

NBER WORKING PAPER SERIES

FINANCIAL INSTABILITY, RESERVES, AND CENTRAL BANK SWAP LINES  
IN THE PANIC OF 2008

Maurice Obstfeld  
Jay C. Shambaugh  
Alan M. Taylor

Working Paper 14826  
<http://www.nber.org/papers/w14826>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
March 2009

We thank the Fondation Banque de France for supporting our research through a grant administered by the CEPR. Matteo Maggiori provided helpful research assistance. The paper was presented at the ASSA Meetings, San Francisco, January 3-5, 2009. We received many helpful comments, especially from our discussant Joshua Aizenman. All errors are ours. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2009 by Maurice Obstfeld, Jay C. Shambaugh, and Alan M. Taylor. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Financial Instability, Reserves, and Central Bank Swap Lines in the Panic of 2008  
Maurice Obstfeld, Jay C. Shambaugh, and Alan M. Taylor  
NBER Working Paper No. 14826  
March 2009  
JEL No. E42,E44,E58,F21,F31,F33,F36,F41,F42,O24

**ABSTRACT**

In this paper we connect the events of the last twelve months, "The Panic of 2008" as it has been called, to the demand for international reserves. In previous work, we have shown that international reserve demand can be rationalized by a central bank's desire to backstop the broad money supply to avert the possibility of an internal/external double drain (a bank run combined with capital flight). Thus, simply looking at trade or short-term debt as motivations for reserve holdings is insufficient; one must also consider the size of the banking system (M2). Here, we show that a country's reserve holdings just before the current crisis, relative to their predicted holdings based on these financial motives, can significantly predict exchange rate movements of both emerging and advanced countries in 2008. Countries with large war chests did not depreciate -- and some appreciated. Meanwhile, those who held insufficient reserves based on our metric were likely to depreciate. Current account balances and short-term debt levels are not statistically significant predictors of depreciation once reserve levels are taken into account. Our model's typically high predicted reserve levels provide important context for the unprecedented U.S. dollar swap lines recently provided to many countries by the Federal Reserve.

Maurice Obstfeld  
Department of Economics  
University of California, Berkeley  
508-1 Evans Hall #3880  
Berkeley, CA 94720-3880  
and NBER  
obstfeld@econ.berkeley.edu

Alan M. Taylor  
Department of Economics  
University of California, Davis  
One Shields Avenue  
Davis, CA 95616  
and NBER  
amtaylor@ucdavis.edu

Jay C. Shambaugh  
Dartmouth College  
Department of Economics  
6106 Rockefeller Hall  
Hanover, NH 03755  
and NBER  
jay.c.shambaugh@dartmouth.edu

For nearly two decades, the group of emerging-market countries increased its holdings of liquid foreign exchange reserves, both in dollar terms and relative to domestic income levels. That trend accelerated in the early 2000s, but it may be ending now as the emerging economies struggle in the backwash of the global financial crisis and economic slowdown. In the mid-2000s, liquidity was abundant in the world economy, but recently there has been an acute global shortage of dollar liquidity. Recent declines in emerging market international reserves are directly related to this shortage.

Figure 1 illustrates reserve developments for three large emerging economies, the Russian Federation, India, and Korea. All three countries' reserve levels peaked and then began to decline in the summer of 2008. In particular, Russia's huge reserve holdings—second in dollar terms only to those of China and Japan—have plummeted by about a quarter since reaching their oil-driven peak in July 2008.<sup>1</sup> There are many other examples beyond the three especially dramatic ones in Figure 1; often, however, the percentage reserve losses are smaller (so far) and start later (for example, after the September 2008 Lehman Brothers collapse). The Russian, Indian, and Korean currencies have all depreciated against the United States dollar since the summer of 2008, with Korea's won declining most dramatically to levels not seen since the Asian crisis of the late 1990s.

Before the recent crisis, commentary on the emerging-market reserve buildup focused on the possibility that reserve stocks might have reached “excessive” levels. Certainly some countries' reserve levels far exceeded the levels needed to counter fluctuations in export earnings, and often even covered the possibility that short-term

---

<sup>1</sup> The Russian situation was exacerbated by noneconomic fundamentals (political risk), most notably following the invasion of Georgia in August 2008. The Russian data are also obfuscated by occasional replenishments of the central bank's reserves by drawing from the country's Sovereign Wealth Fund. The fungibility of central bank and SWF assets, and the rapidly growing size of SWF hoards, will likely complicate measurement even further in future.

external debts might not be rolled over (the so-called “Guidotti-Greenspan” prescription for reserve adequacy). Economic analysis of optimal reserve levels has a long history, going back at least to the writing of Henry Thornton (1939) at the start of the nineteenth century. In recent work, we have followed Thornton’s lead, arguing that governments—especially those of emerging markets—view reserves as protection against “double-drain” crisis scenarios in which banking and currency problems interact in ways likely to cause sharp and disruptive external currency depreciation.<sup>2</sup>

In a specific crisis scenario, investor fear of currency depreciation leads to a run out of domestic deposits, pressuring banks and triggering lender-of-last resort liquidity (LLR) provision by the monetary authorities. This LLR support, however, magnifies the potential claims on official foreign exchange reserves, and hence magnifies the currency depreciation that results when the reserves are expended to support the exchange rate. It follows that reserve levels may have to be quite large if the banking system is highly developed and the government hopes to resist sharp currency depreciation in a potential crisis. Official fear of abrupt depreciation may be due to dollarized financial liabilities, rapid pass-through to inflation, or other factors discussed in the “fear of floating” literature.

