248**	0.0873	0.141	0.123
	(0.0734)	(0.101)	(0.0878)	(0.0984)	(0.106)	(0.105)	(0.103)
Reserve Growth (IFS_IR)	-0.0722	-0.107	-0.0650	-0.0253	-0.118**		
	(0.0435)	(0.116)	(0.0500)	(0.0236)	(0.0551)		
Reserve Growth (SDDS)						-0.141*	
						(0.0727)	
Reserve Growth (BOP)							-0.0600***
							(0.0182)
Constant	0.0104	0.00824	0.00912	0.00949	0.0259	0.0143	0.0250
	(0.0123)	(0.0227)	(0.0134)	(0.0121)	(0.0198)	(0.0227)	(0.0192)
Observations	66	43	54	38	38	31	35
R-squared	0.550	0.472	0.524	0.529	0.632	0.610	0.630

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; dependent variable is real GDP growth after the country-specific crisis period through 2010Q2; real GDP, EMP and Reserve Growth variables are calculated over the country-specific crisis period (based on a peak-to-trough real GDP calculation after 2007), IFS_IR reserve growth (includes interest income, valuation changes, IMF loans, SDRs, SWFs, drawn swap lines, excludes gold), SDDS reserve growth uses the actively managed reserves series (excludes interest income, valuation changes, gold, IMF loans, SDRs, SWFs, and swap lines), BOP reserve growth uses the "Reserves and Related Items" series in the BOP (includes interest income, gold, IMF loans, SDRs, SWFs, and drawn swap lines, excludes valuation changes). EMP is the exchange rate change (depreciation is positive). "Carry-trade Counterparty" countries are defined by a high interest differential relative to the US.

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.[37] 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.[38] Quick calculations from trade data and other statistics led investors to the realization that Mexican international reserves were most likely exhausted. Moreover, investors realized that the Mexican government had large external liabilities in the form of short-term, (de facto) dollar-denominated, government bonds (tesobonos).[39] 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 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 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

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[37] 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').

[38] 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.

[39] 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).

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 the case of emerging market countries, a source of suspicion for adequacy of international reserves at the time of crisis.[40]

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[40] 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.