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FOR A FEW DOLLARS MORE: RESERVES AND GROWTH IN TIMES OF CRISES

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For a Few Dollars More: Reserves and Growth in Times of Crises
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ABSTRACT

Based on a dataset of 112 emerging economies and developing countries, this paper addresses two key questions regarding the accumulation of international reserves: first, has the accumulation of reserves effectively protected countries during the 2008-09 financial crisis? And second, what explains the pattern of reserve accumulation observed during and after the crisis? More specifically, the paper investigates the relation between international reserves and the existence of capital controls. We find that the level of reserves matters: countries with high reserves relative to short-term debt suffered less from the crisis, particularly if associated with a less open capital account. In the immediate aftermath of the crisis, countries that depleted foreign reserves during the crisis quickly rebuilt their stocks. This rapid rebuilding has, however, been followed by a deceleration in the pace of accumulation. The timing of this deceleration roughly coincides with the point when reserves reached their pre-crisis level and may be related to the fact that short-term debt accumulation has also decelerated in most countries over this period.

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1 Introduction

In the decade preceding the 2008 global financial crisis (GFC), emerging market economies accumulated large stocks of international reserves (figure 1). The unprecedented pace of reserve accumulation was, at least partly, a response to the lessons drawn from previous financial crises which predominantly affected emerging markets. Most research on emerging market crises suggests that countries with an insufficient level of reserves, measured against appropriately chosen benchmarks, suffered more from crises in the 1990s[1]. A natural question arising from this observation is to what extent the accumulation of international reserves has protected countries from the negative shock of the latest crisis: have countries with more reserves fared better, in terms of output growth performance, than countries with less reserves? Are there, in addition, other policy tools that can strengthen or dampen the effects of reserves on growth performance?

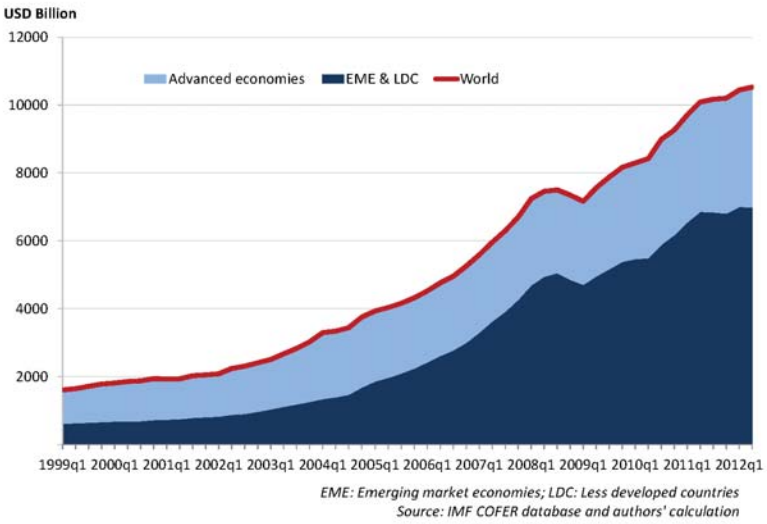


Figure 1: World international reserves

The first objective of this paper is therefore to identify the relationship between pre-crisis foreign reserve accumulation and economic growth during the GFC; the latter can be viewed as an ultimate test for the usefulness of reserves as an insurance mechanism. One aspect we pay particularly close attention to in this paper is the interconnection between international reserve holdings and capital controls. Indeed, one may ask whether a higher level of reserves is needed in a country with a more open capital account, to the extent that an open capital account would expose the country to volatile international capital

[1]For a detailed review of this literature, see Flood and Marion (1999), Berg and Pattillo (1999), Reinhart and Kaminsky (1999), Bussière and Mulder (1999), Gourinchas and Obstfeld (2012), Catao and Milesi-Ferretti (2013) and Obstfeld (2013).

flows. According to this view, reserve accumulation and capital account controls can be understood as substitutes in the quest to avoid financial crises. An alternative view is that these two policy tools can be complementary and reinforce each other: reserves are all the more useful when the capital account is closed. Finally, the paper also devotes attention to the endogeneity issue that may arise from this simple exercise: it is possible that the policy authorities of a highly vulnerable country decide to accumulate more reserves. In this case a simple regression may yield biased results, which we account for using an instrumental variable approach. Aside from this first objective, which focuses on the initial stage of the crisis, the paper also investigates the patterns of reserve accumulation in the subsequent periods. Indeed, the finding that more reserves before the crisis have indeed benefited countries during the GFC may have prompted countries to accumulate even more reserves after the crisis. We therefore seek to uncover the patterns of reserve accumulation after the GFC, distinguishing between the immediate aftermath of the crisis, which recorded a strong rebound, and the following period, during which the pace of reserve accumulation decelerated.

Against this background, the paper presents three sets of findings. First, we test the hypothesis that international reserves fulfill the protective role they are often assigned to, by testing whether the extent of the crisis (proxied here by two different measures of output collapse, which control for idiosyncratic factors) are related to the level of reserves before the crisis. More specifically, given the debate on what constitutes the most appropriate metrics for international reserves, we construct a set of reserve ratios, expressing reserves as a percentage of GDP, imports, M2 and short-term debt. The results indicate that when reserves are measured as a percentage of short-term debt, there is a statistically significant relationship with the dependent variable, but not for the other reserve adequacy ratios (i.e. reserves/M2, reserves/imports and reserves/GDP). This result is robust to using alternative definitions of the crisis variable, different sub-samples (emerging market countries only or combined with developing countries) or introducing additional control variables such as trade openness, dummy variables for oil exporting countries or financial centers, and so forth. In this set of regressions we also use an instrumental variable approach to account for a potential endogeneity bias. We develop two main instruments for our reserve ratio, focusing on reserve accumulation in neighboring countries as an alternative accumulation motive.

Second, we focus on the interaction between international reserves and capital account openness by introducing an interaction term involving these two variables. We find that the coefficient of the interacted term is sometimes significantly different from zero. The magnitude of the marginal effects of reserves depends on the degree of capital controls; that is, a less open capital account reinforces the positive marginal effect of reserves that

we find in the first set of regressions[2]. This finding is especially interesting given the observation in figure 2[3] – namely in comparison with advanced countries, developing and emerging market economies have accumulated more international reserves and have kept their capital account more closed. Advanced countries, by contrast, chose to open their capital account with a clear jump towards greater financial openness around 1992-1993, but typically do not hold large amounts of reserves.

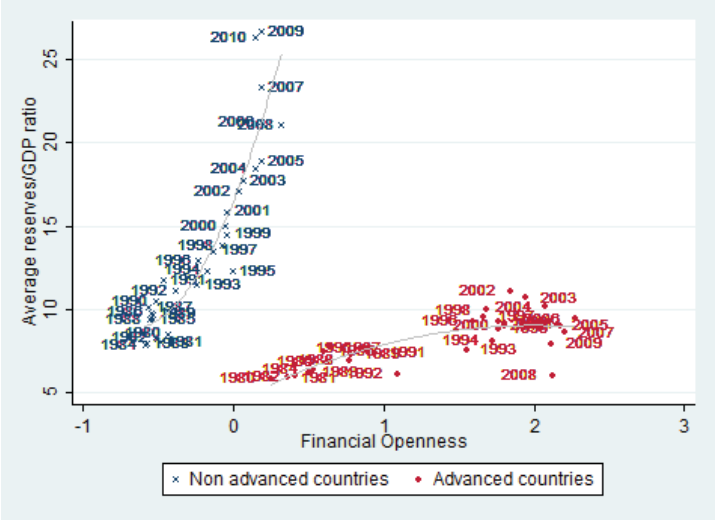


Figure 2: International reserves vs. capital controls

The third set of results aims at identifying changes in the behavior of foreign reserve accumulation after the GFC. To study this, we rely upon data of higher frequency (i.e. monthly and quarterly data). We examine whether countries which experienced greater foreign reserve depletion during the crisis tended to rebuild a large stock of reserve assets in the wake of the crisis. We also investigate the patterns of reserve accumulation in more recent years. We find that the countries that used more reserves during the crisis also rebuilt them more quickly in the aftermath of the crisis. However, in the subsequent period, the pace of reserve accumulation slowed down. One possible explanation may stem from the fact that the level of short-term debt growth declined for most countries, perhaps because of higher risk aversion. To further investigate this hypothesis, we estimated a VECM comprising both reserves and short-term debt: the results suggest that the slowdown in reserves may be related to the slowdown of short-term debt accumulation.

Our paper follows three strands of literature: the motives of foreign reserve accumu-

[2]The relationship between capital controls and foreign reserve accumulation is complex. Several parallel stories can be advanced regarding why the stock of reserves is larger in an economy with capital controls (for keeping the domestic currency undervalued, or for social welfare concerns). We provide an analysis of the subject in Section 3.3. In any case, the multiple motives for reserve accumulation do not prevent us to test the usefulness of reserve holdings during the crisis, alone or with capital controls.

[3]In figure 2, the y-axis represents the average reserves to GDP ratio and the x-axis represents the average financial openness in a given country group.

lation, the impact of foreign reserve accumulation on real economic growth during crisis times and the behavior of reserve holding during and after the GFC. Starting with the literature on the insurance motive of reserve accumulation, both the early literature in the 1970s[4] and a more recent literature based on open-economy macroeconomic models suggest that reserves constitute a buffer stock to limit the impact of negative trade and financial shocks on output should a country be hit by balance-of-payment shocks or 'sudden stops'. In fact, as Jeanne and Rancière (2011), Benigno and Fornaro (2012), Bianchi et al. (2012) demonstrate, a sufficient stock of reserves is useful to purchase foreign imports and to repay external debt coming due when no external borrowing is possible. Based on a calibration using a sample of sudden stops in 34 middle-income countries over 1975-2003, Jeanne and Rancière (2011) show that the negative impact of the financial account reversal on domestic absorption can be offset by reserves. In this perspective, an average country needs to hold a stock of reserves equivalent to 9.1% of its GDP. Our paper thus provides empirical evidence of the role of reserves as insurance against negative external shocks.

In parallel, our paper is closely related to a rich pool of recent empirical studies examining the role of international reserves on macroeconomic performance during the GFC. Rose and Spiegel (2009), Rose and Spiegel (2010), Blanchard et al. (2010), Llaudes et al. (2010) and Frankel and Saravelos (2012) are among the first papers looking at the impact of the GFC on emerging market economies by regressing a set of crisis impact variables (e.g. output losses, consumption growth changes, exchange market pressure index, etc.) on numerous pre-crisis policy variables, including foreign reserves. Blanchard et al. (2010) and Rose and Spiegel (2010) advance the proposition that the pre-crisis level of foreign reserves does not play a central role in protecting countries from the global financial crisis. In contrast, Frankel and Saravelos (2012) find that the foreign reserve level (scaled by GDP, external debt and imports) in 2007, along with exchange rate movements, is a significant leading indicator of the cross-country incidence of the crisis: the higher the foreign reserve ratios, the less likely an economy would be hit by the global financial crisis. In the same vein, Llaudes et al. (2010) find a positive and statistically significant role of reserves scaled by short-term debt on output growth during the crisis. They further argue that this relationship is non-linear; namely, reserves had a more significant impact on output in countries with low levels of reserves but much less in countries with high levels of reserves.