The utility of foreign exchange reserves is well articulated by the International Monetary Fund (2008, p. 37) in a recent overview of the current crisis: “[I]n the face of sharp capital outflows, countries will need to respond quickly to ensure adequate liquidity and deal with emerging problems in weaker institutions. The exchange rate should be

---

<sup>2</sup> See Maurice Obstfeld, Jay C. Shambaugh, and Alan M. Taylor (2008). Similar theoretical ideas have been discussed in the crisis literature, for example by Guillermo A. Calvo (1996, 2006), Calvo and Enrique G. Mendoza (1996), Roberto Chang and Andrés Velasco (2001), Jeffrey D. Sachs (1998), and Velasco (1987). Jeanne (2007) surveys recent commentary and analysis regarding emerging-market reserves.

allowed to absorb some of the pressure, but stockpiles of reserves provide room for intervention to avoid disorderly market conditions.”

## I. Financial Stability and Reserves in the Data

In Obstfeld et al. (2008) we argue that a considerable share of the reserve accumulation in recent years can be explained as an attempt by central banks to insure against this sort of financial instability. Importantly, the financial shock we consider is not simply a “sudden stop”, in which case countries would need to hold reserves only in proportion to their short term external debt. Rather, internal sources of financial instability also can be critical. As a result, when a country has open financial markets and desires exchange rate stability, it needs to hold reserves proportional to the size of its banking system.

Specifically, we show that the reserves/GDP ratio is a function of financial openness, the exchange rate regime and monetary depth (M2/GDP ratio). Despite the focus on the “Guidotti-Greenspan” rule and sudden stops in the literature, short term external debt is not a significant predictor of reserve holdings, though another variable often considered in more traditional models, the Trade/GDP ratio is.<sup>3</sup> Thus, a specification like that in Table 1, Column 1, which combines our basic “financial stability” variables with Trade/GDP does a good job of explaining reserve behavior.<sup>4</sup> We

---

<sup>3</sup> For a review of the recent empirical literature, see Obstfeld et al (2008). Robert Flood and Nancy Marion (2002) have connected reserve holdings to a buffer stock model, Joshua Aizenman and Marion (2003) have argued the buildup of reserves in East Asia can be seen as precautionary savings, and Aizenman and Jaewoo Lee (2007) argue that precautionary not mercantilist reasons can explain the reserves buildup. Relative to these papers, we focus more on the size of the domestic financial system as opposed to fear of sudden stops.

<sup>4</sup> The model is estimated in natural logs and standard errors are clustered at the country level to correct for both heteroskedasticity across countries and serial correlation within countries. We use WDI data for reserves, GDP, and M2. The Financial openness measure is from Edwards (2007), the exchange rate classification is based on Shambaugh (2004), and the measure of “original sin” is from Barry Eichengreen et al. (2005) and is based on BIS issuance data. See Obstfeld et al. (2008) for details on data and sample.

see that the coefficients on financial openness, monetary depth, and trade all have expected signs and are significantly different from zero at 99%. A “soft peg” measure is also positive and significant at 99% while a direct peg is not (though the two are not statistically significantly different). The regressions are in logs, so a 10% increase in the M2/GDP ratio is correlated with a 3% increase in the reserves to GDP ratio. Financial openness is scaled between 0 and 1 (based on the measure proposed by Sebastian Edwards 2007) and the exchange-rate regime variables are dummies.

In the Emerging Market sample (EM), where much of the puzzle over recent behavior lies, a specification like this explains a substantial portion of reserve/GDP variation, both over time for one country (in panel estimations with country fixed effects) and across countries (in cross-sections or in panels with year fixed effects). Column 2 shows the basic EM sample regression. The coefficients on financial openness and monetary depth are even larger, as is the explanatory power of the regression. The  $R^2$  is now as high as 0.6. Differences in exchange rate regimes are not significant in the EM-only sample.<sup>5</sup>

Financial depth is even more important in the last 15 years since the expansion of financial globalization. In Column 3 we show the specification for 1993-2005 for all countries.<sup>6</sup> Here the coefficient on financial depth has increased such that a 10% increase in M2/GDP comes with a 5% increase in reserves/GDP. The coefficient on trade

---

<sup>5</sup> As we note in our previous work, many of the emerging market countries flip back and forth across exchange rate regimes and even when not pegging may intend to peg soon. See Michael W. Klein and Shambaugh (2008).

<sup>6</sup> As noted below, we will also include a measure of the ability to issue debt externally in local currency. This measure is not available until 1993, so we limit ourselves to that sample here. In Obstfeld et al. (2008) we show that a post 1990 sample that is not limited by “sin” data availability also looks like the regression shown here.

openness has declined some. Financial openness is less significant in this sample. There is less variation within country in this shorter sample so some precision is lost.

One other factor that is consistently significant is a dummy for the advanced countries (AD). These countries hold fewer reserves than their M2/GDP, Trade/GDP, exchange rate regime and financial openness suggest they should. This is true even when we control for the ability to issue debt in ones' own currency, or "original sin." Column 4 shows this regression. The sin variable—which varies from 0 (little foreign currency debt issued) to 1 (all external debt is in foreign currency, none local) has a significant and positive coefficient. Going from all local currency debt to all foreign currency debt would double reserve holdings.<sup>7</sup>

In this paper, rather than focusing entirely on the EM sample (as in our previous work) we now include AD countries. While the puzzle of reserve buildup was primarily an EM issue, the current crisis is one that clearly touches both EM and AD countries. Thus, in our predictive work below will be limited to that sample, for which column 5 shows the corresponding results for our preferred benchmark regression with only financial variables.

