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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. This paper examines 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.

   We begin 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 focuses 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 indicate 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 canceled 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 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 gage 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

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 on 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.

Countries accumulate reserves for precautionary purposes against current and capital account shocks and as a byproduct of intervention strategies to keep the international value of the domestic currency stable and low in order to boost export growth (Dooley, Folkerts-Landau and Garber (2003)).[3] There have been a number of recent empirical studies attempting to test 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 gage 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.

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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] There is a large literature exploring the motivation for and efficacy of foreign exchange intervention policy in developed countries (see, for example, Adams and Henderson (1983), Dominguez and Frankel (1993), Dominguez (2006b), Ito (2003, 2004, 2005 and 2007b) and Ito and Yabu (2007)). The efficacy of 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.

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.[4] Obstfeld, Shambaugh and Taylor (2009) and Aizenman, Jinjarak and Park (2011) document the heavy reliance on swap lines of inter-governmental credit during the crisis, especially by developed countries that did not have large reserve accumulations. They suggest that swap lines may substitute for reserves for some countries.[5]

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 and monetary authorities 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 stick to the naming conventions used by the IMF's Special Data Dissemination Standard (SDDS) Reserve template.

Total official reserves (IR) are the broadest definition of international reserves. This concept includes foreign currency reserves (ForexR) and non-currency reserves, which include monetary gold (Gold), Special Drawing Rights (SDR), the reserve position at the International Monetary Fund (IMF) and other reserve assets (Other). Foreign currency reserves (ForexR), in

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[4] 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.

[5] 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.

turn, consist of two categories of financial assets, securities (SEC) and currencies and deposits (DEPO). In equations:

$$(3.1) \quad IR = ForexR + Gold + SDR + IMF + Other$$
$$(3.2) \quad ForexR = SEC + DEPO$$

The securities (SEC) and currencies and deposits (DEPO) component of official reserves reflect foreign reserve policy actions, including foreign exchange market intervention and reserve portfolio management (involving shifts between currency denomination and asset maturities). Our analysis in the next section focuses on the details of foreign reserve policy actions reflected in changes in ForexR. 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.[6]

Cross-country data are available for IR, ForexR, 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 assets between securities and deposits (SEC and DEPO) in the foreign currency component of reserves (ForexR). 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 or monetary authority, 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

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[6] The average share of 'other' in IR for the SDDS countries is 2.84% and the median is .04%; for 80% of the countries in the sample the share is between 0 and 3%. The country with the largest share (45%) of 'other' is South Africa between 2003 and 2005, followed by Norway in 2003-4 and New Zealand in 2006. The financial derivatives component of 'other' is zero for most countries; the average share of financial derivatives in IR is .05%.

[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) In the case of the United States, international reserves are held in the Treasury's Exchange Stabilization Fund (ESF) and the Federal Reserve's System Open Market Account (SOMA). Among the SDDS compliant countries Argentina, Belgium, Germany, Italy, Luxembourg, Slovenia, Spain and the UK separately report reserves held by the central government (CG) and the monetary authority (MA).

[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).

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.

Some SWF assets, including assets managed by Singapore's Government Investment Corporation (GIC), are included in the country's international reserves, since the corporation is designated as a manager of international reserves. However, the assets in Singapore's TEMASEC, another SWF, are not included in the country's international reserves, since these assets include equities and other illiquid assets. Assets in the Chinese sovereign wealth fund, CIC, are most likely not in Chinese international reserves, as they were created to diversify international reserves, mostly US Treasury bonds, into high-risk, high-return assets, such as stakes in financial institutions and alternative assets, which would not qualify as international reserves.

In response to concerns in both the financial markets and by creditor governments to perceived problems with international reserve measurement as well as the reliability of other key macroeconomic variables, the IMF launched the 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.[11] Nevertheless 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

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[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).

[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). In 1997 the IMF announced a second set of more generalized standards, the General Data Dissemination System (GDDS).

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 crises 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, though information on reserve-related liabilities was also encouraged. When the Reserve Template became effective, SDDS subscribers were required to provide detailed monthly reserve data by asset class (gold, SDRs, currency and deposits, securities, financial derivatives)[14] and location (reserves held in other national banks, BIS, IMF, or domestic and foreign commercial banks)[15] as well as detailed information on reserve-related liabilities.

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

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[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 of the Special Data Dissemination Standard, IMF, December 2, 1998. http://www.imf.org/external/np/sta/dsbb/1998/120298.pdf).

[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.

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

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

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 generally 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).[19] 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). The list of central banks to which swap lines were extended was expanded in September 2008 to include the central banks of Japan, England, Canada, Australia, Denmark, Sweden, and Norway; and in October 2008 to New Zealand, Korea, Brazil, Singapore, and Mexico. The addition of the last four countries on the list was an unusual move in that these countries are regarded as emerging rather than advanced countries. The Fed swap 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] Each swap line was originally due to expire in several months, they were later extended and finally expired in February 2010. The swap lines offered to the ECB (originally $20 billion), SNB (originally $4 billion), Bank of England (originally $40 billion), and Bank of Japan (originally $60 billion) were uncapped (these banks could ask for any dollar amount) in October 2008.

Through these swap arrangements foreign central banks were able to obtain US dollars in exchange for their own currency with an agreement to reverse the transaction at a future date. The foreign central banks in turn provided dollar liquidity to commercial banks in their respective countries (Fleming and Klagge (2010) and Goldberg, Kennedy, and Miu (2011)

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[18] SWFs could be defined as reserves if they allow "the monetary authorities control over the disposition of funds" *BPM6* (Chapter 6, 6.95; pp. 115-116).

[19] The Fed does not include the 'mirror-image' of the swaps in their SDDS data (though they do appear in the BOP data), with the view that because the swaps are of short duration (3 months), and many of the currencies received are not highly liquid, they do not really 'count' as reserves. There seems also to be wide variation in the approach taken by countries that drew on swap lines, in terms of where these appear in the Reserve Template. Receipts of foreign currencies due to the swap transactions may be recorded in some categories of the reserve template Section I.A. (which is the data we use in our analysis), but in which exact category they are recorded seems to depend on the country.

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

provide details on the Fed swap facilities established during the financial crisis).[21] The Federal Reserve swap lines were drawn heavily, most notably by the ECB, the BOE, and the BOJ, between September 2008 and December 2008, when the total of outstanding swap amounts reached $543 billion, as shown in Table 2. Not all central banks used the established swap lines.[22]

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[23]) were temporarily inflated.

In addition to the Federal Reserve, the ECB, the Bank of England and the Swiss National Bank provided the liquidity in Euro, British Pounds and Swiss Francs to other central banks during the global financial crisis. The swap lines established by the ECB to central banks of Hungary, Iceland, Denmark, and Poland seem to have been effective as they were heavily drawn upon (Aizenman, et al. (2011)). Although the People's Bank of China (PBoC) also provided swap lines to the central banks of Argentina, Belarus, Hong Kong, Indonesia, Korea, and Malaysia, these swap lines served a different purpose. The Chinese yuan is not a convertible currency and the Yuan was not part of the international liquidity shortage. The extension of these swap lines was motivated by the PBoC's desire to make the Yuan more "international" and to help trade finance rather than to address any Yuan liquidity shortage, which was a moot issue (Ito (2011).