Our paper incorporates several novel aspects. The above cited papers are all broad studies examining many different aspects of the crisis impact using a number of different policy variables. In contrast, our paper focuses on the relationship between pre-crisis reserve accumulation and real economic growth during the crisis. The most important contribution of our paper is to assess the impact of reserves alongside another policy

[4] Bahmani-Oskooee and Brown (2002) provide a detailed review.

instrument, capital controls. We provide intuition and empirical evidence on the complementarity between reserves and capital controls in terms of managing the impact of the global financial crisis. Moreover, we go beyond a mere documentation of the correlation between reserves and growth by introducing instrumental variables. In addition, the results from these early papers lead to diverging conclusions as different authors used different reserve metrics and different country observations. The samples used are smaller than in the present study. Blanchard et al. (2010) run a regression using 29 country points and Llaudes et al. (2010) have a mixed sample of emerging economies and developing countries with 40 observations. For our paper, we construct a large dataset of more than 100 emerging and developing countries and we follow a rigorous econometric procedure to establish the relationship between reserves and economic growth.

Finally, our paper is also related to several papers that examine the use of reserves during the GFC and the rebuilding afterwards. Aizenman and Sun (2009), Aizenman and Hutchison (2010), Dominguez (2012) and Dominguez et al. (2012) have all addressed the following question: if international reserves are held to cope with potential external shocks, were they used during the GFC? Aizenman and Hutchison (2010) focus on the trade-off between exchange rate depreciation and foreign reserve losses for countries facing a high exchange market pressure during the 2008-2009 crisis. They highlight the 'fear of losing reserves' - many countries chose to let their currency depreciate rather than to risk a run on their foreign exchange reserves - and the greater vulnerability of countries with a higher ratio of foreign liabilities to GDP. These results corroborate those of Aizenman and Sun (2009) with regard to the preference for exchange rate depreciation among emerging countries.

In contrast, Dominguez (2012) and Dominguez et al. (2012) distinguish between the total stock of reserves and actively managed reserves; the latter are reserves sold or purchased by a country's authority net of any valuation effect and interests payment. Based on this new definition, they find that countries have actively used foreign reserves during the crisis period. Dominguez (2012) finds that countries whose pre-crisis reserves exceeded optimal levels predicted by standard models of reserve accumulation were the most likely to use their reserves during the crisis. In addition, Dominguez et al. (2012) advance the proposition that both pre-crisis level of reserves and an active management of foreign reserve assets during the crisis are positively correlated with the GDP growth in the wake of the global financial crisis. A limitation of using the decomposition of reserves is that the available sample is very small. One can only calculate the actively managed component of reserves for countries which have subscribed to the IMF's Special Data Dissemination Standard (SDDS) in the Reserve Template[5].

Compared to this strand of literature on the use of reserves, we defend the thesis

[5]There are currently 70 countries which have subscribed to the SDDS, where 41 are emerging and developing countries.

that the pre-crisis level of reserves still matters. For us, international reserves should be viewed as being akin to 'nuclear weapon' having a deterrent effect, rather than to true 'gunpowder', to be used in intervention. In other words, having a large stock of reserves prior to any external shocks will deter speculators from attacking. This is of course consistent with the literature of the second generation crisis model (e.g. Obstfeld (1986)) that demonstrates that the occurrence of a speculative attack on a country's currency is conditional on this country's foreign reserve holdings. A sufficient level of reserves will hence obviate the need for a country to intervene massively as the risk of crises is minimized.

Finally, we also extend some results of Dominguez (2012) and Dominguez et al. (2012) with regard to the reserve accumulation behavior after the financial crisis. Dominguez (2012) argues that countries that experienced losses on their reserve stocks during the crisis tended to accumulate more afterwards. We confirm this trend using more recent data. Moreover, we further document that the pace of reserve accumulation has decelerated in many emerging economies in the last couple of years. We attribute this outcome to a plateauing of the underlying target variable, short term debt.

The rest of the paper is organized as follows. Section 2 describes the data and the methodology used. Section 3 presents our main econometric analysis of the role of international reserves on economic growth during the GFC. Section 4 examines countries' behavior in reserve accumulation in the wake of the financial crisis and section 5 concludes.

2 Data and specification

2.1 Data and key variables

Our primary data source for annual, quarterly and monthly international reserves is the database *International Financial Statistics* (IFS) of the International Monetary Fund (IMF). The macroeconomic data of different frequencies are also retrieved from the *IFS* and complemented with the *World Development Indicators* (WDI) issued by the World Bank (WB). For selected countries that are absent from the IMF and WB databases (e.g. Taiwan), national sources are used.

To preserve the homogeneity of our sample in terms of reserve accumulation and capital account policy, we decided to focus only on non-advanced countries (NAC). Our database includes 161 countries, divided into two sub-samples: 32 emerging market economies (EME) and 129 developing countries (LDC). EMEs are defined according to a combined criteria of the IMF and the economic magazine *the Economist*. For 49 countries, we did not have enough observations for the key independent variables includ-

ing control variables; therefore, 112 countries are effectively used in our main regressions. The details about our country coverage can be found in Appendix A.

International reserves

Several important features of the reserve data we use in this paper need to be highlighted.

Which assets are included in reserves? International reserves can be defined as the immediately available external assets denominated in foreign currencies that a country's government or monetary authority effectively holds. According to the *IFS*, total international reserves comprise foreign exchange reserves[6], reserve position in the Fund, the U.S. dollar value of SDR holdings and gold holdings[7]. Except gold holdings, all the other assets are included in the reserve data we use in the scope of this paper. The reason to exclude gold holdings is that the gold share is very small in non-advanced countries and gold holdings are less liquid than other reserve assets. As foreign reserves constitute the major component of international reserves (reserve position in the Fund and SDR holdings are also very small), we will interchangeably use the terms international reserves and foreign reserves in this paper.

Similarly, external assets held by sovereign wealth funds are not included in our reserve data. Foreign assets held by a sovereign wealth fund and that under control of a central bank are indeed managed under very different principles. While higher returns and strategic value are the objective of reserve management in a sovereign wealth fund, the liquidity and security of foreign assets are the guidelines for reserve management in a central bank. As we focus on the insurance role of foreign reserves, we only consider those foreign assets managed under the liquidity and security motives.

Moreover, the IMF credit facilities (e.g. Precautionary and liquidity line, Flexible credit line, Stand-by facility, etc.) and bilateral swap lines between countries are not included in foreign reserves defined by the *IFS* and used in this paper[8]. There are fundamental differences between the self-owned stock of foreign reserves and *ad hoc* contingent facility instruments which are short-term in nature. A few papers examine the substitutability between swap lines and foreign reserves (See Aizenman et al. (2011), Obstfeld et al. (2009)); this is however out of the scope of this paper.

Finally, it is very important to notice that there is an issuance of 183 billion of Special Drawing Rights by the IMF in August 2009 (equivalent to 283 billion of U.S. dollars). This

[6]This includes 'official claims on nonresidents in the form of foreign banknotes, bank deposits, treasury bills, short- and long-term government securities and other claims usable in the event of balance of payments need' (IFS Yearbook 2012).

[7]Gold holdings are expressed in millions of fine troy ounces and valued in U.S. dollar by each country.

[8]However, we used a dummy variable for the Fed swap lines. This only concerns Korea and Mexico in our non-advanced country sample. The introduction of this dummy does not change our results. Details are available upon request.

is in part due to the requirements of reforming the international monetary system under the G20 negotiations. This new issuance can be regarded as an exogenous increase of member countries' SDRs, thus of their stock of foreign reserves; it leads to an unexpected jump in the reserve data from 2009 and constitutes an issue when we examine the after-crisis behavior of reserve accumulation. Therefore, in order to concentrate on a given country's own decision of holding foreign reserves, we subtract this newly issued SDR in 2009 from our monthly and quarterly data on foreign reserves which is used in Section 4.

How to incorporate reserve data into our analysis? In this paper, we will use reserve adequacy ratios (in log[9]) instead of the absolute level of reserves. The reasons are two-fold. First, a reserve adequacy ratio facilitates cross-country comparison; the heterogeneity in the stock of reserves is tremendous, for example between China, which holds more than a third of the world foreign reserves, and small African countries. Second, the absolute level of reserves does not provide useful information about the robustness and resilience of a country facing shocks; at most it shows the country has enough financial resources to purchase reserve assets. On the contrary, reserve adequacy ratios do provide information about how reserves can be deployed to cope with some underlying target variables. Based on an extensive literature, we use the following four indicators:

- GDP based indicator : $log(\frac{\text{Reserves}}{\text{GDP}} \times 100)$ (rsv_gdp)
- Trade based indicator: $log(\frac{\text{Reserves}}{\text{Imports}} \times 12)$ $(rsv\_imports)$
- Debt based indicator: $log(\frac{\text{Reserves}}{\text{Short-term debt}} \times 100)$ (rsv_std)
- Money based indicator: $log(\frac{\text{Reserves}}{M_2} \times 100)$ (rsv_m2)

The GDP based indicator is a way to control for country size, no further information can be inferred from it. The trade based indicator is a traditional metric of the reserve adequacy. It reflects the capacity of a country to purchase foreign goods (for production or final consumption) even in case of limited or no access to external financing. The common wisdom requires that foreign reserves cover at least three-month imports. The debt based indicator has developed with the financial integration of emerging market economies and less developed countries. When a country's economic growth is financed by external debt, it is important for that country to insure the service of its debt, at least that coming due in short-term. Sufficient foreign reserves need to cover the repayment of

[9]We use the log ratio in our regressions for several reasons. First, it is commonly used in the existing literature regarding the role of foreign reserves during crises in emerging market economies. Second, the evolution of international reserves, especially in non-advanced countries, is non-linear, displaying an exponential pattern. Third, based on our analysis, the effect of *ex ante* holding of reserves on economic growth is non-linear; it exhibits positive and concave patterns, meaning that the marginal contribution of the reserve adequacy ratio on growth is diminishing. The effect is more pronounced for countries with low values of reserves to short-term debt ratio. Llaudes et al. (2010) provides a more detailed account on the non-linearity of this effect.

all the short-term debt denominated in foreign currencies. The money based indicator has gained popularity with Obstfeld et al. (2010) who emphasize the role of foreign reserves on stabilizing domestic financial market. A country needs to hold enough foreign reserves to offset the capital flight triggered by a weak confidence in the market of that economy. The amount of immediately available domestic assets which can be drained out during an episode of capital flight is proxied by the monetary aggregate M_2. This amount of assets needs to be covered by foreign reserves.

Capital controls

An important control variable for our analysis regards the controls on capital flows. There are a number of measures of capital controls in the literature, either *de jure* or *de facto*[10]. Our measure of capital controls is based on the *de jure* measure of capital openness constructed by Chinn and Ito (2006). This is not only a widely used index of the financial openness, it also captures well regulatory restrictions on capital account transactions, which is essential as we focus on policy variables.

For ease of interpretation, we invert the Chinn-Ito index such that the higher our capital control index, the more stringent the constraints on both capital inflows and outflows. Table 1 summarizes the basic statistic descriptions of our measure. We observe that advanced countries are much more financially open than non-advanced countries. 50% of advanced countries have a fully open capital account; their capital control index reaches the minimum -2.50.

