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## Financial Instability, Reserves, and Central Bank Swap Lines in the Panic of 2008

By MAURICE OBSTFELD, JAY C. SHAMBAUGH, AND ALAN M. TAYLOR\*

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 incomes. 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.

Reserve developments for three large emerging economies, the Russian Federation, India, and Korea, illustrate this story. The reserves of all three countries peaked and then began to decline in the summer of 2008. In particular, Russia's huge 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 these three especially dramatic ones;

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 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 external debt 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 (1802) 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

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<sup>1</sup> See the online Appendix (<http://www.aeaweb.org/articles.php?doi=10.1257/aer.99.2.480>) for figure of the reserves. 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 (SWF). The fungibility of central bank and SWF assets, and the rapidly growing size of SWF hoards, will likely complicate measurement even further in future.

<sup>2</sup> See Obstfeld, Shambaugh, and Taylor (2008). Similar theoretical ideas have been discussed in the crisis literature, for example by Guillermo A. Calvo (1996). See Obstfeld et al. for a review of the literature. Olivier Jeanne (2007) surveys recent commentary and analysis regarding emerging-market reserves.

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 articulated by the International Monetary Fund (2008, 37) in a recent overview: “[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 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,

<sup>3</sup> For a review of the recent empirical literature, see Obstfeld et al. (2008). Joshua Aizenman and Nancy 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.

a specification that combines our basic “financial stability” variables (financial openness, exchange rate regime, and financial depth) with Trade/GDP does a good job of explaining reserve behavior.<sup>4</sup>

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 one’s own currency, or “original sin.” The sin variable has a significant and positive coefficient.

In this paper, rather than focusing entirely on the emerging market (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, our predictive work below will be limited to that sample. The regression we use includes only our financial variables over the period where “sin” data are available (1993–2005). The regression we use to predict reserve holdings is:<sup>5</sup>

$$\begin{aligned} (1) \quad \ln(\text{Res}/\text{GDP}) = & -6.514 + 1.047 \text{ FinOpen} \\ & + 0.224 \text{ Peg} \\ & + 0.187 \text{ SoftPeg} \\ & + 0.604 \ln(\text{M2}/\text{GDP}) \\ & -1.098 \text{ AD} \\ & + 1.498 \text{ Sin.} \end{aligned}$$

### 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.”

<sup>4</sup> See Obstfeld et al. (2008) for details on data, sample, estimation methodology, robustness, and full analysis.

<sup>5</sup> All coefficients are significant at 95 percent except “peg,” which is significant at 90 percent. See the online Appendix for details.

Thus, we first generate 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 percent of GDP on average) relative to those of AD countries (9 percent). Some have accumulated far beyond these levels, especially between 2005 and 2007. By 2007, actual reserves were 26 percent of GDP on average for EM countries.<sup>6</sup> For example, in 2005, China's predicted reserves were 29 percent of GDP while actual reserves were 37 percent. 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 percent of GDP. Likewise Malaysia, Singapore, and Korea were all predicted to have reserves of 20 percent of GDP or more, but actual levels were substantially higher. Also, countries like Brazil or India that 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 ratio is 0.68.

On the other hand, many advanced countries held fewer reserves than our model predicts.<sup>7</sup> Australia, the United Kingdom, and Canada all hold considerably fewer reserves than expected. What if we do not think advanced countries should hold fewer reserves than other countries? That is, what if we run the regression above *without* the AD dummy? Then, the predicted values suggest the advanced countries should be holding larger stocks of reserves than they actually own (predicted 14 percent versus actual 10 percent). 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>8</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 1 addresses the first of these questions with a simple scatter of percentage depreciation of the currency against the US dollar in the year 2008 (up to 12/15 at time 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 feeble war chests at the end of 2007 suffered larger currency crashes in 2008, offering preliminary support for our arguments.

We explore this relationship further (table in online Appendix) and add some controls. The bivariate relationship is only borderline significant. In contrast to common arguments regarding the perils of financial openness, currency values of more financially open economies were steadier in 2008, hinting at reverse causality from (more) financial stability to (more) openness. Finally, 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>9</sup>

<sup>6</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 percent of GDP and the actual is 21 percent.

<sup>7</sup> Due to a lack of individual country reserve holdings or M2, euro-area countries are not included in the analysis of predicted reserves.

<sup>8</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>9</sup> We also experimented 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,

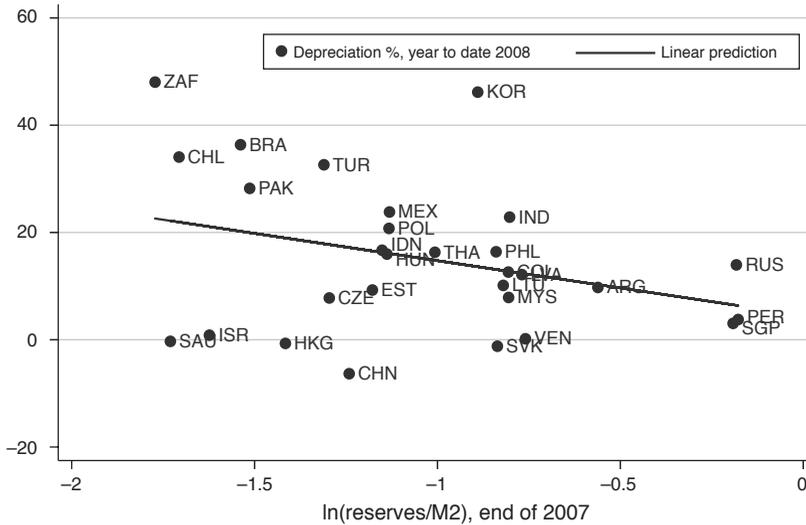


FIGURE 1. DEPRECIATION IN 2008 VERSUS RESERVES/M2 IN 2007  
(EM sample)