## **II. Implications for Today**

What can our positive empirical model tell us about reserves, central bank swaps of foreign currency, and exchange rates during the recent financial panic? We want to know how actual reserve holdings on the eve of the crisis compare to what our model would predict, to see if countries were "underinsured" or "overinsured." Thus, we first generate

---

<sup>7</sup> This variable is largely cross-sectional. There is little variation within countries. Further, there is little variation across the EM and developing countries. Nearly all issue almost exclusively foreign currency debt externally. There is, however, cross-country variation within the advanced sample.

predicted values for reserve-to-GDP ratios in 2005. We then adjust those ratios for M2/GDP changes in the last two years to get approximate predicted values for 2007, since M2 growth is the main regressor that changes at high frequency in our sample. (More details are shown in Appendix Table 1.)

For the year 2007, EM countries were predicted to hold substantial reserves; predicted ratios are quite high (20% of GDP on average) relative to those of AD countries (9%). Some have accumulated far beyond these levels, especially between 2005 and 2007. By 2007, actual reserves were 26% of GDP on average for these countries.<sup>8</sup> For example, in 2005, China's predicted reserves were 29% of GDP while actual were 37%. China held more reserves than expected, but not dramatically so. By 2007, however, predicted reserves had not moved much but China's actual reserves were up to 47% of GDP. Likewise Malaysia, Singapore, and Korea were all predicted to have reserves of 20% of GDP or more, but actual levels were substantially higher. Also, countries like Brazil or India who were at or below predicted levels in 2005 were above them by 2007. The model predicts the variation across these countries reasonably well. The correlation of predicted and actual reserve/GDP ratios is 0.68.

On the other hand, we can see that many advanced countries held fewer reserves than our model predicts.<sup>9</sup> Australia, the U.K., and Canada are notable examples. What if we do not think advanced countries should hold fewer reserves than other countries? That is, what if we run the regression in column 5 *without* the AD dummy, we see that the predicted values (based on the large financial sectors and tendency towards financial

---

<sup>8</sup> Hong Kong and Singapore are both predicted to and do hold far more reserves than other countries. Excluding them, the predicted reserve ratio for the group is 17% of GDP and the actual is 21%.

<sup>9</sup> Due to a lack of individual country reserve holdings or M2, euro area countries are not included in the analysis of predicted reserves.



openness) suggest the advanced countries should be holding larger stocks of reserves than they actually own. In this exercise we also find that Denmark, Sweden, and New Zealand are holding fewer reserves than the typical country with their characteristics. Only Japan holds substantially more reserves than the predicted value suggests they would.<sup>10</sup>

Perhaps some advanced countries held too few reserves? On the other hand, many of these advanced countries received substantial U.S. dollar swap lines from the Federal Reserve in 2007 and 2008. Perhaps they knew such types of arrangements would be available to them in a pinch, so they did not feel the need to hold reserves in the same pattern as EM countries. In that case, estimation with the AD dummy may be the right benchmark to examine.<sup>11</sup>

### **III. Currency Pressure versus the War Chests in The Panic of 2008**

Echoing Thornton, our theoretical model assumes that it is in the event of a panic that reserves will be used to quell M2 flight and avert depreciation. It is natural to ask whether this mechanism was at work in 2008: were exchange rates better stabilized in countries with more reserves relative to M2?—or, to be more faithful to the multivariate model, with more reserves relative to what the model would have predicted?

Figure 2a addresses the first of these questions with a simple scatter of percentage depreciation of the currency against the U.S. dollar in the year 2008 [up to 12/15 at time

---

<sup>10</sup> Iceland's predicted reserves are lower than some other countries because their financial account is coded as less open than other advanced countries in the Edwards measure. The Chinn-Ito index also codes Iceland as more closed than other advanced nations.

<sup>11</sup> Admittedly, some EM countries (surprisingly) received swap lines from the Fed in 2008. However, the size of these lines appears small compared to their hypothetical needs in the event that a run from M2 should materialize. Skeptics have therefore argued that these lines may be signals at best, or pure window dressing. At the time of writing, it is an open question whether they would be expanded, or augmented by IMF lines or other funding, should disaster strike.

of writing] versus the country's reserves/M2 ratio at the end of 2007. The sample is restricted to just the emerging countries, as our regressions suggest that advanced countries have an intrinsically smaller need for reserves due to, say, more policy credibility and certainty, or better access to private credit or official swap lines. The scatter shows that countries with feebler war chests at the end of 2007 suffered larger currency crashes in 2008, offering preliminary support for our arguments. However, Table 2, panel (a) explores this relationship further and adds some controls. Column 1 shows that the bivariate relationship is only borderline significant (p value 0.106). In contrast to arguments regarding the perils of financial openness, Column 2 shows that currency values of more financially open economies saw their currency values more likely to hold in 2008, hinting at reverse causality from (more) financial stability to (more) openness. Column 3 enters openness and reserves together and the results are similar. Finally, Column 4 entertains another prevalent explanation, namely that depreciations are really a result of unsustainable current account deficits. But lagged current account deficit as a share of GDP was not a highly statistically significant influence in this sample, once we control for the size of the reserve war chest.<sup>12</sup>

Table 2, panel (b) takes the next step of using not actual 2007 reserves as a control variable, but the ratio of actual reserves to what our preferred model would have predicted. We now see whether “underinsurance” (as judged by our positive model) was associated with larger depreciations in 2008. Indeed it was in all samples once we exclude an influential extreme outlier—the infamous case of Iceland. In Columns 2