Table 1: *capital controls*: Descriptive Statistics (2007)

	Non-advanced countries			Advanced countries
	EME	LDC	Total	
mean	-0.69	-0.04	-0.18	-2.20
median	-0.12	1.14	0.29	-2.50
s.d.	1.53	1.58	1.59	0.61
min	-2.50	-2.50	-2.50	-2.50
max	1.14	1.86	1.86	-0.12
obs	31	117	148	30

2.2 Specification

The analysis of this paper is based on cross-section econometrics; this allows us to make cross-country comparisons and to homogenize the shock of the recent crisis. Our benchmark specification is described below:

[10]For *de jure* measures see Chinn and Ito (2006), Kose et al. (2009), etc.; for *de facto* measures see Lane and Milesi-Ferretti (2007)

$$y_{i,09} = \beta_0 + \beta_1 rsv_{i,07} + \boldsymbol{\beta X_{i,07}} + \epsilon_{i,09} \quad (1)$$

$rsv_{i,07}$ stands for one of the four reserve adequacy ratios mentioned above. $\boldsymbol{X_{i,07}}$ corresponds to additional control variables. Note that all the independent variables (except for dummies) are lagged two periods[11]. Taking lagged independent variables allows us to have a snapshot of the situation of the country before the start of the crisis, and to use this picture to explain its performance during the crisis. Using later values for reserves and other controls would be problematic, since countries may already have changed their reserve holdings by the end of 2008 due to the start of the crisis. Yet, this does not solve endogeneity issues, which we will tackle in Section 3.4.

Construction of the dependent variable $y_{i,09}$

To assess the role of foreign reserves in mitigating the crisis impact on real economic growth in 2009, we need to construct appropriate measures of the GFC impact. Based on the above-cited literature on this issue, we use two measures that aim at capturing the gap between the actual real economic growth rate and a counterfactual growth rate should the crisis have not occurred.

The first method calculates the difference between the realized real economic growth rate and a linear prediction from a historical mean. We call this dependent variable 'purged real GDP growth', and denote it *rgdp_residual* in our equations and tables. It is obtained as follows:

$$rgdp\_residual_{i,09} = \Delta ry_{i,09} - \widehat{\Delta ry}_{i,09}$$
$$\widehat{\Delta ry}_{i,09} = \hat{\alpha}_0 + \hat{\alpha}_1 \overline{\Delta ry}_{i,03-08}$$

The coefficients $\hat{\alpha}_0$ and $\hat{\alpha}_1$ are estimated using a preliminary regression:

$$\Delta ry_{i,09} = \alpha_0 + \alpha_1 \overline{\Delta ry}_{i,03-08} + \epsilon_{i,09}$$

This preliminary regression assumes constant coefficients across countries, namely the contribution of the historical trend to real economic growth rate at a given time t being identical for all countries in our sample.

Our alternative dependent variable follows Blanchard et al. (2010) and Berkmen et al. (2012) and captures the change between the actual real GDP growth in 2009 and the IMF World Economic Outlook (WEO) forecast in the first quarter of 2008 (before the Lehman collapse in September of the same year). This variable measures the real output

[11] As a robustness test, we have also used independent variables lagged three periods. The results remain very similar to that presented in the paper. Details can be provided upon request.

losses due to the unexpected magnitude of the financial crisis. We call it 'unexpected real GDP growth' and denote it $rgdp\_fe$. One caveat about this variable is that there might be estimation errors associated with the forecast model that the IMF adopts. We assume that these errors are not time-varying and consistent over time.

We have also tried another potential dependent variable: the difference between actual real GDP growth and a historical mean, over 2003-2008. We find consistent results using this different dependent variable[12].

In Appendix B, figures 11 and 12 illustrate the ranking of a few big emerging market economies (belonging to the G20) in terms of our two dependent variables $rgdp\_residual$ or $rgdp\_fe$. In the same appendix, a list of the main variables used in our econometric analysis is also available.

3 Econometric analysis: the role of pre-crisis reserve adequacy during the GFC

3.1 Reserve adequacy ratios: which one works better?

Based on the 2008-2009 global financial crisis, we first try to examine whether *ex ante* foreign reserve accumulation has played any role in preventing output losses during the crisis. We pay a particular attention to the distinct explanatory power of each of the above-mentioned four reserve metrics.

We find that the reserves to short-term debt ratio is the most useful indicator to explain the real output growth during the crisis. The stock of foreign reserves scaled by the level of short-term debt two years prior to the crisis is positively and significantly correlated with the real GDP growth deviation from the trend. We illustrate this result using the full sample and the 'purged real GDP growth' as dependent variable in table 2 (The different numbers of observations are due to the data availability of the scaling variables.).

This result is robust if we switch the dependent variable to the 'unexpected real GDP growth' (table 12 in Appendix C). The coefficient associated with the reserves to short-term debt ratio is significant. We have also checked the robustness of this result by removing outliers[13] and small countries[14] from the sample. As can be seen in tables 13 and 14 in Appendix C, the main conclusions remain unchanged. Given that China has

[12]The results using this third variable as dependent variable are available upon request.

[13]The outliers removed are countries whose reserve adequacy ratio or dependent variable fall below the 1st percentile or above the 99th percentile. It corresponds to Armenia, Bahamas, Botswana, Latvia, Lebanon, Liberia, Libya.

[14]We use the World Bank classification to define small countries.

Table 2: Results with different reserve adequacy ratios

	(1) rgdp_residual	(2) rgdp_residual	(3) rgdp_residual	(4) rgdp_residual
L2.log rsv/gdp	-0.359			
	(0.607)			
L2.log rsv/imports		0.704		
		(0.627)		
L2.log rsv/m2			-0.0378	
			(0.564)	
L2.log rsv/std				0.624**
				(0.257)
Constant	1.522	-0.590	0.491	-3.165**
	(1.814)	(1.058)	(2.097)	(1.588)
Observations	143	134	138	138
R^2	0.002	0.009	0.000	0.042
Adjusted R^2	-0.005	0.002	-0.007	0.035

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

a very specific behavior in terms of reserve accumulation, we also removed this country from the sample, and obtained largely unchanged results[15].

3.2 Do reserves matter for economic growth during the GFC?

In order to better understand the influence of reserve holdings on output growth, we add control variables and estimate the full specification of our regression equation (1). The control variables $\boldsymbol{X_{i,07}}$ include capital controls, trade openness, an exchange rate

[15] As these findings are obtained with a ratio, a natural question to ask is which term in the ratio drives the results. However, this is a complex question: testing both terms separately may not be conclusive if what really matters is the ratio of the two. Bearing this caveat in mind, we ran two additional sets of regressions. First, when using $log(\frac{reserves}{STD})$ and $log(\frac{reserves}{GDP})$, both are significant with $rgdp\_residual$ as dependent variable, but only the first term is significant with $rgdp\_fe$ as dependent variable. Second, when using $log(\frac{reserves}{STD})$ and $log(\frac{STD}{GDP})$, only the second term is significant with $rgdp\_residual$ as dependent variable, and nothing is significant with $rgdp\_fe$ as dependent variable (with a collinearity issue). Third, $log(\frac{reserves}{GDP})$ and $log(\frac{STD}{GDP})$ have also been used to replace the reserve adequacy ratio. Only the second term turns out to be significant; but this result cannot validate the hypothesis that short-term debt matters more than foreign reserves, as $log(\frac{reserves}{GDP})$ is not a significant regressor even in a bivariate regression with our two dependent variables (table 2). These complementary results, which are available upon request, are therefore mixed, such that it is hard to conclude whether one of the two terms is predominantly driving the main result.

regime dummy[16] and an oil exporter dummy[17].

After controlling for further specific characteristics of different countries, we still find that the accumulation of foreign reserves prior to the crisis positively and significantly contributes to the real GDP growth during the crisis. The significance and magnitude of the coefficient associated with the reserve adequacy ratio remain similar when adding controls, for both of our dependent variables (columns (1) and (2) in table 3).

We further test the robustness of our results by estimating the same regressions using trimmed samples. Appendix D provides the results obtained after outliers[18] or/and small countries are ruled out. The coefficients have the same signs as in table 3 but have larger magnitude and stronger significance. One additional control variable, trade openness, turns out to be significant and has a negative sign as expected when *rgdp_residual* is used as dependent variable. The goodness of fit, in terms of R^2 and adjusted R^2, also becomes larger. Hence, our results can be regarded as robust and do not depend on the inclusion of outliers and small countries.

For robustness, we tested our results with additional control variables (i.e. net foreign assets and current account balance); the results are qualitatively similar. More restrictively trimmed samples have also been used throughout the paper[19]; the estimates of interest (reserves to short-term debt ratio and capital controls) become even larger and more significant. These results are available upon request.

3.3 Controlling for the interaction between reserves and capital controls

The introduction of an interacted term between foreign reserves and capital controls as a further control variable can help us check the robustness of our results, and shed light on the complementarity between foreign reserves and capital controls.

We show how the role of foreign reserves on economic growth may depend on other relevant policies, in particular capital account management, and then present the specification we adopt to estimate the interacted term.

[16] Our exchange rate regime dummy is constructed based on the classification by Reinhart and Rogoff (2004). It takes the value 1 when a country has a 'crawling peg' or more controlled exchange rate regime; it takes the value 0 when a country has a 'managed floating' or 'free floating' regime.

[17] The countries classified as oil exporters/producers are the following: Algeria, Angola, Bahrain, Cameroon, Chad, Congo, Ecuador, Equatorial Guinea, Gabon, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Oman, Qatar, Russia, Saudi Arabia, Sudan, Timor-Leste, Trinidad and Tobago, Turkmenistan, United Arab Emirates, Uzbekistan, Venezuela, Yemen.

[18] Defined in the same line as in footnote 12, namely all observations which fall below the 1st percentile or above the 99th percentile of any continuous variables (i.e. dependent variable, reserve ratio and trade openness). This criteria will apply in the subsequent sections when outliers are eliminated. As a result we further drop Brazil, Hong Kong, Rwanda and Singapore from the sample (no financial centers in this case).

[19] In these regressions, we have removed the top and bottom 5% observations of any continuous variables, or countries whose reserves to short-term debt ratio exceeds 1000 (75th percentile) in 2007.

Table 3: Full specification

	(1) rgdp_fe	(2) rgdp_residual
L2.log rsv/std	0.615**	0.729**
	(0.291)	(0.317)
L2.capital controls	0.498*	0.689**
	(0.282)	(0.307)
L2.exchange regime index	-1.282	-0.652
	(1.335)	(1.457)
L2.trade openness	-0.0194*	-0.0184
	(0.0117)	(0.0128)
oil dummy	-2.612**	-1.561
	(1.292)	(1.410)
financial center	5.374	5.284
	(4.941)	(5.395)
Constant	-5.527**	-1.400
	(2.358)	(2.575)
Observations	112	112
R^2	0.154	0.155
Adjusted R^2	0.106	0.107

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Intuition

Our empirical results suggest that foreign reserves and capital controls are complements with regard to their impact on economic growth during the GFC. We provide here an intuition which supports this particular relationship. In fact, if foreign reserves can be seen as munitions of liquidity that can be deployed when a country is cut off from external financial markets, a closed capital account can be interpreted as a neutralized playing field for the impact of reserves to be effective. Indeed, capital controls insure that public capital outflows (foreign reserve purchasing) are not completely offset by private capital inflows (accumulation of private foreign liabilities). As a matter of fact, foreign reserves can be used to provide an aggregate insurance to the economy, but the moral hazard associated with foreign reserve accumulation might incite the private sector, firms and banks, to take extra risks given that the government will provide foreign currency liquidity when it is necessary. Therefore, the insurance provided by foreign reserves can be offset by private capital inflows should the capital account be completely open. There are a few recent theoretical works which support our intuition and empirical finding. For example, Benigno and Fornaro (2012), Bacchetta et al. (2013) and Cheng (2013) all argue that the imperfect substitutability between public and private capital flows is crucial for foreign reserves to play a role. According to this strand of literature, foreign reserve accumulation and a closed capital account are complements rather than substitutes.