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

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[21] 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.

[22] See http://www.federalreserve.gov/newsevents/reform_swaplines.htm

[23] 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 al. (2011, p. 11)).

members or, in some cases, by the IMF designating members with strong external positions to purchase SDRs from members with weak external positions. It is in this way that SDRs are transferred among IMF countries. General allocations of SDRs are based on long-term global needs to supplement existing reserve assets and have been made only three times, in 1970-72, in 1979-81, and in 2009.[24] 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 allocations 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
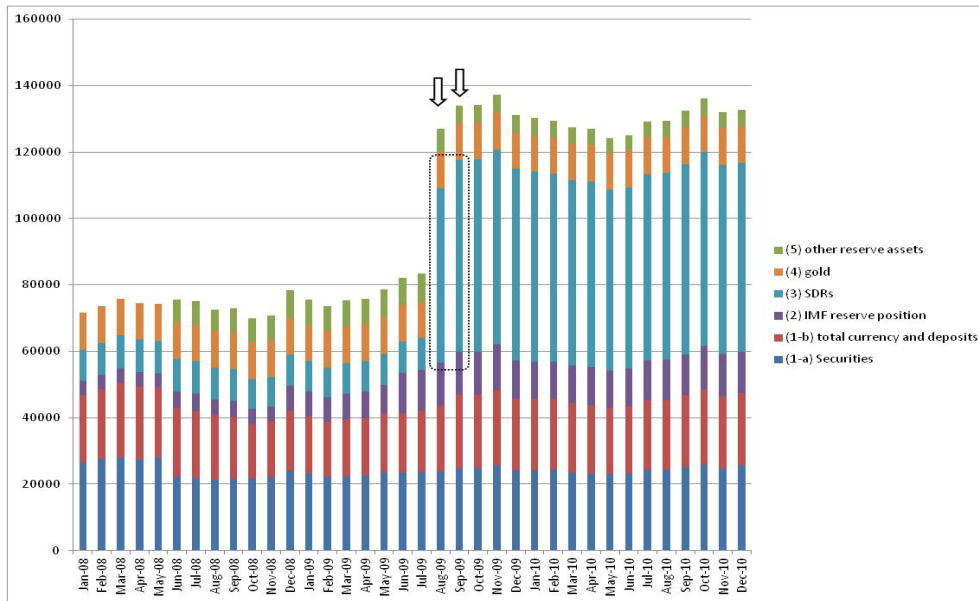
Note: arrows show the 2009 General SDR allocation (August) and the special allocation (September).

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

Figure 1b: Iceland International Reserve Assets, 2008-10
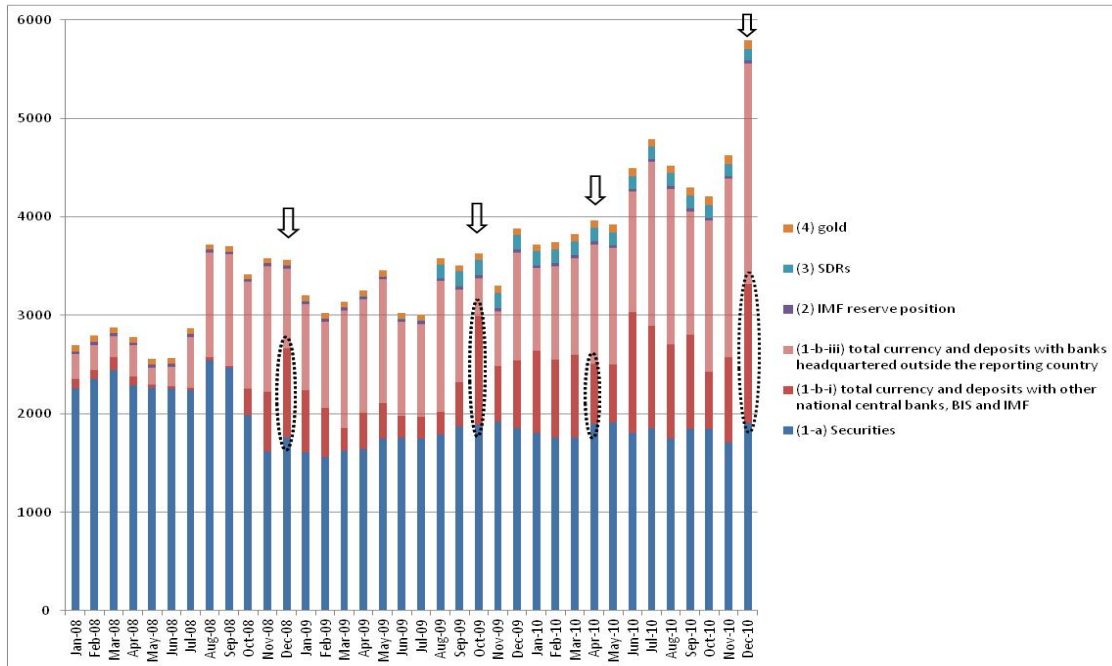
Note: arrows show IMF loans.

4. Measuring Reserve Changes

Worldwide international reserves increased dramatically in the 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 of 2010, the top four reserve holding countries are China, Japan, Saudi Arabia, and Russia.

Figure 2: World International Reserves (USD million)
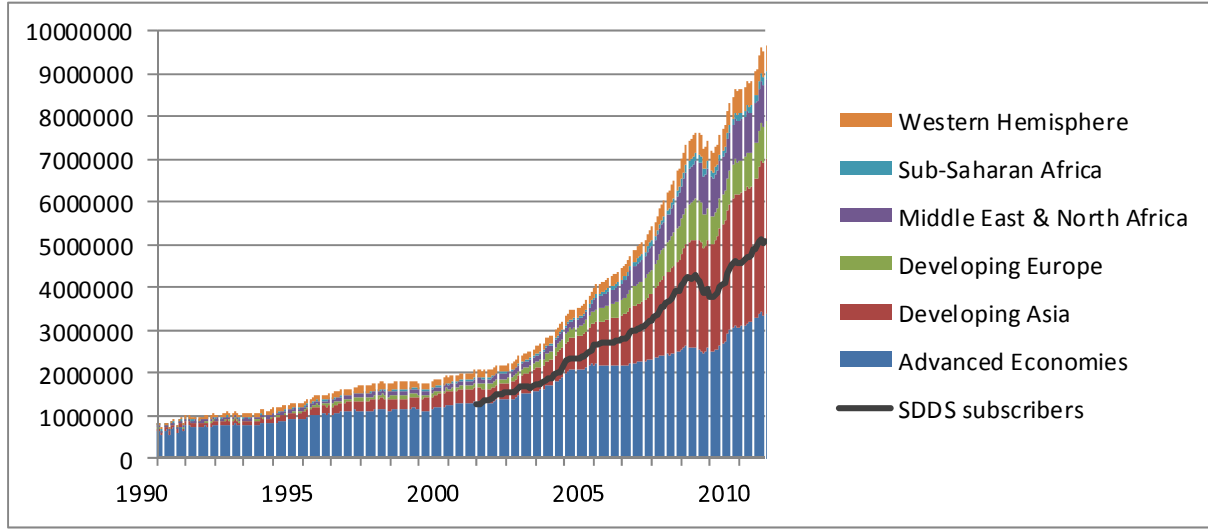
Official Reserves grow as a result of: (1) purchases of foreign currency reserve assets, (2) the receipt of interest income on existing assets, (3) capital gains on existing assets, and (4) increases in non-currency asset holdings. Recall from equation (3.1) that Official Reserve Assets (IR) are composed of foreign currency reserves (ForexR), Gold, SDRs, the reserve position in the IMF, and Other reserve assets. Foreign currency reserves, ForexR, is further divided into securities (SEC) and currency and deposits (DEPO).