---

<sup>12</sup> We also experimented in both panels of Table 2 with lagged short term debt to GDP ratio as an extra regressor, to address the claim that rollover problems might exacerbate depreciation, but we found its coefficient always had the wrong (negative) sign, so that bigger debts appeared to be related to smaller depreciations, contradicting the theory.

through 5, which unlike Column 1 exclude Iceland, the relationship between low reserves and high depreciation is clear. Actual relative to predicted reserves is significant at the 1% level in the full and AD samples, and the 10% level in the more noisy EM sample. In Column 6 this result is again robust to the inclusion of the lagged current account surplus to GDP ratio, which is once more statistically insignificant (though of the expected sign). As a convenient graphical summary of our argument, we present a scatter plot of actual depreciation in 2008 versus our model's actual/predicted reserve ratio for the AD & EM sample. This is shown in Figure 2b, with Iceland excluded from the line of best fit, as in Column 2. Excluding the bizarre case of Iceland, the results are quite striking: international reserves did provide effective insurance against currency instability, for both advanced and emerging countries alike.

#### **IV. Central Bank Currency Swaps in the Panic of 2008**

This crisis has also generated one of the most notable examples of central bank cooperation in history—the large swap lines set up between a number of central banks.<sup>13</sup> The Federal Reserve extended large swap lines to industrial-country central banks first (ECB, BoJ, BoE, and SNB) starting in 2007; then extended those to nearly every advanced economy; and finally, on October 29, 2008, granted similar arrangements to four major emerging market countries (Brazil, Korea, Mexico, and Singapore).<sup>14</sup>

In these swaps, the Fed has provided dollar liquidity to the other central banks allowing these central banks, in turn, to provide dollars to their own domestic banking systems. Why are such swap lines needed? Two alternatives for the provision of dollar

---

<sup>13</sup> See Setser (2008) for real-time commentary on the extraordinary nature of the measures.

<sup>14</sup> See <http://www.federalreserve.gov/newsevents/press/monetary/20081029b.htm> and links therein for press releases on the swap lines.

liquidity in the foreign country would be (a) for the foreign central bank to provide the domestic currency and let the bank sell the local currency for dollars on the open market or (b) for the foreign central bank to use its own dollar reserves to provide the liquidity. The former would put downward pressure on the local currency and the latter would possibly exhaust the central bank's dollar reserves. Examining current reserve holdings relative to our positive model's predictions is a useful way to provide some empirical context for these swap lines.

The size of the swap lines available has varied across countries and for the major industrial-country central banks eventually became unlimited. The ECB and SNB also instituted smaller swap lines, in their own currencies, with a number of smaller European countries.<sup>15</sup> In Table 3, for swap recipients, we show actual and predicted reserves/GDP as well as actual reserves in dollars, the gap in our model between actual to predicted (in dollars), and the size of the initial swap lines themselves.

The swaps were clearly large in magnitude for many advanced countries. For every advanced country except Japan, the size of the swap exceeded 50% of actual reserves held and in the case of the U.K., Australia, and the ECB, the swap was larger than the existing level of reserves.<sup>16</sup> In addition, for a number of countries, such as Denmark, Sweden, and New Zealand, not only was the swap line nearly as big as existing reserves, but it was larger than the gap with our model's prediction. On the other hand, in some cases, the swap line was too small to plug the gap relative to predicted reserves.

---

<sup>15</sup> See Fender and Gyntelberg (2008) for a discussion of the swap lines. Data for the size of the swaps is taken from there. Swaps that were eventually increased to infinity are listed in the table at the largest amount prior to that increase and are noted in the table.

<sup>16</sup> Detailed information on reserves on the Bank of England website shows currency composition of reserves and this reveals that the BoE holdings of US dollars was much smaller than the total reserves and by the time the swap line was instituted, the BoE was down to less than \$10 billion in US dollar reserves.

Australia, Canada and the U.K. all still have fewer reserves than expected even counting the swap (and not counting the decline in their reserves in 2008 so far).

In contrast, the swaps to emerging countries are never larger than 50% of their actual reserves. Further, in most cases, the country already had more reserves than predicted. Korea's was \$30 billion, though the country already had \$260 billion. For Singapore the figure was, \$30 billion against \$162 billion already held, and Brazil received \$30 billion versus \$180 billion on hand. It is hard to see how these magnitudes could be very meaningful; all three countries already held more reserves than predicted by our model. Instead, these swap lines could be interpreted as signals. For Mexico and Hungary, the swaps are more substantial relative to actual reserves and those two countries were holding fewer reserves than predicted, so the swap lines may have had a more substantive impact beyond mere signaling in those cases.

This way of looking at the swaps demonstrates a number of important issues in the current international monetary system. Even with nearly a trillion dollars committed, in some cases the Fed's action was primarily symbolic because the foreign country already had so many dollars. In other cases, the swap may have been quite important, but the scale required to for effective lending is not available to organizations such as the IMF or other multilateral agencies. Only the world's largest central banks can intervene on such a scale. Some players (such as China and India) do have foreign reserves sufficient to allow them to act as crisis lenders to foreign governments, but so far such actions have been limited, including Nordic central banks lending euros to Iceland and Japan's offer of \$100 billion in resources to the IMF.