Specification

There are several ways to introduce an interactive term. To facilitate interpretation, we use a demeaned interacted term: $(rsv\_std_i - \overline{rsv\_std_i}) \times (cc_i - \overline{cc}_i)$ as stated in equation (2). Using this setting, the coefficient before rsv_std_i (respectively cc_i) refers to the marginal effect of that variable when cc_i (respectively rsv_std_i) is valued at its mean. Note that $\boldsymbol{x_{i,07}}$ refers to the set of control variables we used in Section 3.2 except capital controls.

$$y_{i,09} = \beta_0 + \beta_1 rsv\_std_{i,07} + \beta_2 cc_{i,07} + \beta_3 \underbrace{(rsv\_std_{i,07} - \overline{rsv\_std}_{07}) \times (cc_{i,07} - \overline{cc}_{07})}_{\text{interaction}} + \boldsymbol{\beta x_{i,07}} + \epsilon_{i,09} \tag{2}$$

The marginal effect of foreign reserves is calculated as follows:

$$\frac{\partial y_{i,09}}{\partial rsv\_std_{i,07}} = \beta_1 + \beta_3 \times (cc_{i,07} - \overline{cc}_{07})$$

To fully validate the introduction of an interacted term, we need to make sure that a statistically significant coefficient before the interacted term does not come from a

bivariate relationship between the two variables incorporated in the interacted term, namely rsv_std_i and cc_i in this paper[20].

Results

In the following exercise, we try to identify the contribution of foreign reserves to support economic growth during the crisis time, conditional on the degree of capital account openness.

In table 4, columns (1) and (2), we see that foreign reserves and capital controls both contribute to reduce a country's real GDP losses during the recent financial crisis (they both have a positive and significant coefficient). The coefficient associated with the interacted term is also significant and positive, reinforcing the marginal effects of the reserve adequacy ratio and of capital controls. One can look at the joint F-test (test scores reported at the bottom of table 4) between reserves and the interaction term in order to infer the significance of the impact of foreign reserves on growth. These estimates are indeed jointly highly significant (at the 98% significance level).

Taking into account the interactive term, we can calculate the marginal effects of foreign reserves in terms of capital controls using the estimates presented in table 4 column (2):

$$\frac{\partial y_{i,09}}{\partial rsv\_std_{i,07}} = 0.623 + 0.333 \times (cc_{i,07} - \overline{cc}_{07})$$

The marginal effect of reserves on our purged measure of GDP growth is equal to 0.623 for a country that has average capital controls. The more stringent a country's capital account (higher value of cc), the more pronounced the marginal effect of the *ex ante* foreign reserve adequacy ratio on economic growth during the GFC. Figure 3a gives an illustrative overview of the evolution of the marginal effects of reserves as a function of the tightness of capital controls. The marginal effects of reserves is increasing and becomes positive slightly before capital controls reach their 3rd decile ($cc > -1.18$); it becomes significantly different from zero when capital controls are beyond their 5th decile ($cc > -1.12$). Moreover, figure 3b shows how the predicted real detrended economic growth improves with a higher reserves to short-term debt ratio when all other variables (including capital controls) are valued at their mean value.

[20]To avoid spurious regressions, we have controlled for the quadratic forms of rsv_std_i and cc_i respectively. We have also orthogonalized these two key variables using the Frisch-Waugh theorem before constructing the interacted term. The details of these results are available upon request.

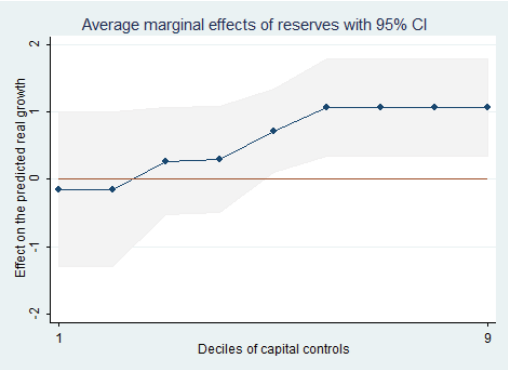
Table 4: Foreign reserve accumulation and capital controls

	full sample		without outliers	
	(1)	(2)	(3)	(4)
	rgdp_fe	rgdp_residual	rgdp_fe	rgdp_residual
L2.log rsv/std	0.506*	0.623*	0.911***	0.866***
	(0.291)	(0.319)	(0.305)	(0.329)
L2.capital controls	0.586**	0.774**	0.0713	0.281
	(0.281)	(0.308)	(0.274)	(0.292)
L2.log rsv/std × capital controls	0.345**	0.333*	0.0965	0.170
	(0.170)	(0.187)	(0.199)	(0.216)
L2.exchange regime index	-1.344	-0.711	-0.934	-0.260
	(1.316)	(1.443)	(1.234)	(1.316)
L2.trade openness	-0.0191*	-0.0181	-0.0233**	-0.0283**
	(0.0115)	(0.0126)	(0.0105)	(0.0113)
oil dummy	-2.642**	-1.590	-3.124***	-1.962
	(1.273)	(1.396)	(1.137)	(1.214)
financial center	4.718	4.649		
	(4.881)	(5.352)		
Constant	-4.981**	-0.872	-6.921***	-1.477
	(2.340)	(2.566)	(2.305)	(2.477)
Observations	112	112	104	102
R^2	0.186	0.180	0.215	0.206
Adjusted R^2	0.131	0.125	0.166	0.156
F-test capital controls	3.656	4.155	0.127	0.615
P-value	0.0292	0.0184	0.881	0.543
F-test reserves	4.350	4.287	5.359	4.685
P-value	0.0153	0.0163	0.00620	0.0115

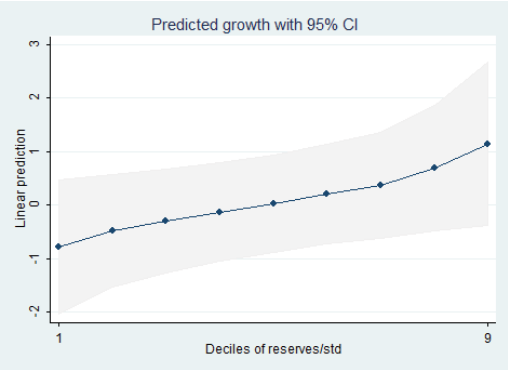
Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



(a) Marginal effects of reserves



(b) Predicted real economic growth

Figure 3: Marginal effects and predictions

Here again, we check for robustness by dropping outliers[21]. Whereas the previous results (without the interaction term between reserves and capital controls) were fairly robust to this change of sample, here both the coefficients of capital controls and of the interaction term lose significance when we control for outliers, as one can see in columns (3) and (4) of table 4[22]. However, the coefficient associated with the reserves to short-term debt ratio is highly significant and increases in magnitude. From this, we can conclude that the impact of the reserve adequacy ratio itself is still fairly robust, even after we drop outliers from our sample. Finally, as regards the magnitude of the coefficient associated with the reserve adequacy ratio, it seems that the estimate we obtained in our benchmark regression (table 3) is rather a minimal value, since the associated coefficient tends to increase when excluding outliers.

3.4 Accounting for endogeneity

As mentioned above, using foreign reserves as an explanatory variable to explain real economic growth can cause endogeneity issues. Foreign reserves might be held by a central bank as in anticipation of a future negative shock to the national economy; foreign reserves and higher GDP growth might also both be by-products of a mercantilist exchange rate policy. So far, we have been using lagged metrics of foreign reserves as our main explanatory variable without controlling for endogeneity; this is also the method adopted by most existing empirical papers on foreign reserves. This may induce a bias in our coefficient estimates, the direction of which is however ambiguous. On the one hand, if we consider that fragile countries accumulate more reserves for precautionary reasons,

[21]Results are similar when excluding both small countries and outliers. They are presented in Appendix E table 17. Results using more restrictively trimmed samples are available upon request.

[22]Note that by dropping outliers (top and bottom 1% of observations of each continuous variable), we drop all financial centers from our sample, which explains the absence of the financial center dummy in columns (3) and (4) of table 4.

and are more likely to be affected in a crisis (because of the idiosyncratic fragility), we can argue that the OLS coefficient associated to reserves may be biased downwards. On the other hand, reserve accumulation can be a buy-product of an undervalued domestic currency which stimulates economic growth through strong exports. This mechanism implies an upward bias of our OLS coefficient. It is therefore difficult to predict the direction of the bias altogether. We go one step further to account for endogeneity and reverse causality by choosing appropriate instrumental variables for foreign reserve metrics.

Construction of instrumental variables

Finding an instrumental variable for reserves is not an easy task. An appropriate instrumental variable needs to fulfill two conditions: first, it needs to be correlated with the instrumented variable; second, it must be uncorrelated with the error term in the original OLS regression (equation (1)). We have thought of various candidates, including a dummy for the occurrence of currency crises in the 1970's and 1980's, a measure of the severity of past crises, real GDP per capita expressed in purchasing power parity, or metrics of regional peer pressure for reserves accumulation. After carefully examining different possibilities, we conclude that the regional peer pressure is the best suited instrumental variable with respect to our analysis.

Regional peer pressure for reserve accumulation captures the idea of 'keeping up with the Joneses', namely a country might be motivated to hold foreign reserves as its neighbors do so. In many empirical papers[23], this idea of regional peer pressure is introduced to study the demand function of foreign reserves. Therefore, it should be highly correlated with foreign reserve accumulation *per se*. Furthermore, these instrumental variables allow us to focus on reserves accumulated for 'neighborhood' motives, and disregard those related to precautionary or mercantilist motives, which are related to the economic performance of a country and therefore endogenous.

As for our instrumental variables, we propose two proxies to measure the regional peer pressure:

- $\boldsymbol{IDW06_i}$: An inverse distance weighted mean for country i measures the average of the reserves to GDP ratio of all other countries in the world ($j \neq i$) weighted by the inverse distance between country i and country j (so that country i's neighbors matter more than remoter countries). We assume that country i can only observe the decision made by other countries in terms of reserve accumulation in the previous year. As a result, we use the inverse distance weighted mean in 2006 as the instrument for the reserves to short-term debt ratio in 2007. The advantage of this

[23] See Bastourre et al. (2009), Cheung and Sengupta (2011), etc.

instrument is that it is more broadly defined and comprises much more information than regional dummies. The construction of $IDW06_i$ is detailed below and the data on geographical distance is retrieved from Mayer and Zignago (2011). Note that country i's own reserve ratio is not included in its distance weighted mean.

$$IDW06_i = \sum_{j \neq i} w_i^j \frac{Reserves_j}{GDP_j}$$
$$w_i^j = \frac{(dist_{ij})^{-2}}{\sum_{k \neq i}(dist_{ik}^{-2})}$$

- ***Joneses$_i$***: The Joneses index defined by Cheung and Sengupta (2011) is calculated by the sum of the reserves to GDP ratio of country i's neighboring countries $j \neq i$ in a given geographical region[24]. Here again, country i's own reserve ratio is excluded from this sum.

$$Joneses_i = \sum_{j \neq i} \frac{Reserves_j}{GDP_j}$$

Given the regional patterns we observe in terms of reserves accumulation (Asian countries for instance accumulate much more reserves than others), we expect a positive correlation between our instrumental variable and our reserve adequacy ratio. Moreover, we need to insure that our instrumental variables are orthogonal to the error term in our original OLS regression. Remember that our dependent variable in equation (1) measures a country's economic performance during the global financial crisis compared to non-crisis times, namely a 'detrended' real GDP growth rate. This is thus a measure of short-term economic growth, mainly affected by circumstantial factors (i.e. temporary external shocks). The importance of reserve holdings of a country's neighbors in 2006 should not be directly related to the impact of the 2009 financial crisis on economic growth.