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

$\qquad$ = (SEC + DEPO) + Gold + SDR + 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. Figures 1a and 1b show visually how changes in two of these components, new SDR allocations and IMF loans, influence reserve stocks. Define the sum of changes in Gold, SDRs, IMF reserves, and Other, as Non-Currency Reserves (NonCR). Then,

(4.2) $\quad$ IR = SEC + DEPO + NonCR.

(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. We categorize these purchases and sales as "active management" because they are made at the discretion of authorities; they may be made for investment purposes, precautionary reasons, or for the purpose of influencing exchange rates. In equations:

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

Interest income	Active management including intervention	Passive Management (valuation changes)	Changes in Gold, SDRs, IMF, and Other

Researchers often use changes in official reserves, $\triangle IR$, as a proxy for foreign exchange market interventions because few countries report these operations. However, as equation (4.4) shows, $\triangle IR$ includes components that have nothing to do with intervention (or active management). Changes in reserves will be a particularly poor proxy for interventions 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 (ForexR).[25] Ideally, researchers would like data on the types of securities (by currency, maturity, and risk-class), and types of deposits (by currency, type of financial institution taking deposits, and domestic or foreign) held in ForexR, in order to analyze portfolio management of foreign currency reserves and intervention policy. However, in most countries this kind of detailed information is not made public.

The SDDS Reserve Template, which requires reporting countries to break down the asset categories of foreign currency reserves, goes some way toward allowing researchers to estimate interest income. Unfortunately, details such as the currency composition of foreign currency

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[25] An alternative approach to isolating the purchases and sales of foreign currency reserve assets is to use "flow variables" reported in the Balance of Payments (BOP) data set. There are two potential ways to back out the "active management" component of reserves using the BOP statistics. First, using the Current Account, Capital Account, and Financial Account data, net foreign reserves can be inferred, though because these data come from different statistical inferences and aggregations, net errors and omissions are huge. A second approach involves using the Reserves and Related Items category of the BOP, which records the market valued purchases and sales of reserve assets. These data also include non-currency components of official reserves. Our approach is to strip the nonCR components from Reserves and Related Items in order to estimate the valuation change component in (4.4).

reserves are not provided in the Reserve Template. The method we use to estimate interest income is explained in the next section.

The Reserve and Related Items category in the Balance of Payment Statistics (BOP) records the market valued purchases and sales of reserve assets. These data come directly from the balance sheet of the authorities and represent real transactions (at market value) because these data are compiled by authorities based on their transaction records. This data category also includes transactions of gold, SDRs, the reserve position in the IMF, and other assets. Using the notation of the $\triangle$IR equation, Reserves and Related Items (Res_BOP) can be expressed as follows:

(4.5) $\text{Res\_BOP} = r^s * \text{SEC} + r^d * \text{DEPO} + \triangle^{ps}\text{SEC} + \triangle^{ps}\text{DEPO} + \triangle\text{NonCR}$

| Interest income | Active management including intervention |

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

(4.6) $\triangle\text{IR} - \text{Res\_BOP} = \triangle^{val}\text{SEC} + \triangle^{val}\text{DEP}$

Because Res_BOP includes interest income and changes in NonCR (the transactions involving gold, reserves at the IMF, SDRs, and other assets) it, like $\triangle$IR, is not a good proxy for intervention. But, together with estimates for interest income (which can be substantial for countries with large stocks of reserves), and information on nonCR, we use Res_BOP to calculate reserve stock valuation changes.

5. Active versus Passive Reserve Accumulation

While all SDDS compliant countries report detailed, marked-to-market,[26] 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* valuation changes in the underlying assets held, or *active* purchases or sales of reserves.[27] 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 some reserve assets are declining, which was likely 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.[28] 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 (ForexR) 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[29]. We use the monthly

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

[27] While we know of no countries that provide detailed accounts of the individual 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.

[28] 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.

[29] These data are available at http://www.imf.org/external/np/sta/cofer/eng/index.htm. There are two studies that provide limited, but more disaggregated, information on currency composition. Truman and Wong

SDDS Reserve Template foreign currency reserve (ForexR) composition data (SEC and DEPO), together with proxies for returns to securities (10-year government bond yields) and deposits (3-month inter-bank yields)[30], and the quarterly COFER approximations of currency denomination[31], to strip out *passive* interest income. We use the Reserves and Related Items line in the BOP (Res_BOP) to strip out *passive* valuation changes. Figure 4 presents the underlying security and deposit data that we use in the interest income calculations. The long-term (ten-year) government bond yields fell gradually over this time period, while the short-term (three-month) bank yields are more dispersed and volatile prior to the GFC.

Figure 3: Yields used in the interest income simulation

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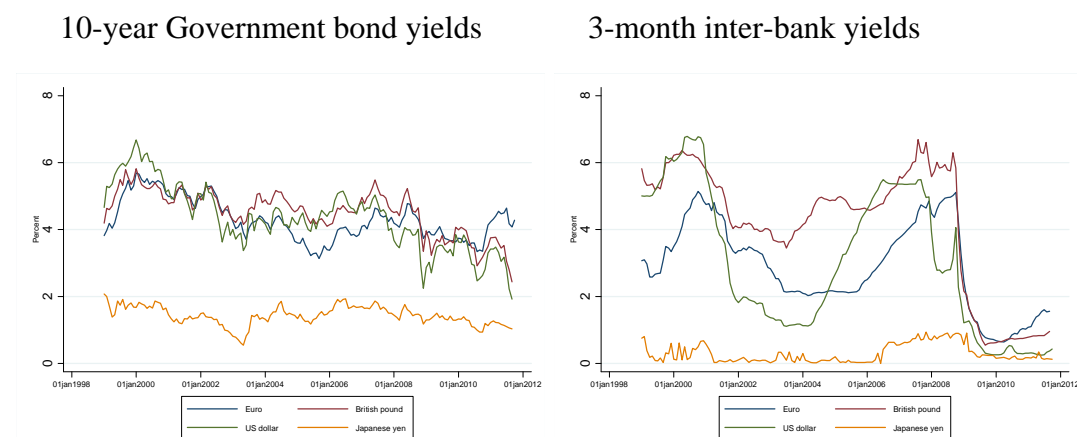
Source: Haver