The swap lines also have implications for reserve holdings. One could argue that the expectation that such swap lines could be available rationalizes advanced countries' decisions to hold fewer reserves than other countries. This would suggest EM countries will continue to hold large reserves until they are confident that they will have access to substantial foreign exchange swaps when in need. Alternatively, these extraordinary measures may have been just that—extraordinary. The advanced countries may now recognize this and increase their reserve stocks (or in some cases adopt the euro to reduce the need for reserves). An increase in IMF resources could also be in the cards.

## **V. Conclusion**

International reserves are in some ways the ultimate rainy day fund for a country. They are hard, liquid assets that have value in times of need. The Panic of 2008 is more than a rainy day: it is a torrential downpour. Elsewhere we have argued that reserve holdings are strongly connected to the size of the banking system. Countries insure not just against an end of foreign financial inflows, but also against runs on the currency by domestic savers. Here we show that interpreting reserve holdings in this manner is helpful for understanding reserve adequacy and countries' seemingly different abilities to weather the current storm.

Currencies of countries holding more reserves relative to M2—and in particular, more reserves relative to our measure of predicted reserves based on financial motives—have tended to appreciate in the crisis. Those of countries with smaller war chests have depreciated. Understanding these motives for reserve demand also shows that central bank swap lines to some smaller advanced countries have been sizable as a share of

current and needed reserves. For most EM countries, though, the swaps have been largely symbolic. The scale of reserves needed to backstop emerging markets simply surpasses the resources of the multilateral organizations and all but the largest reserves holders in the world.

## REFERENCES

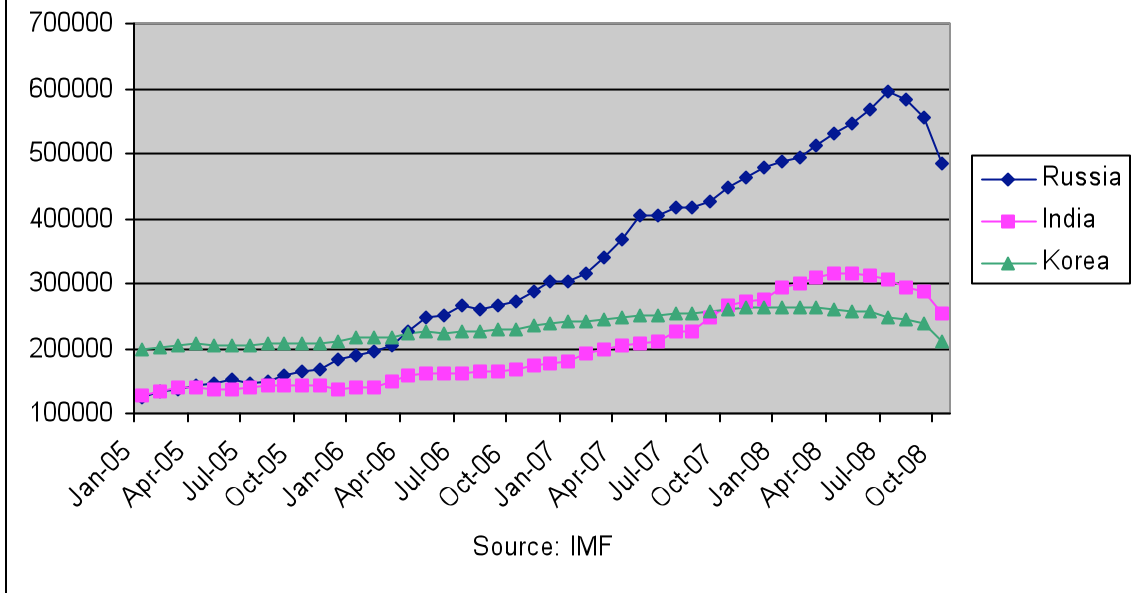
- Aizenman, Joshua, and Jaewoo Lee.** 2007. “International Reserves: Precautionary versus Mercantilist Views, Theory and Evidence.” *Open Economies Review*, 18(2): 191–214.
- Aizenman, Joshua, and Nancy Marion.** 2003. “The High Demand for International Reserves in the Far East: What’s Going On?” *Journal of the Japanese and International Economies*, 17 (September): 370–400.
- Calvo, Guillermo A.** 1996. “Capital Flows and Macroeconomic Management: Tequila Lessons.” *International Journal of Finance and Economics*, 1 (July): 207–23.
- Calvo, Guillermo A.** 2006. “Monetary Policy Challenges in Emerging Markets: Sudden Stop, Liability Dollarization, and Lender of Last Resort.” Working Paper 12788, National Bureau of Economic Research.
- Calvo, Guillermo A., and Enrique G. Mendoza.** 1996. “Mexico’s Balance-of-Payments Crisis: A Chronicle of a Death Foretold.” *Journal of International Economics*, 41 (November): 235–64.
- Chang, Roberto, and Andres Velasco.** 2001. “Financial Crises in Emerging Markets: A Canonical Model.” *Quarterly Journal of Economics*, 116: 489–517.