Table 1, 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 through 4, 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 percent level in the full and AD samples, and at the 10 percent level in the more noisy EM sample. In column 5, 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 scatterplot of actual depreciation in 2008 versus our model’s actual/predicted reserve ratio for the AD and EM sample. This is shown in Figure 2, with Iceland excluded from the line of best fit, as in column 2. The results are quite striking: international reserves did provide effective insurance against

currency instability, for 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>10</sup> The Federal Reserve extended large swap lines to major industrial-country central banks first (European Central Bank, Bank of Japan, Bank of England, and Swiss National Bank) starting in 2007; then, in the fall of 2008, 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>11</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 liquidity in the foreign

<sup>10</sup> See Brad Setser (2008) for real-time commentary on the extraordinary nature of the measures.

<sup>11</sup> See <http://www.federalreserve.gov/newsevents/press/monetary/20081029b.htm> and links therein for press releases on the swap lines.

so that bigger debts appeared to be related to smaller depreciations, contradicting the theory.

TABLE 1—DEPRECIATION IN 2008 VERSUS RESERVES IN 2007

Sample	AD and EM (1)	AD and EM Ex. Iceland (2)	AD only Ex. Iceland (3)	EM only (4)	AD and EM Ex. Iceland (5)
Actual/predicted reserves	-2.56 (6.64)	-8.90*** (2.42)	-13.08*** (1.22)	-5.27* (2.76)	-7.67** (3.01)
Current account 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 <sup>2</sup>	0.01	0.20	0.56	0.06	0.22

*Notes:* The dependent variable is percent change in the local currency price of one dollar 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). Robust standard errors in parentheses.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

country would be (i) 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 (ii) 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 industrialized 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>12</sup> In Table 2, we show actual and predicted reserves/GDP as well as actual reserves in dollars, the gap in our model between actual and predicted (in dollars), and the size of the initial swap lines.

The swaps were clearly large in magnitude for many advanced countries. For every advanced country except Japan, the size of the swap was exceeded 50 percent of actual reserves held and in the cases of the UK, Australia, and the ECB,

the swap was larger than existing reserves.<sup>13</sup> In addition, for 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 still too small to plug the gap relative to predicted reserves. Australia, Canada, and the United Kingdom all still have fewer reserves than predicted, even counting the swap (and not counting the decline in their reserves in 2008 thus far).

In contrast, the swaps to emerging countries are never larger than 50 percent 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; 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

<sup>12</sup> See Ingo Fender and Jacob Gyntelberg (2008) for discussion. Data for the size of the swaps are taken from there.

<sup>13</sup> Detailed information on reserves on the Bank of England Web site shows currency composition of reserves, and this reveals that the BoE holdings of US dollars was much smaller than the total reserves; by the time the swap line was instituted, the BoE was down to less than \$10 billion in US dollar reserves.

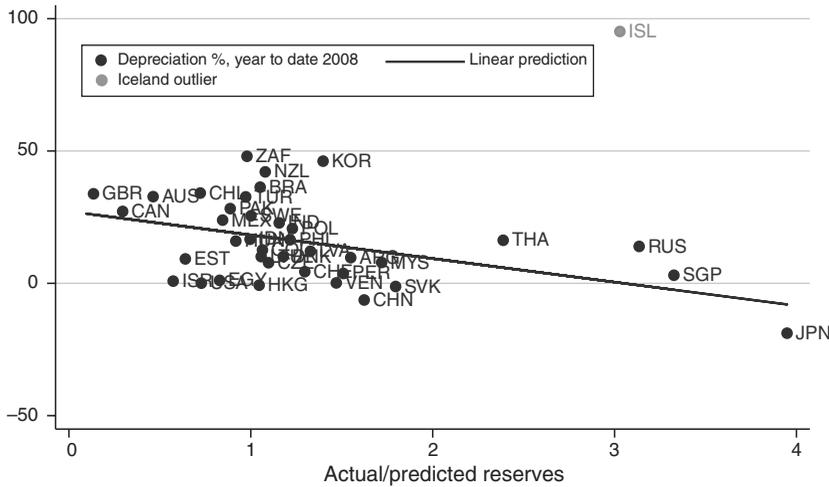


FIGURE 2. THE RATIO OF ACTUAL RESERVES TO PREDICTED, AD AND EM SAMPLE

TABLE 2—CENTRAL BANK CURRENCY SWAPS

Country	Res./GDP actual (1)	Res./GDP predicted (2)	Predicted no AD dummy (3)	Actual reserves (4)	Gap in \$B (5)	FED swap (6)	ECB swap (7)
Brazil	13.7	13.1		\$180.31	\$8.79	\$30.00	
Hungary	17.4	19.0		\$24.06	-\$2.15		€ 5.00
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
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>	

Notes: First four columns are for 2007. Columns 1–3 are in percentages, columns 4–6 are in billions of dollars, and column 7 is in billions of euros. Gap in reserves (column 5) uses the predicted reserves based on the ratio from 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. They are listed at the size prior to uncapping.

Source: WDI data and authors' calculations.

predicted, so the swap lines may have had a more substantive impact beyond mere signaling in those cases.

Thus, 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 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, for example, 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 reserves 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.

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