(2006: Table 3) provide an annual breakdown of the currency composition of reserves for selected countries in 2004 (based on Central Bank annual reports). Lim (2006: Table 2) disaggregates the COFER-reporting countries into dollar-area and euro-area countries for end-of-year 1998 through 2004 and the first three quarters of 2005. He does not identify the countries in each area due to confidentiality issues. It is also the case that some individual countries provide currency composition information. For example, the Swiss National Bank provides current currency denomination data on reserve assets at http://www.snb.ch/en/iabout/assets/id/assets_reserves and historical data are available through 2006 at http://www.snb.ch/en/iabout/stat/statpub/histz/id/statpub_histz_actual. Likewise, the US provides a current breakdown of reserves into euro and yen at http://www.treasury.gov/resource-center/data-chart-center/IR-Position/Pages/01272012.aspx. The UK provides the most comprehensive data which includes detailed monthly current and historical (starting in 1999) currency denomination data at http://www.bankofengland.co.uk/statistics/reserves/index.htm,
[30] 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.
[31] 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.

An important assumption we must make for this "simulated" interest income calculation is that each country's shares of foreign currency reserve assets in securities and deposits are not adjusted over the month; interest income in period $t+1$ is based on shares of securities and deposits in various currency denominations reported in period t.

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

$$\Delta IR = \Delta ForexR + \Delta NonCR$$

$$\Delta ForexR = \underbrace{r^s * SEC + r^d * DEPO}_{\text{Interest income}} + \underbrace{\Delta^{ps}SEC + \Delta^{ps}DEPO}_{\text{Active management}} + \underbrace{\Delta^{val}SEC + \Delta^{val}DEPO}_{\text{Passive management}}$$
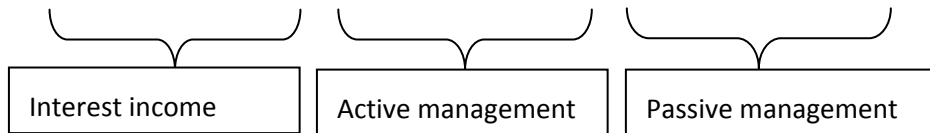
If we decompose the level of foreign currency reserves at $t+1$ into the level that would have been achieved without active management together with the active management component:

(5.1) $ForexR(t+1) = ForexR^{sim}(t+1) + \underbrace{\Delta^{ps}Sec + \Delta^{ps}Dep}_{\text{Active management}}$

where simulated ForexR in $t+1$ is:

(5.2) $ForexR^{sim}(t+1) = ForexR(t) + \underbrace{r^s * SEC + r^d * DEPO}_{\substack{\text{Interest income,} \\ \text{estimated}}} + \underbrace{\triangle^{val}SEC + \triangle^{val}DEPO}_{\substack{\text{Passive management,} \\ \text{based on BOP data}}}$

    Figures 4 to 8 present selected country level plots of actual reserves (the solid lines) and our "simulated" reserves series (the dashed lines) over the period 2000-2011. (Appendix B provides these graphs for all the countries in our sample). The second plot in each figure shows the difference between actual and simulated reserves (the bars), which we term "actively managed reserves" and the accumulation of actively managed reserves (the solid line). In each of these figures we also shade the country-specific crisis period (based on a peak-to-trough real

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seasonally adjusted GDP calculations after 2007). While the full set of country plots indicate wide variation in reserve accumulation patterns, for many countries actual 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, 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, Korea and Singapore provide good examples of this pattern).