- Edwards, Sebastian.** 2007. "Capital Controls, Sudden Stops, and Current Account Reversals." In *Capital Controls and Capital Flows in Emerging Economies: Policies, Practices, and Consequences*, ed. S. Edwards. Chicago: University of Chicago Press.
- Eichengreen, Barry, Ricardo Hausmann, and Ugo Panizza.** 2005. "The Pain of Original Sin." In *Other Peoples' Money*, ed. B. Eichengreen and R. Hausmann, 13–47. Chicago: University of Chicago Press.
- Fender, Ingo, and Jacob Gyntelberg.** 2008. "Overview: Global Financial Crisis Spurs Unprecedented Policy Actions." *BIS Quarterly Review*, December.
- Flood, Robert, and Nancy Marion.** 2002. "Holding International Reserves in an Era of High Capital Mobility." In *Brookings Trade Forum 2001*, ed. S. M. Collins and D. Rodrik, 1–68. Washington, DC: Brookings Institution.
- International Monetary Fund.** 2008. *World Economic Outlook: Financial Stress, Downturns, and Recoveries*. Washington, DC: International Monetary Fund.
- Jeanne, Olivier.** 2007. "International Reserves in Emerging Market Countries: Too Much of a Good Thing?" *Brookings Papers on Economic Activity*, 1: 1–79.
- Klein, Michael W., and Jay C. Shambaugh.** 2008. "The Dynamics of Exchange Rate Regimes: Fixes, Floats, and Flips." *Journal of International Economics* 75(1): 70–92.
- Obstfeld, Maurice, Jay C. Shambaugh, and Alan M. Taylor.** 2008. "Financial Stability, the Trilemma, and International Reserves." NBER Working Paper no. 14217.



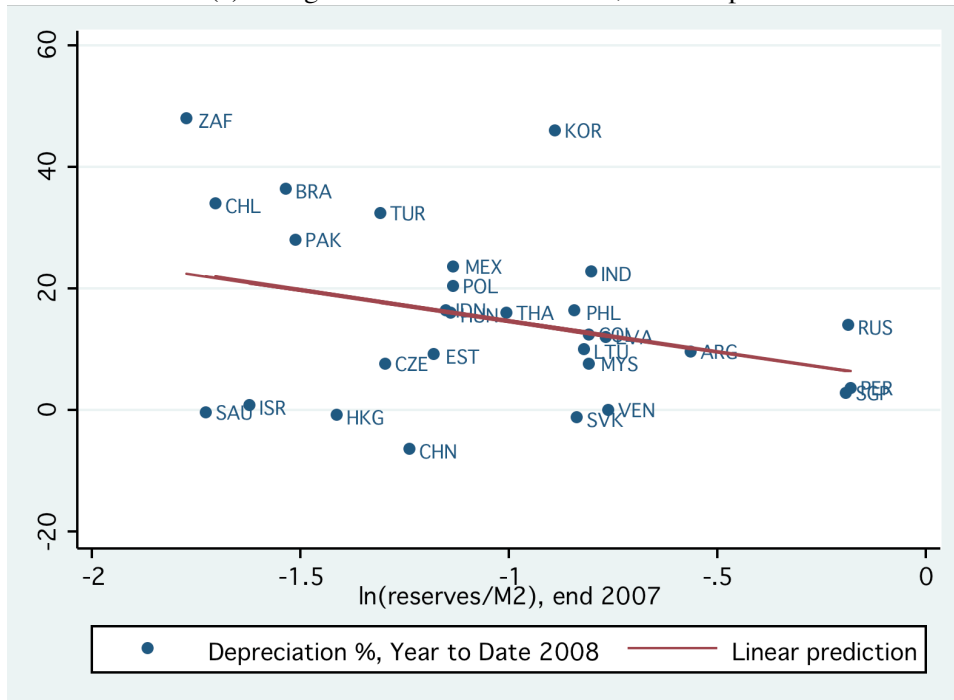
- Sachs, Jeffrey D.** 1998. “Creditor Panics: Causes and Remedies.” Photocopy. Harvard University (October). <http://www.cid.harvard.edu/archive/hiid/papers/cato.pdf>.
- Setser, Brad.** 2008. “More extraordinary moves: \$620 billion is real money, and it isn’t even for American financial institutions ...”, <http://blogs.cfr.org/setser/2008/09/29/more-extraordinary-moves-620-billion-is-real-money-and-it-isnt-even-for-american-financial-institutions/>.
- Shambaugh, Jay C.** 2004. “The Effects of Fixed Exchange Rates on Monetary Policy.” *Quarterly Journal of Economics*, 119(1): 301–52.
- Thornton, Henry.** 1939 [1802]. *An Enquiry into the Nature and Effects of the Paper Credit of Great Britain*. Edited with an introduction by F. A. von Hayek. London: George Allen and Unwin.
- Velasco, Andres.** 1987. “Financial Crises and Balance of Payments Crises: A Simple Model of Southern Cone Experience.” *Journal of Development Economics*, 27: 263–83.