Hence, the reserve accumulation behavior of neighbor countries before the crisis has no clear relationship with residuals of our OLS regression (which correspond to the crisis impact that is not explained by reserves, capital controls, trade openness, exchange rate regime, and financial centers)[25].

[24]We define 8 regions: East Asia & Pacific, South Asia, Eastern Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, Sub-Saharan Africa, European Union (27) and North America. Advanced countries being dropped out, the latter two regions, European Union (27) and North America do not have observations.

[25]One caveat: one may argue that countries in a given region have similar trade and financial flows,

We provide the results of the first-stage regressions using our candidate instrumental variables, in table 18 in Appendix F. Column (1) shows the results using the distance-weighted index, column (2) uses the Joneses index, while column (3) uses both variables as joint instruments. In all three cases we find a significant correlation with the instrumented variable, reserves to short-term debt ratio, and obtain signs consistent with our expectation, namely the stronger regional pressure, the higher reserve adequacy ratio. The R^2 is also reasonably large, around 14% in all three cases. These findings confirm our choice of instrumental variables. The sign and goodness of fit of the distance-weighted index remain stable when we drop outliers; that of the Joneses index is slightly weaker (see table 19 in Appendix F).

Two-stage least square regressions

We present in table 5 the results of the second stage regression when the reserve adequacy ratio is instrumented. To facilitate interpretation, we repeat our OLS results in column (1). Columns (2), (3) and (4) respectively show the final results of the two-stage least square procedure (2SLS) using the distance-weighted index, the Joneses index and both.

Using instrumental variables, the coefficients of interest in our regressions are not significant any more. This result is not very surprising, since we know that the 2SLS procedure usually yields larger standard errors, driving down the significance of the 2SLS estimates. For this reason, it is hard to conclude anything in terms of bias correction and magnitude. The signs of the 2SLS estimates are consistent with the OLS estimates, although the magnitude of the 2SLS estimates are higher, but none of the coefficients estimated through 2SLS are significantly different from zero[26].

For robustness checks, table 20 in Appendix F presents similar results when dropping outliers from the sample. We also instrumented the reserve adequacy ratio when adding the interaction term between reserves and capital controls in the regression; results are fairly similar to that presented above and are available upon request.

therefore the pattern of their reserve accumulation may have a common component related to common growth expectations in the region. This would weaken the exogeneity of our instruments.

[26]Considering that the corresponding Hausman test fails to reject the null hypothesis of exogenous right-hand-side variables, we feel more confident on relying on our OLS estimates.

Table 5: 2SLS: Second stage

	(1) OLS	(2) distance weighted index	(3) Joneses	(4) both
L2.log rsv/std	0.729**	2.088	0.944	1.413
	(0.317)	(1.888)	(1.485)	(1.213)
L2.capital controls	0.689**	0.506	0.660*	0.597*
	(0.307)	(0.408)	(0.356)	(0.343)
L2.exchange regime index	-0.652	-1.330	-0.759	-0.993
	(1.457)	(1.789)	(1.589)	(1.556)
L2.trade openness	-0.0184	-0.00567	-0.0164	-0.0120
	(0.0128)	(0.0220)	(0.0184)	(0.0167)
oil dummy	-1.561	-2.131	-1.651	-1.848
	(1.410)	(1.673)	(1.498)	(1.479)
financial center	5.284	1.700	4.718	3.479
	(5.395)	(7.488)	(6.488)	(6.169)
Constant	-1.400	-9.972	-2.754	-5.716
	(2.575)	(12.03)	(9.502)	(7.821)
Observations	112	112	112	112
R^2	0.155	0.007	0.151	0.117
Adjusted R^2	0.107	-0.049	0.103	0.067
Hausman $p-value$	.	0.442	0.886	0.563

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.5 Foreign reserves: gunpowder or nuclear weapons?

We have so far seen that foreign reserve adequacy (relative to short-term debt) contributes, on its own or jointly with capital controls, to real output growth during the recent global financial crisis. Other papers (e.g. Aizenman and Sun (2009) and Dominguez et al. (2012)) rather focus on reserve depletion and its impact on economic growth of the same period. These different views reflect an interesting question behind: are foreign reserves 'gunpowder', meaning that they have to be deployed during a war (crisis), or are they akin to 'nuclear weapons' - the mere existence of reserves suffices to act as a protection? We try to bring some empirical evidence to this question here.

First, we want to know whether countries that had a larger pre-crisis level of reserves compared to short-term debts depleted more reserves during the GFC. The scatter plot in figure 4 does not show a clear relationship between pre-crisis reserve adequacy and reserve depletion during the GFC[27]. This feature remains true even if we exclude outliers. It seems like only countries whose pre-crisis reserves to short-term debt ratio falls in the middle range depleted reserve assets during the GFC; both countries which had a very high or very low reserve adequacy ratio did not use much their reserves. Notice that in order to cover a broader range of non-advanced countries, we use the change in the *total* reserve stock as our proxy for reserve depletion during the GFC (different from Dominguez et al. (2012) who use SDDS data).

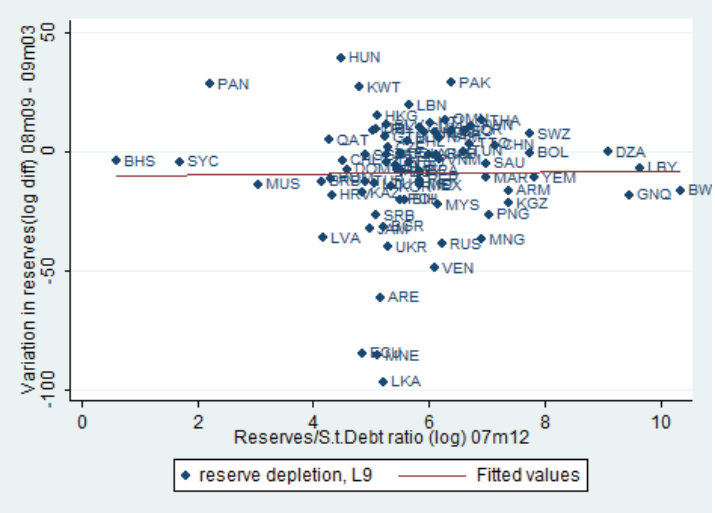


Figure 4: Depletion vs. Pre-crisis adequacy

Next, we proceed to include a control variable of reserve depletion in our main specification, equation (2), so that we can see whether this control variable has an effect on the coefficients we estimated above. In particular, we are interested to see whether including reserve depletion changes the coefficient of pre-crisis reserve adequacy ratio.

[27] We also tested this relationship empirically using an OLS regression. Results can be provided upon request.

For this exercise, we construct a dummy variable as a proxy of reserve depletion. It takes the value 1 if the growth rate of reserves is zero or negative between 2008 and 2009 and the value 0 otherwise. We find that the pre-crisis reserve adequacy ratio remains statistically significant when the variable of reserve depletion is added (reserve depletion itself not significant, see table 6).

Table 6: Reserve depletion as a control variable

	(1) rgdp_residual	(2) rgdp_residual
L2.log rsv/std	0.729**	0.752**
	(0.317)	(0.321)
L2.capital controls	0.689**	0.719**
	(0.307)	(0.313)
L2.exchange regime index	-0.652	-0.681
	(1.457)	(1.469)
L2.trade openness	-0.0184	-0.0169
	(0.0128)	(0.0130)
oil dummy	-1.561	-1.179
	(1.410)	(1.563)
financial center	5.284	4.844
	(5.395)	(5.458)
reserve depletion dummy		-0.758
		(1.422)
Constant	-1.400	-1.594
	(2.575)	(2.603)
Observations	112	111
R^2	0.155	0.157
Adjusted R^2	0.107	0.100

Standard errors in parentheses
Homoscedasticity not rejected according to the White test
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4 Foreign reserve accumulation after the global financial crisis

So far, we have analyzed the role of foreign reserves on real economic growth during the GFC and have concluded that sufficient reserves with respect to a country's short-

term debt level are important to limit output losses during a crisis. Did the GFC then reshape countries' perception about the necessity of hoarding foreign reserves? As noted by the IMF, '[a]uthorities in several countries, including some advanced economies, had started focusing anew on the role of reserves in crisis mitigation and management [...] and even several small advanced countries have since taken a new look at their need for reserves in relation to the international exposures of their financial systems (IEO (2012)).'

In fact, in line with existing papers (Dominguez et al. (2012)), we find that many countries see their reserves 'bounce back' immediately after a period of reserve losses during the GFC. Compared to the existing literature, this paper takes advantage of more recent data to better describe reserve rebuilding after the GFC, and more importantly, to document a recent trend of deceleration in reserve accumulation.

Figure 5 illustrates how the monthly growth rate in foreign reserve accumulation has changed from a high speed before the crisis to a relatively slow pace in more recent years. We can especially observe a spectacular depletion of reserves during the crisis period, a fast 'bounce-back' in the aftermath of the crisis followed by a 'flattening-out'. We will document these three phenomena in this section.

Figure 5: Evolution of foreign reserve accumulation

4.1 Reserve rebuilding in the immediate aftermath of the crisis

Two features draw our attention with respect to reserve rebuilding. First, a significant rebuilding is more pronounced in countries which had a relatively low pre-crisis reserve adequacy ratio. Figure 6 shows a scatter plot comparing pre-crisis reserves to short-term debt in December 2007 with reserve rebuilding from April to December 2009. This time

span is defined as the period immediately following the peak of the GFC. We take the timing of being hit by the GFC from Dominguez et al. (2012)[28].

We can see a clear negative relationship between these two variables. Namely, the lower the pre-crisis reserve adequacy ratio, the stronger the rebuilding. This might reflect an increasing demand for reserves in countries that were insufficiently self-insured before the GFC.