Figure 4: Estimates of Bulgaria's Foreign Reserve Management
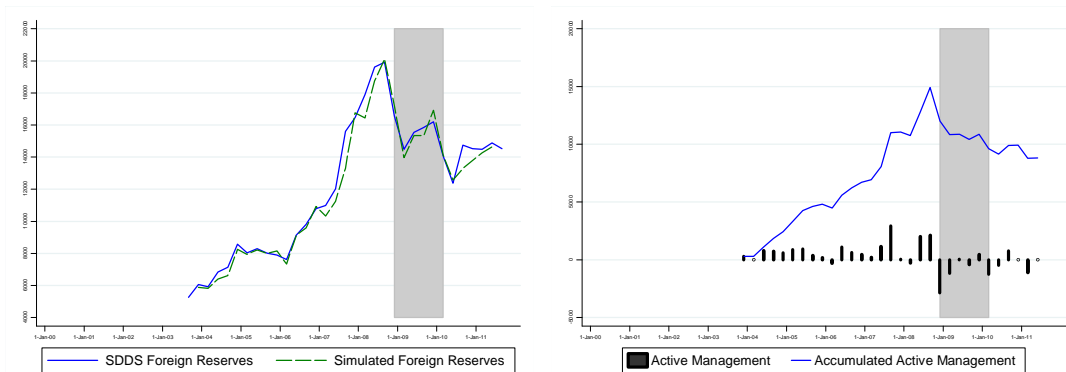
Figure 5: Estimates of Japan's Foreign Reserve Management
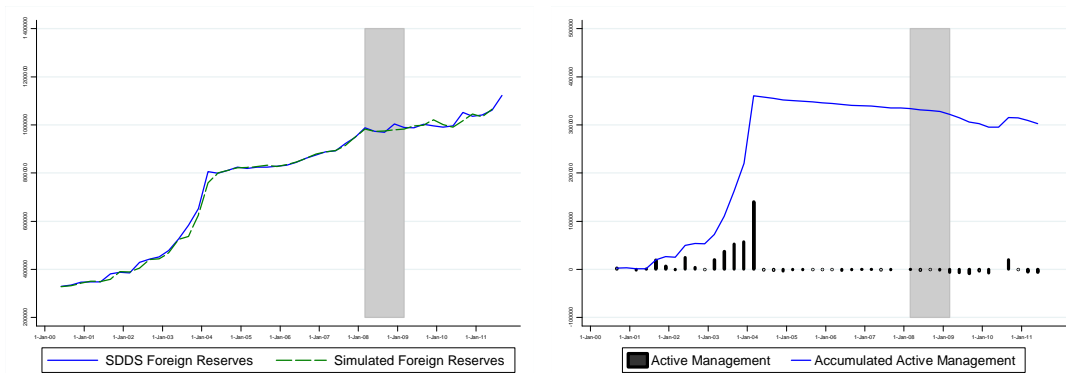
Figure 6: Estimates of Russia's Foreign Reserve Management
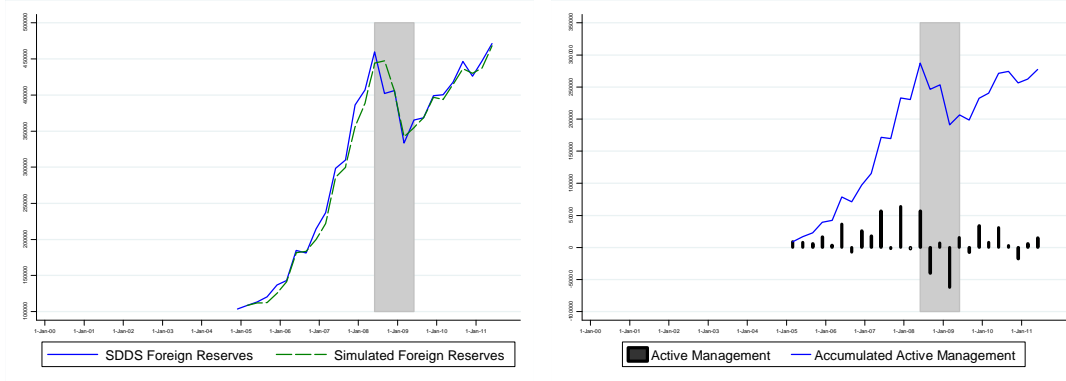
Figure 7: Estimates of South Korea's Foreign Reserve Management
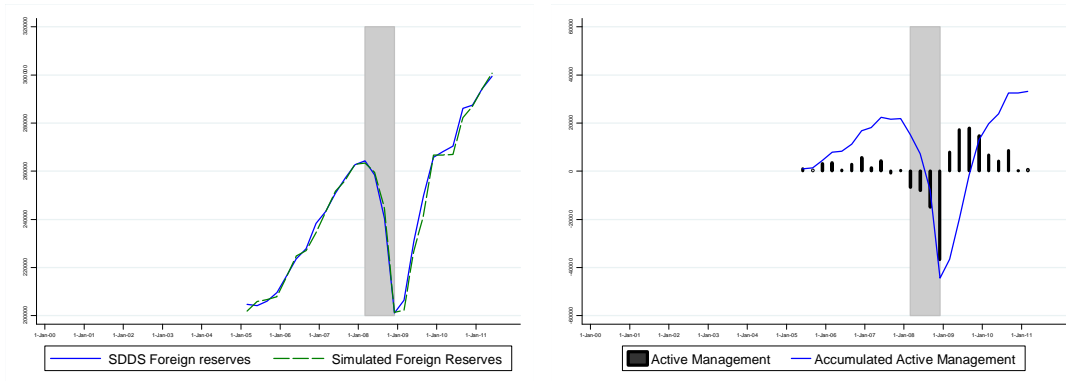
Figure 8: Estimates of Singapore's Foreign Reserve Management
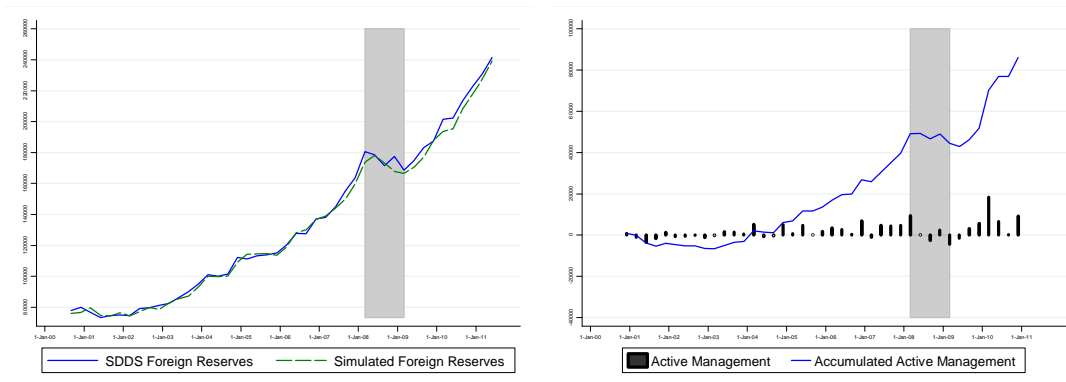
Reserve data for developed countries generally show little evidence of active reserve accumulation (indeed a number of Euro-zone members were actively depleting reserves well

before the global financial crisis).[32] 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).[33] These intervention operations are reflected in the large increases in actual reserves as well as active reserve accumulation in figure 5. 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.

    Figure 9 shows average yearly active reserve accumulation for our full sample of SDDS compliant countries starting in 2000 as well as the emerging market sample. The data indicate that most countries were actively accumulating reserves in the five years prior to the GFC, reserve growth slowed dramatically in 2008-9, and in the case of the emerging market sample went negative in 2008, and then rapidly "bounced back" to pre-GFC levels by 2010.

Figure 9 Average *Active* Reserve Accumulations

All Countries	Emerging Market Countries

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6. Reserve Changes during the GFC

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, (4) impose capital controls, or (5) 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 and to moderate the speed of currency depreciation. 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.[34]

In order to measure the strength of exchange rate market pressure (EMP) during the global financial crisis we calculate the correlation between changes in actively managed reserves and changes in the exchange rate during the country-specific crisis periods, the two components of EMP. Figure 10 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 reserve changes for each country are measured during the country-specific crisis period (as shown in the shaded portions of figures 4-8; based on a peak-to-trough real SA GDP calculation after 2007). Note that because exchange rate and reserve changes are measured over each country's crisis period, countries that share the same currency (for example the euro-zone countries) will not necessarily scatter vertically on the graph as they would if changes were measured over the same time period for all countries. The figure shows that the Japanese yen appreciated most among the currencies of sample countries, while Denmark was the largest reserve accumulator and Belarus experienced the largest reserve decline. Country labels are included in the figure for all countries involved in swap arrangements during the crisis, interestingly there seems to be no systematic relationship between involvement in swap

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[34] 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).

arrangements and reserve depletion, though the figure indicates that most of the countries receiving swap lines did experience currency depreciations.

Figure 10 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. Interestingly, if we use the international reserves data (IR) to measure reserve changes during the country-specific crisis, rather than our active management series, we find that more of the observations appear in the upper-right quadrant of the figure, suggesting that fewer countries that allowed their currencies to depreciate *also* depleted reserves during the crisis. The reason for this is that 'international reserves' include components that do not reflect reserve policy actions during the crisis (recall from equation 4.4 that changes in IR include: interest income, valuation changes, changes in the non-currency components, *and* active management), which obscures the role of reserve sales.