**Figure 1: Foreign Exchange Reserves of Russia, India, and Korea, January 2005-October 2008**

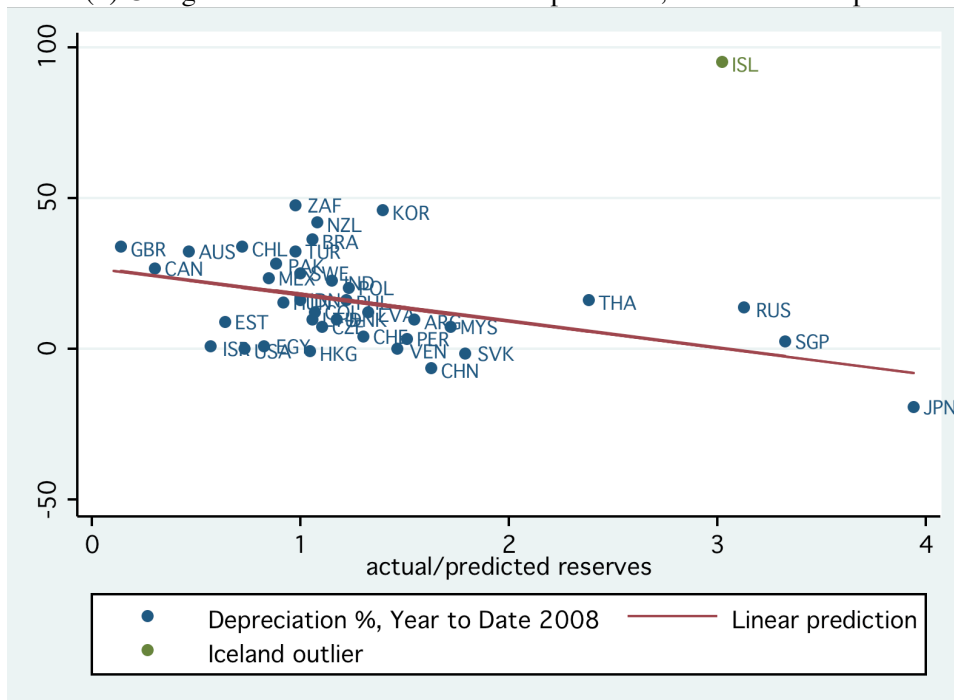


**Figure 2. Depreciation in 2008 versus Reserves in 2007**

(a) Using raw data on reserves/M2, EM sample



(b) Using the ratio of actual reserves to predicted, AD & EM sample



**Table 1—Financial Stability Motives for Holding Reserves**

The dependent variable is  $\ln(\text{reserves}/\text{GDP})$ . The full sample is all countries, including advanced (AD), emerging (EM), and others (developing). The sample consists of annual panel data.

Sample	(1)	(2)	(3)	(4)	(5)
Years	Full 1980-2005	EM only 1980-2005	Sin available Full 1993-2005	Sin available Full 1993-2005	Sin available AD & EM 1993-2005
Financial openness	0.524 0.177**	0.894 0.183**	0.328 0.22	0.364 0.218+	1.047 0.408*
Peg	0.127 0.082	0.029 0.119	0.146 0.096	0.109 0.091	0.224 0.128+
Softpeg	0.167 0.058**	0.012 0.111	0.131 0.077+	0.082 0.064	0.187 0.082*
$\ln(\text{M2}/\text{GDP})$	0.322 0.070**	0.246 0.118*	0.473 0.089**	0.52 0.095**	0.604 0.118**
$\ln(\text{trade}/\text{GDP})$	0.584 0.070**	0.567 0.075**	0.471 0.094**	0.42 0.100**	—
Advanced	-0.597 0.126**	0 0	-0.911 0.153**	-0.793 0.172**	-1.098 0.210**
Sin	—	—	—	0.995 0.568+	1.498 0.586*
Constant	-6.204 0.356**	-5.909 0.425**	-6.095 0.474**	-7.033 0.703**	-6.514 0.932**
Observations	2911	677	860	860	552
R-squared	0.37	0.61	0.54	0.56	0.52

Note: Robust standard errors clustered at country level in parentheses: + $p < 0.1$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ . Column 5 is our preferred model using only financial variables, and is the basis for all results below.

**Table 2—Depreciation in 2008 versus Reserves in 2007**

The dependent variable is percent change in the local currency price of \$1 from 12/31/07 to 12/15/08 (+ = depreciation). All independent variables take their 2007 values. The samples include advanced (AD) and/or emerging (EM).

(a) Using raw data on reserves/M2

Sample	(1) EM	(2) EM	(3) EM	(4) EM
ln(reserves/M2)	-10.18 (6.10)	—	-10.21+ (5.49)	-9.81+ (5.38)
Financial openness	—	-37.05** (10.03)	-37.13** (10.85)	-31.06* (12.56)
CA surplus/GDP	—	—	—	-0.32 (0.22)
Constant	4.56 (5.38)	37.09** (7.37)	26.45** (7.69)	23.68** (7.52)
Observations	29	29	29	29
R-squared	0.10	0.14	0.24	0.29

(b) Using the ratio of actual reserves to predicted

Sample	(1) AD & EM	(2) AD & EM Excluding Iceland	(3) AD only Excluding Iceland	(4) EM only	(5) AD & EM Excluding Iceland
Actual/predicted reserves	-2.56 (6.64)	-8.90** (2.42)	-13.08** (1.22)	-5.27+ (2.76)	-7.67* (3.01)
CA surplus/GDP					-0.24 (0.25)
Constant	21.21** (7.29)	27.17** (4.03)	32.17** (5.60)	22.25** (5.18)	25.72** (4.40)
Observations	39	38	9	29	38
R-squared	0.01	0.20	0.56	0.06	0.22

Note: Robust standard errors in parentheses: + $p < 0.1$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ .

**Table 3—Central Bank Currency Swaps**

	1	2	3	4	5	6	7
country	2007 res/gdp	2007 res/gdp pred	2007 pred no AD	2007 actual reserves	gap in \$B	FED swap	ECB swap
Argentina	17.6%	11.4%		\$46.14	\$16.36		
Brazil	13.7%	13.1%		\$180.31	\$8.79	\$30.00	
China	47.1%	29.0%		\$1,546.34	\$593.93		
Hungary	17.4%	19.0%		\$24.06	-\$2.15		€ 5.00
India	23.6%	20.4%		\$276.59	\$37.22		
Korea, Rep.	27.1%	19.4%		\$262.53	\$74.65	\$30.00	
Mexico	9.8%	11.5%		\$87.21	-\$15.90	\$30.00	
Poland	15.6%	12.7%		\$65.72	\$12.22		€ 10.00
Russia	36.9%	11.8%		\$476.45	\$324.51		
Singapore	101.0%	30.4%		\$162.91	\$113.93	\$30.00	
Australia	3.3%	7.1%	11.3%	\$26.91	-\$65.86	\$30.00	
Canada	3.1%	10.5%	11.2%	\$41.07	-\$107.73	\$30.00	
Denmark	11.1%	9.5%	16.4%	\$34.32	-\$16.28	\$15.00	€ 15.00
Iceland	13.5%	4.5%	10.0%	\$2.63	\$0.68		€ 1.50
Japan	22.2%	5.6%	4.7%	\$973.36	\$766.33	<i>\$120.00</i>	
New Zealand	13.3%	12.3%	18.4%	\$17.25	-\$6.50	\$15.00	
Sweden	7.0%	7.0%	12.5%	\$31.03	-\$24.36	\$30.00	
Switzerland	18.1%	14.0%	20.0%	\$75.17	-\$8.14	<i>\$60.00</i>	
United Kingdom	2.1%	15.6%	21.9%	\$57.28	-\$540.35	<i>\$80.00</i>	
United States	2.0%	2.8%	1.9%	\$277.52	\$15.87		
ECB	1.8%			\$215.56		<i>\$240.00</i>	

Source: WDI data and authors' calculations. Gap in reserves uses column 3 for the advanced countries, the higher estimate for reserves needs. Swap line amounts from Fender and Gyntelberg (2008). Swap lines in italics were eventually uncapped, providing effectively infinite resources if the country chooses to use them.

**Appendix Table 1—Reserve Holdings in 2007: Predicted versus Actual**

country_name	1 2007 res/gdp	2 2007 res/gdp pred	3 2007 res/gdp pred	4 2005 res/gdp	5 2005 res/gdp pred	6 2007 actual/pred	7 2008 dner
Argentina	17.6%	11.4%		15.4%	11.5%	155%	5.3%
Brazil	13.7%	13.1%		6.8%	12.6%	105%	21.6%
Chile	10.3%	14.2%		14.7%	13.9%	72%	26.4%
China	47.1%	29.0%		37.3%	29.0%	162%	-6.5%
Colombia	12.2%	11.5%		12.3%	12.4%	106%	16.0%
Czech Republic	20.8%	18.9%		23.9%	18.3%	110%	7.0%
Egypt, Arab Rep.	25.1%	30.4%		24.5%	30.8%	83%	1.0%
Estonia	15.4%	24.0%		14.9%	22.9%	64%	13.4%
Hong Kong, China	73.9%	70.7%		69.7%	66.9%	105%	-0.7%
Hungary	17.4%	19.0%		17.1%	18.1%	92%	18.3%
India	23.6%	20.4%		17.1%	21.3%	116%	23.4%
Indonesia	13.2%	13.2%		12.1%	13.7%	100%	15.6%
Israel	17.6%	30.8%		22.8%	32.6%	57%	-0.3%
Korea, Rep.	27.1%	19.4%		26.8%	19.9%	140%	41.9%
Latvia	21.2%	16.0%		14.9%	15.2%	133%	16.1%
Lithuania	20.1%	19.1%		14.9%	17.6%	106%	14.3%
Malaysia	56.4%	32.8%		54.2%	33.5%	172%	7.2%
Mexico	9.8%	11.5%		9.6%	11.2%	85%	17.6%
Pakistan	11.0%	12.4%		10.0%	12.3%	89%	31.9%
Peru	25.5%	16.9%		17.9%	16.6%	151%	2.4%
Philippines	23.4%	19.2%		18.7%	18.9%	122%	17.7%
Poland	15.6%	12.7%		14.1%	11.9%	123%	14.6%
Russian Federation	36.9%	11.8%		23.8%	10.3%	314%	10.0%
Singapore	101.0%	30.4%		99.1%	29.6%	333%	2.7%
Slovak Republic	25.3%	14.1%		33.4%	14.4%	180%	3.6%
South Africa	11.9%	12.1%		8.6%	11.3%	98%	44.3%
Thailand	35.6%	14.9%		29.4%	15.6%	239%	16.3%
Turkey	11.6%	12.0%		14.5%	12.7%	97%	30.3%
Venezuela, RB	14.8%	10.1%		21.3%	8.4%	147%	0.3%
Australia	3.3%	7.1%	11.3%	5.9%	6.3%	46%	29.2%
Canada	3.1%	10.5%	11.2%	3.0%	10.6%	30%	19.6%
Denmark	11.1%	9.5%	16.4%	13.1%	8.8%	118%	14.7%
Iceland	13.5%	4.5%	10.0%	6.8%	4.5%	303%	113.9%
Japan	22.2%	5.6%	4.7%	18.7%	5.7%	395%	-12.7%
New Zealand	13.3%	12.3%	18.4%	8.2%	11.5%	108%	29.9%
Sweden	7.0%	7.0%	12.5%	7.0%	6.6%	100%	22.4%
Switzerland	18.1%	14.0%	20.0%	15.7%	13.9%	130%	3.6%
United Kingdom	2.1%	15.6%	21.9%	2.0%	14.3%	13%	25.9%
United States	2.0%	2.8%	1.9%	1.5%	2.6%	73%	0.0%

Source: WDI data and authors' calculations. Column 6, actual reserves to predicted reserves uses column 2, the predicted reserves based on column 5 of table 1 for both the advanced and emerging countries. Using the higher estimate for reserves needs for AD countries strengthens the results in table 2b.