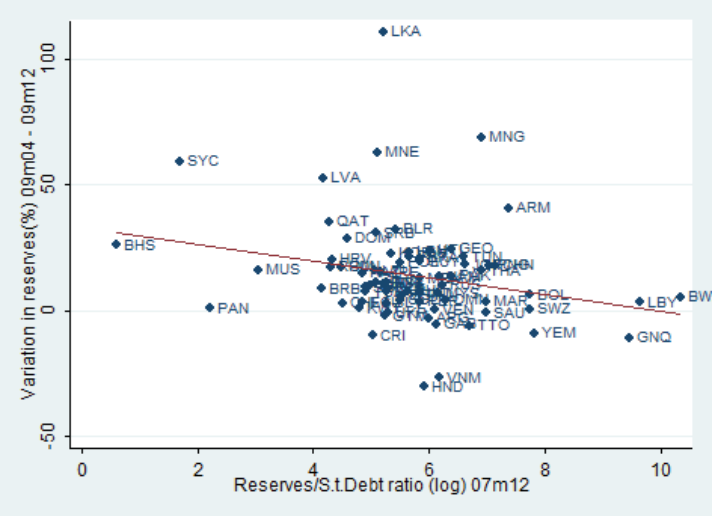


Figure 6: Rebuilding vs. Pre-crisis level of reserves

We further test this bivariate relationship with a simple OLS regression specified as follows:

$$\Delta rsv_{09m04-09m12,i} = \gamma_0 + \gamma_1 log(\frac{rsv}{std})_{07m12} + \boldsymbol{\gamma x} + \epsilon_i \tag{3}$$

$\boldsymbol{x}$ stands for control variables, including especially a dummy variable which indicates whether a country drew credit lines from the IMF before 2009Q1. We construct this dummy variable based on the IMF annual report and we conjecture that if a country resorted to an IMF program during the crisis its willingness to re-build foreign reserves after the financial crisis would be enhanced.

We observe from table 7 that the post-crisis reserve rebuilding rate is significantly and negatively correlated with pre-crisis reserve adequacy ratio in most cases. The coefficient of the pre-crisis adequacy ratio loses the significance once we add the oil country dummy. Oil countries did not seem to recover their reserve stock after the GFC; this however might be due to the collapse of world oil demand. This result is robust after controlling for outliers (column (4)). A more pronounced reserve rebuilding seems to be associated with a lower pre-crisis reserve adequacy ratio.

We now turn to the relationship between reserve rebuilding after the crisis and reserve depletion during the crisis. From figure 7, we observe that a massive depletion of reserves

[28]Dominguez et al. (2012) report that most non-advanced countries experienced the crisis between 2008Q4 and 2009Q1 in spite of some heterogeneities.

Table 7: Reserve rebuilding vs. Pre-crisis adequacy ratio

		full sample		w/t outliers
	(1)	(2)	(3)	(4)
	rebuilding	rebuilding	rebuilding	rebuilding
log rsv/std (07m12)	-3.326**	-2.368	-2.724*	-2.636*
	(1.555)	(1.565)	(1.542)	(1.478)
IMF credit dummy		10.83**	12.24**	10.67**
		(5.269)	(5.151)	(4.340)
financial center		-5.035	-3.413	-3.143
		(19.79)	(19.81)	(15.91)
oil dummy		-7.138		
		(5.960)		
Constant	32.95***	25.94***	26.06***	25.36***
	(9.121)	(9.391)	(9.420)	(8.947)
Observations	73	73	73	69
R^2	0.061	0.151	0.133	0.152
Adjusted R^2	0.047	0.101	0.096	0.113

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

during the crisis is associated with a stronger rebound. This seems once again to confirm countries' increasing appetite for reserve assets as a self-insurance.

We can also test this relationship using the following OLS regression:

$$\Delta rsv_{09m04-09m12,i} = \gamma_0 + \gamma_1 \Delta rsv_{08m09-09m03,i} + \boldsymbol{\gamma x} + \epsilon_i \tag{4}$$

Table 8 shows that the negative relationship between the growth rate of reserves during and after the GFC that we can see from the scatter plot in figure 7 is statistically significant. A higher rebuilding rate is associated with a more severe reserve depletion. This result is also robust even if we control for other variables (column (2)) or eliminate outliers (column (3)).

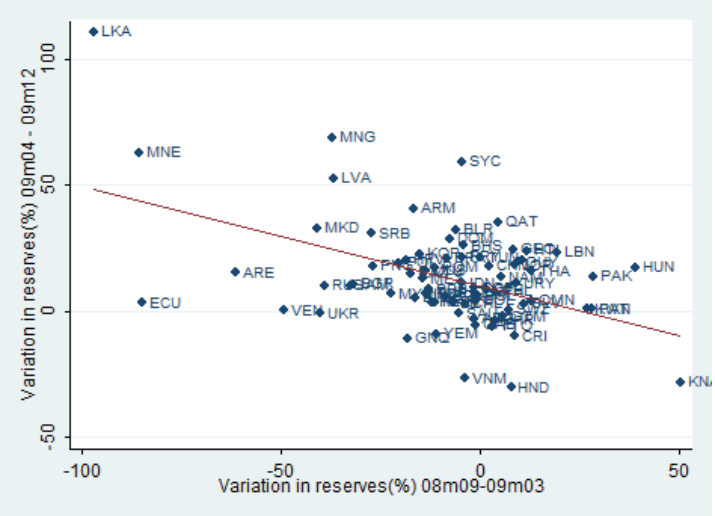


Figure 7: Rebuilding vs. Depletion of reserves

Table 8: Reserve rebuilding vs. Reserve depletion

	full sample		w/t outliers
	(1)	(2)	(3)
	rebuilding	rebuilding	rebuilding
reserve depletion	-0.394***	-0.427***	-0.232***
	(0.0844)	(0.0802)	(0.0779)
IMF credit dummy		8.497*	10.06**
		(4.504)	(3.939)
oil dummy		-13.25**	-11.39**
		(5.118)	(4.307)
financial center		-1.185	
		(17.48)	
Constant	10.10***	9.843***	11.03***
	(2.237)	(2.847)	(2.374)
Observations	77	76	73
R^2	0.225	0.358	0.266
Adjusted R^2	0.215	0.322	0.234

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.2 Foreign reserve accumulation: a recent deceleration

Thanks to ampler data, we now analyze the more recent behavior in reserve accumulation. We observe a noticeable slow-down in the pace of foreign reserve accumulation in several emerging market economies, like India, Russia, and some Eastern European countries (e.g. Bulgaria, Croatia and Romania). One important exception is China.

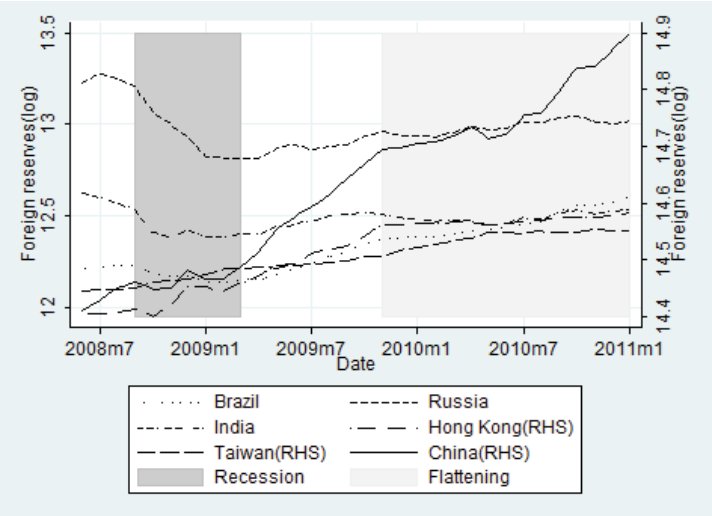


Figure 8: Recent foreign reserve accumulation in BRIC, Hong Kong and Taiwan

From figure 8, apart from China where foreign reserve accumulation has a clearly different pattern, there is a general tendency of a deceleration in the pace of foreign reserve purchasing from the end of 2009. This tendency is especially observable in India, Russia and Hong Kong; foreign reserves in Taiwan also tail off, though with a delay, from mid-2010[29].

A 'flattening-out' of foreign reserve accumulation is also noticeable in other countries when a more recent period is considered. This is the case for Indonesia, Malaysia and Thailand (figure 9) and many East European countries (figure 10) from the end of 2010.

What drives this 'flattening' in foreign reserve accumulation? We come up with several possible explanations. First, it is possible that, once a country reached its pre-crisis level of reserves, it slows down the accumulation as foreign reserves are no free lunch and the opportunity cost and risks associated with valuation effects may be high. Second, the deceleration of foreign reserve accumulation may reflect a change of policy priority with regard to monetary autonomy, exchange rate stability and financial openness in the wake of the 2008-2009 financial crisis, as Aizenman et al. (2010) put forward. After all, reserve accumulation may be motivated by the need to reconcile the 'Impossible Trinity' (this is however an aspect of reserve accumulation that we do not consider in this paper). Last but not least, if foreign reserve accumulation tails off, it might be because of the

[29]The GFC period corresponds to the finding of Dominguez et al. (2012) as noted before.

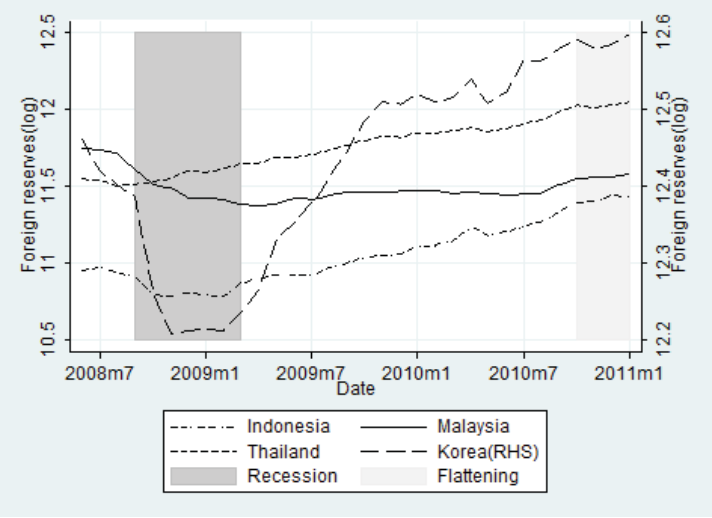


Figure 9: Selected Asian countries

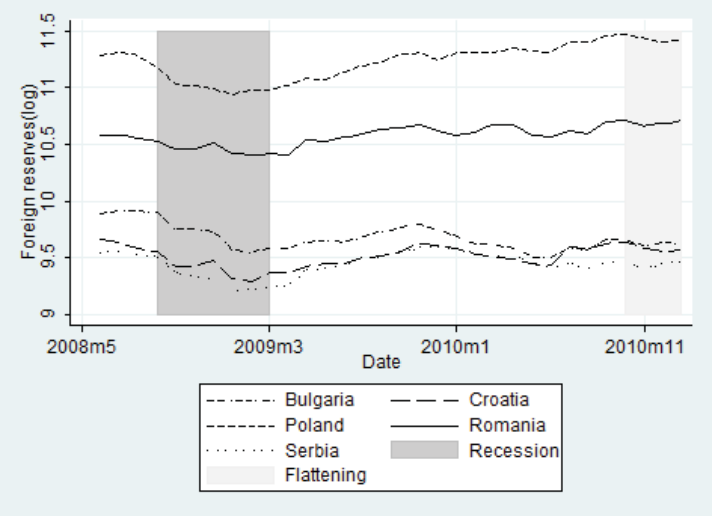


Figure 10: Selected East European countries

stabilization of the underlying macroeconomic variable that foreign reserves are used to cover. In our paper, we argue that this macroeconomic variable is short-term debt. With the 'flattening-out' of short-term debt after the financial crisis (the reasons why short-term debt diminishes after the GFC are multiple, e.g. Great Retrenchment), the demand for foreign reserves must fall.