Figure 10: Reserve Changes and Exchange Rate Changes
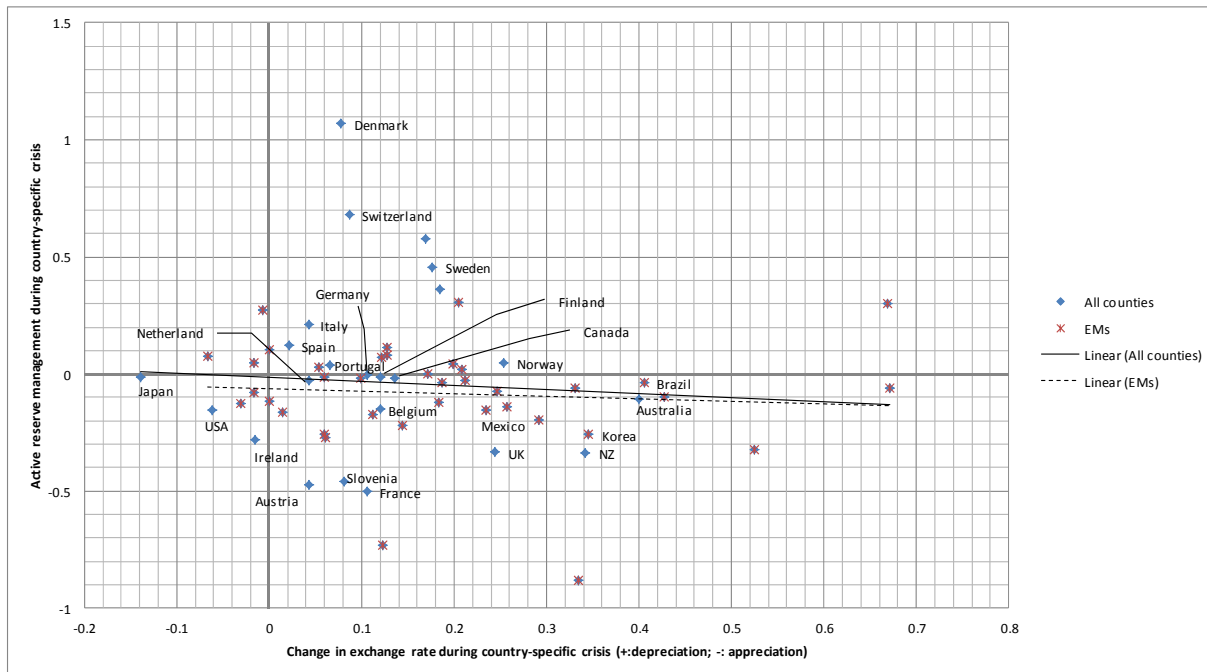
Note: country labels are included for those countries that were involved in swap arrangements during the crisis.

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 emerging market countries experienced rapid reserve accumulation in the pre-crisis period, indicating that they actively increased their foreign currency reserve stocks in the 2007-8 period (when many of the advanced countries were already in crisis) with depletion of reserves only starting in late 2008 and 2009. Our data also indicate that many of these same countries reverted to their pre-crisis accumulation trends by 2010. This "reserve bounce back" is apparent in the full sample of countries as shown in Figure 11, 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 11: International Reserve Bounce-back
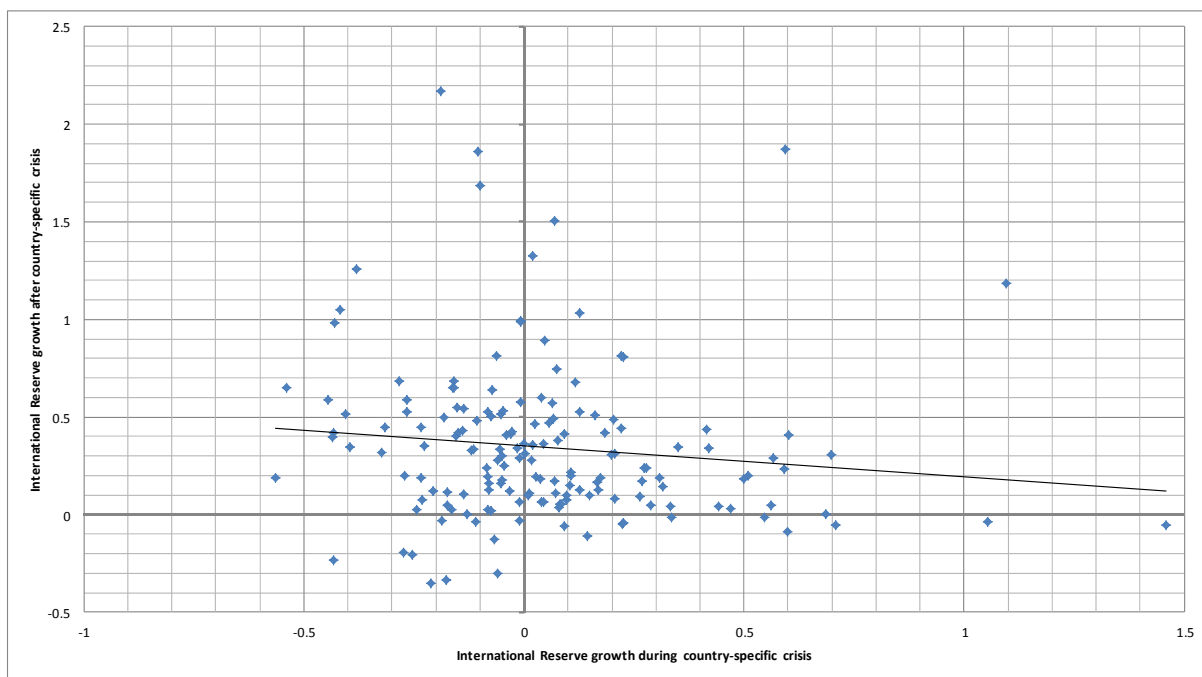
Source: IFS

7. 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 management patterns. While the global financial crisis may have officially started in late fall of 2007 for the advanced countries (the NBER dates the US recession from December 2007 through June 2009), for many emerging market countries the crisis started much later (these country-specific 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]

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 12 we examine the relationship between a measure of reserve adequacy (international reserves measured against GDP in 2006Q4) and output growth during the crisis. In this case, we find a *negative* relationship, indicating that countries with higher reserve adequacy prior to the crisis experienced greater output declines during the crisis.

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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 Spiegel (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.