We can test the relationship between short-term debt and foreign reserves based on a Vector Error Correction Model (VECM), which can identify the long-run co-integration relation as well as short-term dynamics between these two variables. Due to the availability of data and the minimum data points needed, we use quarterly data of reserves and short-term debt, as well as other control variables for this exercise. We consider the period running from 2002Q1 to 2012Q1.

The VECM specification can be written as:

$$\Delta log(rsv_{i,t}) = \phi_i \Big(log(rsv_{i,t-1}) - \theta_0 - \theta_1 log(std_{i,t-1}) \Big) + \delta_{1,i} \Delta log(std_{i,t}) + \boldsymbol{\delta_i'} \boldsymbol{\Delta x_{i,t}} + \epsilon_{i,t} \quad (5)$$

ϕ_i is the error correcting term, namely the speed of adjustment. If it is significantly negative, one can conclude that there is convergence to the long run relationship which is described as follows:

$$log(rsv_{i,t-1}) = \theta_0 + \theta_1 log(std_{i,t-1})$$

The short run dynamics are captured by the short run coefficients $\delta_{1,i}$ and $\boldsymbol{\delta_i'}$.

To estimate equation (5), several methods can be used. Below we present the estimation results using pooled mean group estimates, which assume a common long-run coefficient across countries but heterogeneous short-term adjustment.

From table 9, we observe that there is a clear positive long-run relationship between foreign reserves and short-term debt both expressed in logarithm. In the baseline case (column (1)), $log(rsv_{i,t}) = 0.436\ log(std_{i,t})$. In the short-term, the error correction coefficient (-0.0743) is significant and negative, meaning that if foreign reserves exceed the long-run equilibrium level a country reduces its foreign reserve accumulation with an adjustment rate of 7% in the baseline case.

As a robustness check, we also tried different estimation methods and used additional control variables. The main coefficients presented in table 9 do not change in signs nor in magnitude.

The VECM confirms our initial guess on why foreign reserve accumulation tails off in recent years. It is likely that the underlying target variable for foreign reserves, namely short-term debt, stabilizes after the financial crisis; this, in turn, may be associated with the global liquidity crunch and Great Retrenchment (Milesi-Ferretti and Tille (2011)) in international capital flows that took place in the wake of the GFC.

Table 9: Vector Error Correction Model (2002Q1 - 2012Q1)

	(1)	(2)	(3)
	Δ log(reserves)	Δ log(reserves)	Δ log(reserves)
Long-run			
L.std_log	0.436***	0.445***	0.448***
	(0.0249)	(0.0243)	(0.0270)
Short-run			
error correction	-0.0743***	-0.0815***	-0.186***
	(0.0107)	(0.0130)	(0.0514)
D.std_log	0.138***	0.128***	0.148***
	(0.0188)	(0.0173)	(0.0277)
LD.reserves_log		0.113***	0.0338
		(0.0296)	(0.0399)
L2D.reserves_log		-0.0357*	-0.131***
		(0.0213)	(0.0436)
Δ log(RGDP)			0.282
			(0.485)
Δ log(M2)			0.225
			(0.199)
Δ log(REER)			0.0474
			(0.0920)
Constant	0.438***	0.468***	0.950***
	(0.0584)	(0.0697)	(0.230)
Observations	2752	2750	1093

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusion

In the late 1990s and early 2000s, a consensus developed that reserves were useful in averting, or at least mitigating, the occurrence of crises in emerging market and developing countries. Policy makers from these countries have apparently absorbed the lessons from this literature, as the level of international reserves dramatically increased in the 2000s (even accepting that other motives have played a role). The results presented in this paper suggest that the Great Financial Crisis has further demonstrated the usefulness of reserves: empirically, the countries that held more reserves as a percentage of short-term debt have been less negatively impacted than others, ceteris paribus. The results also suggest that this effect is especially strong when the capital account is less open.

Given that reserves seem to have played a role in offsetting the effect of the crisis, it is not surprising that the countries that depleted reserves to a greater extent are also the ones that rebuilt them more quickly in the direct aftermath of the crisis, as shown in the paper. One possible factor is that policy makers in emerging market and developing countries have concluded from the experience of the GFC that reserves are indeed very useful in protecting countries against crises. Nonetheless, we also find that in the most recent period, the pace of reserve accumulation has slowed down, in line with the deceleration in the pace of short-term debt. This outcome suggests that countries target the level of short-term debt: if, for whatever reason, short-term debt accumulation decelerates, then reserves are likely to follow the same course.

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A Country sample

For Eastern European countries, we decided to classify countries at the periphery of Europe and not in the Eurozone as emerging market economies, whereas countries that belong to the Eurozone are considered as advanced economies and not included in our sample.

Table 10: Country list

country	cncode	region	regioncode	country group
Afghanistan	AFG	South Asia	1	LDC
Albania	ALB	Europe & Central Asia	8	LDC
Algeria	DZA	Middle East & North Africa	4	LDC
Angola	AGO	Sub-Saharan Africa	7	LDC
Antigua and Barbuda	ATG	Latin America & Caribbean	3	LDC
Argentina	ARG	Latin America & Caribbean	3	EME
Armenia	ARM	Europe & Central Asia	8	LDC
Aruba	ABW	Latin America & Caribbean	3	LDC
Azerbaijan	AZE	Europe & Central Asia	8	LDC
Bahamas	BHS	Latin America & Caribbean	3	LDC
Bahrain	BHR	Middle East & North Africa	4	LDC
Bangladesh	BGD	South Asia	1	LDC
Barbados	BRB	Latin America & Caribbean	3	LDC
Belarus	BLR	Europe & Central Asia	8	LDC
Belize	BLZ	Latin America & Caribbean	3	LDC
Benin	BEN	Sub-Saharan Africa	7	LDC
Bhutan	BTN	South Asia	1	LDC
Bolivia	BOL	Latin America & Caribbean	3	LDC
Bosnia and Herzegovina	BIH	Europe & Central Asia	8	LDC
Botswana	BWA	Sub-Saharan Africa	7	LDC
Brazil	BRA	Latin America & Caribbean	3	EME
Brunei Darussalam	BRN	East Asia & Pacific	6	LDC
Bulgaria	BGR	Europe & Central Asia	8	EME
Burkina Faso	BFA	Sub-Saharan Africa	7	LDC
Burundi	BDI	Sub-Saharan Africa	7	LDC
Cambodia	KHM	East Asia & Pacific	6	LDC
Cameroon	CMR	Sub-Saharan Africa	7	LDC
Cape Verde	CPV	Sub-Saharan Africa	7	LDC
Central African Republic	CAF	Sub-Saharan Africa	7	LDC
Chad	TCD	Sub-Saharan Africa	7	LDC
Chile	CHL	Latin America & Caribbean	3	EME
China	CHN	East Asia & Pacific	6	EME
Colombia	COL	Latin America & Caribbean	3	EME
Comoros	COM	Sub-Saharan Africa	7	LDC
Congo	COG	Sub-Saharan Africa	7	LDC
Congo (Dem)	ZAR	Sub-Saharan Africa	7	LDC
Costa Rica	CRI	Latin America & Caribbean	3	LDC
Cote d'Ivoire	CIV	Sub-Saharan Africa	7	LDC
Croatia	HRV	Europe & Central Asia	8	LDC
Czech Republic	CZE	Europe & Central Asia	8	EME
Djibouti	DJI	Middle East & North Africa	4	LDC
Dominica	DMA	Latin America & Caribbean	3	LDC
Dominican Republic	DOM	Latin America & Caribbean	3	LDC
Ecuador	ECU	Latin America & Caribbean	3	LDC
Egypt	EGY	Middle East & North Africa	4	EME
El Salvador	SLV	Latin America & Caribbean	3	LDC
Equatorial Guinea	GNQ	Middle East & North Africa	4	LDC
Eritrea	ERI	Sub-Saharan Africa	7	LDC
Ethiopia	ETH	Sub-Saharan Africa	7	LDC
Fiji	FJI	East Asia & Pacific	6	LDC
Gabon	GAB	Sub-Saharan Africa	7	LDC
Gambia	GMB	Sub-Saharan Africa	7	LDC
Georgia	GEO	Europe & Central Asia	8	LDC
Ghana	GHA	Sub-Saharan Africa	7	LDC
Grenada	GRD	Latin America & Caribbean	3	LDC
Guatemala	GTM	Latin America & Caribbean	3	LDC
Guinea	GIN	Sub-Saharan Africa	7	LDC
Guinea-Bissau	GNB	Sub-Saharan Africa	7	LDC
Guyana	GUY	Latin America & Caribbean	3	LDC
Haiti	HTI	Latin America & Caribbean	3	LDC
Honduras	HND	Latin America & Caribbean	3	LDC
Hong Kong	HKG	East Asia & Pacific	6	EME
Hungary	HUN	Europe & Central Asia	8	EME
India	IND	South Asia	1	EME
Indonesia	IDN	East Asia & Pacific	6	EME
Iran	IRN	Middle East & North Africa	4	LDC