Figure 12: International Reserve Adequacy and Country-Specific Output Declines
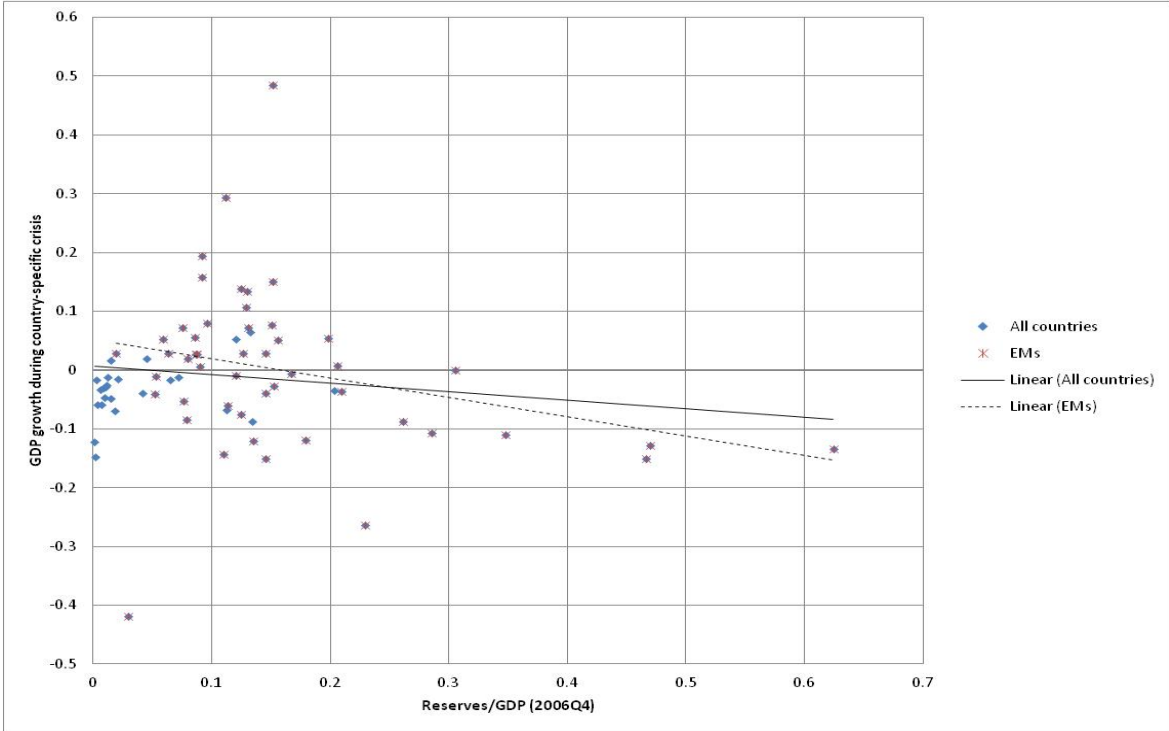
It is also useful to examine the relationship between foreign currency reserve management and *post*-crisis economic performance. Did the countries that used their reserves during the global financial crisis experience faster GDP bounce-back after the crisis? Figure 13 indicates that foreign currency reserve sales during the country-specific crisis periods are positively associated with post-crisis (through 2010Q4) GDP recovery.

Figure 13: Foreign Reserve Accumulation and Post-Crisis GDP Recovery
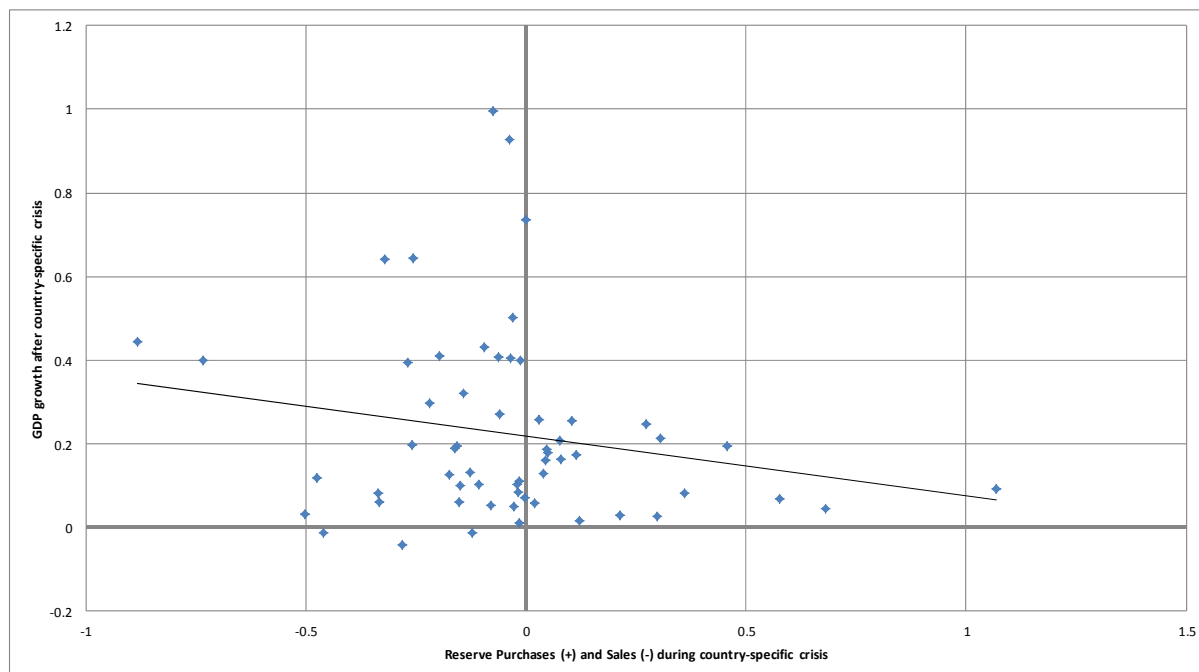
The relationship between reserve accumulation and post-crisis output growth is consistent with the reserve bounce-back pattern we found earlier (shown in Figure 11). It suggests that those countries that *used* their reserves during the crisis, and replenished their reserve stocks after the crisis, were also the countries that experienced higher GDP bounce-back by 2010Q4. This does not suggest that building reserve stocks leads to higher economic performance, but it does indicate a positive (unconditional) 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 4 presents these regression results. The dependent variable is real GDP growth *after* the country-specific crisis through 2010Q4. The explanatory variables include real GDP growth *prior* to the crisis, real GDP growth *during* the crisis, the reserves-to-GDP ratio prior to the crisis (in 2006Q4), reserve growth during the crisis (measured using International Reserves and Active-Management), exchange rate changes during the crisis, and changes in the terms-of-trade[36] during the crisis. The first column in table 4 presents results for our full sample of countries and subsequent columns restrict our sample in

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[36] Terms of Trade (TOT) data are from Haver and are measured as the percent change during the country-specific crisis, so that a larger number indicates an improvement in that country's terms-of-trade. Kazakhstan and Russia experienced the largest TOT declines in our sample, while TOT improved the most for Australia, Indonesia and Israel.

various ways. The second column excludes the developed countries, the third column excludes countries that are not SDDS compliant, the fourth column excludes major commodity exporters, the fifth column is restricted to countries with low reserves-to-debt ratios, and column six restricts the sample to those countries with high interest differentials relative to the US, which we label as "carry-trade counterparty countries".

In column 3 of Table 4 we measure reserve growth during the GFC using the active-management series (which excludes interest income and valuation changes), which is only available for the SDDS compliant country sample. Real GDP growth prior to the GFC (measured from 2005 to the quarter prior to the country-specific crisis) is positive and highly significant in the first two columns, suggesting that those countries that were on a high growth trend prior to the crisis were more likely to return to higher growth after the crisis. Real GDP growth during the (country-specific) crisis did not influence post-crisis recovery in any of the regression specifications. In all the country samples we find that the larger the reserve stocks were, relative to GDP before the GFC started, the higher was post-crisis growth. The statistical significance of the coefficient on exchange rate changes, terms-of-trade changes, and reserve changes during the crisis is less consistent across the columns, but the estimates often indicate that countries which experienced larger depreciations during the crisis and larger improvements in their terms-of-trade, had better post-crisis recovery (most likely through higher exports) . Likewise, depletion of reserves during the crisis (measured using the active management series), conditional on having accumulated reserves prior to the crisis, improved post-crisis growth.

We restrict our sample of countries in column 4 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. 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.

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 Spiegel (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 5 of table 4 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. In this sample of countries we find that larger reserve stocks prior to the crisis increased GDP recovery, but exchange rate depreciation, terms-of-trade changes, and reserve depletion during the crisis did not make a difference.

Another of the explanatory variables that has been found to be important in explaining reserve accumulation 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 regression results reported in column 6 indicate that they also benefitted from high pre-crisis reserve stocks. 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). We also find that exchange rate depreciation (which would lead to capital gains on reserves) played an important role, in terms of GDP recovery, for these countries.

8. 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.

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 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: Details on Federal Reserve dollar auctions (swaps), October 2008- February 2010.

Details on Dollar Auctions (swaps) by Central Banks with Federal Reserve Bank, October 2008-February 1, 2010				
			Net Outstanding Positions ($ billion)	
Central banks	Line size ($ billion)	Starting	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		
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		Res_BOP (Annual) Start date	Res_BOP (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			1965	10	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	1998	1999	1	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	1968	1996	1	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	1993	1	1993	1993	1	2008	4	2009	1
Denmark	AE	1-Sep-00	Dec-99	1957	1	1975	1975	1	2007	4	2009	1
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

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Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		Res_BOP (Annual) Start date	Res_BOP (Quarterly) Start date		GFC start date		GFC end date	
		Date	Start date	year	M	year	year	Q	year	Q	year	Q
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			1991	7	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
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

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Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		Res_BOP (Annual) Start date	Res_BOP (Quarterly) Start date		GFC start date		GFC end date	
		Date	Start date	year	M	year	year	Q	year	Q	year	Q
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			1963	2	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
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			1969	3				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	2006			2007	4	2009	1

Country	EM/AE	Date when subscriber met SDDS specifications	SDDS reserve data (Monthly) Start date	IFS_IR (Monthly) Start date		Res_BOP (Annual) Start date	Res_BOP (Quarterly) Start date		GFC start date		GFC end date	
		Date	Start date	year	M	year	year	Q	year	Q	year	Q
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			1966	1	1977	1981	1	2007	4	2009	1
Total number of SDDS subscribers: 68 (as of May 2011)												

Notes: Available IFS-IR data for Czech Republic, Bahrain, Guinea, Nepal and Zimbabwe are Total Reserves minus Gold. Zimbabwe's IFS_IR data ends pm 2002M2. Taiwan's IFS_IR data are from Bank of China. 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 SA GDP after 2007.

Data Used in Regressions Analyses

Variable	Description	Frequency	Source
IFS_IR	International Reserves	Monthly	IFS
ForexR	Foreign Currency Reserves	Monthly	IMF SDDS database
Active Management	change in ForexR - interest income - valuation changes	Quarterly	author calculations
Res_BOP	Reserves and Related Items	Quarterly	IFS BOP
GDP_WEO	Annual GDP (current prices)	Annual	World Economic Outlook (WEO)
Reserves/GDP	International Reserves over WEO GDP		IFS and WEO
GDP	Quarterly GDP (national currency)	Quarterly	IFS
GDP deflator	GDP deflator or CPI deflator if not available	Quarterly	IFS
EMP	Quarterly Exchange Rate Growth (relative to USD)	Quarterly	IFS
Interest Differential	Domestic minus US interest rate	Monthly	IFS, Central Bank of Taiwan
ST Debt/GDP	[(ST liabilities to BIS banks + ST International debt securities + cross-border loans from BIS reporting banks + International debt securities)/WEO GDP] *100	Quarterly	WB (JEDH) and WEO
Primary Exporter Indicator	Dummy for countries in the top 25% of primary exporters	Quarterly	IFS
TOT	Terms of Trade	Quarterly	Haver
GFC-Crisis	Dummy indicating country-specific peak to trough SA real GDP during the GFC	Quarterly	author calculations

Table 4: Determinants of Real GDP Growth After the GFC (based on Quarterly Observations through 2010Q4)

VARIABLES	(1) Full Sample	(2) Emerging Market Countries	(3) SDDS Compliant Countries	(4) Excludes Commodity Exporters	(5) Low Reserves to Short-term Debt	(6) Carry-trade Counterparty Countries
Real GDP growth prior to GFC	0.694***	0.871**	0.190	0.182	-0.334	0.192
	(0.186)	(0.323)	(0.141)	(0.137)	(0.195)	(0.149)
Real GDP growth during GFC	0.153	0.215	-0.264	-0.261	-0.551	-0.250
	(0.202)	(0.383)	(0.324)	(0.306)	(0.636)	(0.311)
Reserves/GDP (2006Q4)	0.181*	0.318*	0.286***	0.281***	0.387***	0.275**
	(0.0972)	(0.155)	(0.0564)	(0.0512)	(0.0476)	(0.119)
EMP during GFC	0.0755	0.371**	0.304***	0.290***	0.125	0.296***
	(0.0924)	(0.172)	(0.0901)	(0.0911)	(0.137)	(0.0991)
TOT change during GFC		-0.238	0.313	0.330*	-0.0301	0.344
		(0.350)	(0.219)	(0.192)	(0.0982)	(0.220)
Reserve growth during GFC (IFS_IR)	-0.0155	-0.0463		-0.0120	0.00922	-0.00787
	(0.0326)	(0.147)		(0.0234)	(0.0269)	(0.0253)
Active Management during GFC			-0.00771*			
			(0.00398)			
Constant	-0.0195	-0.190*	-0.0311	-0.0253	0.0252	-0.0271
	(0.0331)	(0.104)	(0.0240)	(0.0243)	(0.0277)	(0.0260)
Observations	67	24	33	33	23	29
R-squared	0.453	0.557	0.580	0.582	0.554	0.548

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 2010Q4; real GDP, Exchange Market Pressure (EMP), the Terms-of-Trade (TOT), Reserve Growth and Active Management variables are calculated over the country-specific crisis period (based on a peak-to-trough real SA GDP calculation after 2007). IFS_IR reserve growth includes gold, IMF loans, SDRs, SWFs, drawn swap lines. The Active Management series excludes interest income, valuation changes, gold, IMF loans, SDRs, SWFs, swap lines. EMP is the exchange rate change (depreciation is positive). Carry-trade counterparty countries are defined by a high interest differential relative to the US interest rate.

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

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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).

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

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

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

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