Iraq	IRQ	Middle East & North Africa	4	LDC
Jamaica	JAM	Latin America & Caribbean	3	LDC
Jordan	JOR	Middle East & North Africa	4	LDC
Kazakhstan	KAZ	Europe & Central Asia	8	LDC
Kenya	KEN	Sub-Saharan Africa	7	LDC
Kiribati	KIR	East Asia & Pacific	6	LDC
Korea	KOR	East Asia & Pacific	6	EME
Kosovo	KSV	Europe & Central Asia	8	LDC
Kuwait	KWT	Middle East & North Africa	4	LDC
Kyrgyz Republic	KGZ	Europe & Central Asia	8	LDC
Lao	LAO	East Asia & Pacific	6	LDC
Latvia	LVA	Europe & Central Asia	8	EME
Lebanon	LBN	Middle East & North Africa	4	LDC
Lesotho	LSO	Sub-Saharan Africa	7	LDC
Liberia	LBR	Sub-Saharan Africa	7	LDC
Libya	LBY	Middle East & North Africa	4	LDC
Lithuania	LTU	Europe & Central Asia	8	EME
Macao	MAC	East Asia & Pacific	6	LDC
Macedonia	MKD	Europe & Central Asia	8	LDC
Madagascar	MDG	Sub-Saharan Africa	7	LDC
Malawi	MWI	Sub-Saharan Africa	7	LDC
Malaysia	MYS	East Asia & Pacific	6	EME
Maldives	MDV	South Asia	1	LDC
Mali	MLI	Sub-Saharan Africa	7	LDC
Marshall Islands	MHL	East Asia & Pacific	6	LDC
Mauritania	MRT	Sub-Saharan Africa	7	LDC
Mauritius	MUS	Sub-Saharan Africa	7	EME
Mexico	MEX	Latin America & Caribbean	3	LDC
Micronesia	FSM	East Asia & Pacific	6	LDC
Moldova	MDA	Europe & Central Asia	8	LDC
Mongolia	MNG	East Asia & Pacific	6	LDC
Montenegro	MNE	Europe & Central Asia	8	LDC
Montserrat	MSR	Latin America & Caribbean	3	LDC
Morocco	MAR	Middle East & North Africa	4	EME
Mozambique	MOZ	Sub-Saharan Africa	7	LDC
Myanmar	MMR	East Asia & Pacific	6	LDC
Namibia	NAM	Sub-Saharan Africa	7	LDC
Nepal	NPL	South Asia	1	LDC
Nicaragua	NIC	Latin America & Caribbean	3	LDC
Niger	NER	Sub-Saharan Africa	7	LDC
Nigeria	NGA	Sub-Saharan Africa	7	LDC
Oman	OMN	Middle East & North Africa	4	LDC
Pakistan	PAK	South Asia	1	EME
Panama	PAN	Latin America & Caribbean	3	LDC
Papua New Guinea	PNG	East Asia & Pacific	6	LDC
Paraguay	PRY	Latin America & Caribbean	3	LDC
Peru	PER	Latin America & Caribbean	3	EME
Philippines	PHL	East Asia & Pacific	6	EME
Poland	POL	Europe & Central Asia	8	EME
Qatar	QAT	Middle East & North Africa	4	LDC
Romania	ROM	Europe & Central Asia	8	EME
Russia	RUS	Europe & Central Asia	8	EME
Rwanda	RWA	Sub-Saharan Africa	7	LDC
Samoa	WSM	East Asia & Pacific	6	LDC
Sao Tome and Principe	STP	Sub-Saharan Africa	7	LDC
Saudi Arabia	SAU	Middle East & North Africa	4	EME
Senegal	SEN	Sub-Saharan Africa	7	LDC
Serbia	SRB	Europe & Central Asia	8	LDC
Seychelles	SYC	Sub-Saharan Africa	7	LDC
Sierra Leone	SLE	Sub-Saharan Africa	7	LDC
Singapore	SGP	East Asia & Pacific	6	EME
Solomon Islands	SLB	East Asia & Pacific	6	LDC
Somalia	SOM	Sub-Saharan Africa	7	LDC
South Africa	ZAF	Sub-Saharan Africa	7	EME
Sri Lanka	LKA	South Asia	1	LDC
St. Kitts and Nevis	KNA	Latin America & Caribbean	3	LDC
St. Lucia	LCA	Latin America & Caribbean	3	LDC
St. Vincent and the Grenadines	VCT	Latin America & Caribbean	3	LDC
Sudan	SDN	Sub-Saharan Africa	7	LDC
Suriname	SUR	Latin America & Caribbean	3	LDC
Swaziland	SWZ	Sub-Saharan Africa	7	LDC
Syrian Arab Republic	SYR	Middle East & North Africa	4	LDC
Taiwan	TWN	East Asia & Pacific	6	EME
Tajikistan	TJK	Europe & Central Asia	8	LDC
Tanzania	TZA	Sub-Saharan Africa	7	LDC
Thailand	THA	East Asia & Pacific	6	EME
Timor-Leste	TMP	East Asia & Pacific	6	LDC
Togo	TGO	Sub-Saharan Africa	7	LDC

Tonga	TON	East Asia & Pacific	6	LDC
Trinidad and Tobago	TTO	Latin America & Caribbean	3	LDC
Tunisia	TUN	Middle East & North Africa	4	LDC
Turkey	TUR	Europe & Central Asia	8	EME
Turkmenistan	TKM	Europe & Central Asia	8	LDC
Tuvalu	TUV	East Asia & Pacific	6	LDC
Uganda	UGA	Sub-Saharan Africa	7	LDC
Ukraine	UKR	Europe & Central Asia	8	EME
United Arab Emirates	ARE	Middle East & North Africa	4	LDC
Uruguay	URY	Latin America & Caribbean	3	LDC
Uzbekistan	UZB	Europe & Central Asia	8	LDC
Vanuatu	VUT	East Asia & Pacific	6	LDC
Venezuela	VEN	Latin America & Caribbean	3	EME
Vietnam	VNM	East Asia & Pacific	6	LDC
Yemen	YEM	Middle East & North Africa	4	LDC
Zambia	ZMB	Sub-Saharan Africa	7	LDC
Zimbabwe	ZWE	Sub-Saharan Africa	7	LDC

B Variables used for econometric analysis

Table 11: Key variable description

Variable	Full Name	Description	Source
$rgdp\_residual$	Purged real GDP growth	real GDP 09 - linear prediction from a mean 03-08	IMF IFS (2012)
$rgdp\_fe$	Unexpected real GDP growth	real GDP 09 - forecast in 2008Q1	IMF WEO (2008), IFS (2012)
rsv	Reserve adequacy ratios	One of the four ratios detailed in p.9	IMF IFS (2012)
rsv_std	Reserves to short-term debt ratio in log	$log\frac{reserves}{s.t.debt} \times 100$	IMF IFS (2012)
capital controls (cc)	Capital control index	$-kaopen$	Chinn and Ito (2006)
trade openness	Trade openness index	$\frac{X+M}{GDP} \times 100$	IMF IFS (2012)
exchange regime dummy	De facto exchange rate classification	dummy variable	Reinhart and Rogoff (2004)
oil dummy	Oil producer/exporter index	dummy variable	IMF (2012)
financial center	Financial center index	dummy variable	IMF (2012)
$\Delta rsv_{08m09-09m03}$	Reserve depletion	log-difference of reserves between 08m09 and 09m03	IMF (2012)
$\Delta rsv_{09m04-09m12}$	Reserve rebuilding	log-difference of reserves between 09m04 and 09m12	IMF (2012)

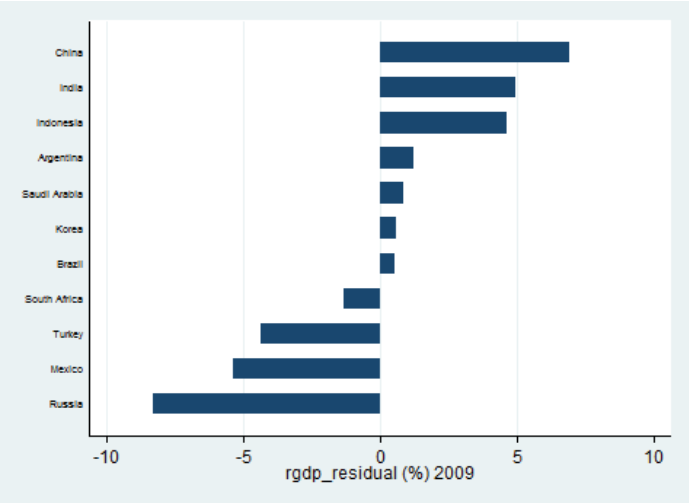

Figure 11: Crisis impact using $rgdp\_residual$

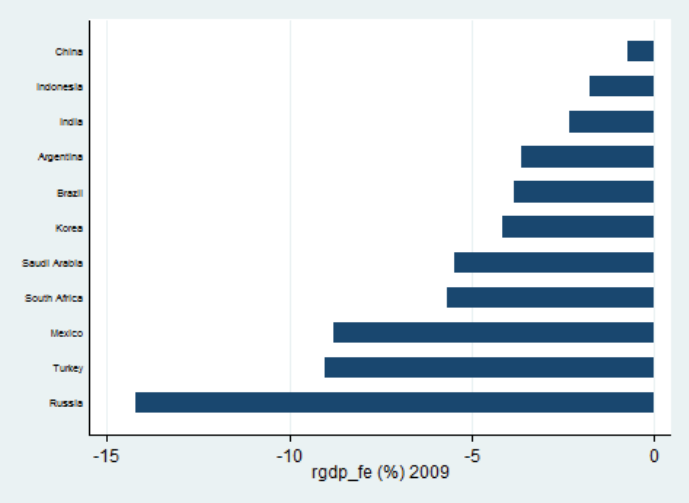

Figure 12: Crisis impact using $rgdp\_fe$

C Complementary results for Section 3.1

Table 12: Results with different reserve adequacy ratios, with $rgdp\_fe$ as dependent variable

	(1) rgdp_fe	(2) rgdp_fe	(3) rgdp_fe	(4) rgdp_fe
L2.log rsv/gdp	-0.0670			
	(0.566)			
L2.log rsv/imports		0.810		
		(0.574)		
L2.log rsv/m2			-0.0315	
			(0.524)	
L2.log rsv/std				0.671***
				(0.238)
Constant	-4.956***	-6.455***	-5.131***	-9.090***
	(1.691)	(0.970)	(1.948)	(1.473)
Observations	142	133	138	138
R^2	0.000	0.015	0.000	0.055
Adjusted R^2	-0.007	0.007	-0.007	0.048

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Results with different reserve adequacy ratios, without outliers

	(1) rgdp_residual	(2) rgdp_residual	(3) rgdp_residual	(4) rgdp_residual
L2.log rsv/gdp	-0.135			
	(0.630)			
L2.log rsv/imports		0.649		
		(0.677)		
L2.log rsv/m2			0.468	
			(0.595)	
L2.log rsv/std				0.857***
				(0.253)
Constant	0.966	-0.350	-1.200	-4.406***
	(1.876)	(1.116)	(2.202)	(1.561)
Observations	135	126	130	131
R^2	0.000	0.007	0.005	0.082
Adjusted R^2	-0.007	-0.001	-0.003	0.075

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Results with different reserve adequacy ratios, without outliers and small countries

	(1) rgdp_residual	(2) rgdp_residual	(3) rgdp_residual	(4) rgdp_residual
L2.log rsv/gdp	-0.723			
	(0.729)			
L2.log rsv/imports		0.213		
		(0.816)		
L2.log rsv/m2			-0.431	
			(0.775)	
L2.log rsv/std				0.957***
				(0.355)
Constant	3.006	0.611	2.336	-4.971**
	(2.160)	(1.391)	(2.898)	(2.216)
Observations	100	95	97	101
R^2	0.010	0.001	0.003	0.068
Adjusted R^2	-0.000	-0.010	-0.007	0.059

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

D Complementary results for Section 3.2

Table 15: Full specification without outliers

	(1) rgdp_fe	(2) rgdp_residual
L2.log rsv/std	0.951***	0.937***
	(0.292)	(0.316)
L2.capital controls	0.0352	0.220
	(0.263)	(0.281)
L2.exchange regime index	-0.892	-0.196
	(1.226)	(1.311)
L2.trade openness	-0.0235**	-0.0286**
	(0.0104)	(0.0113)
oil dummy	-3.142***	-1.987
	(1.132)	(1.211)
Constant	-7.111***	-1.830
	(2.263)	(2.431)
Observations	104	102
R^2	0.213	0.201
Adjusted R^2	0.173	0.159

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Full specification without outliers and small countries

	(1) rgdp_fe	(2) rgdp_residual
L2.log rsv/std	1.311***	1.239**
	(0.469)	(0.512)
L2.capital controls	-0.0365	0.315
	(0.352)	(0.373)
L2.exchange regime index	-1.147	-0.341
	(1.323)	(1.410)
L2.trade openness	-0.0274**	-0.0302**
	(0.0127)	(0.0138)
oil dummy	-2.925**	-1.852
	(1.260)	(1.344)
Constant	-8.958***	-3.422
	(3.111)	(3.357)
Observations	82	80
R^2	0.206	0.197
Adjusted R^2	0.153	0.143

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E Complementary results for Section 3.3

Table 17: Foreign reserve accumulation and capital controls, without outliers and small countries

	(1) rgdp_fe	(2) rgdp_residual
L2.log rsv/std	1.355***	1.292**
	(0.472)	(0.516)
L2.capital controls	-0.00486	0.347
	(0.354)	(0.375)
L2.log rsv/std × capital controls	0.248	0.277
	(0.273)	(0.299)
L2.exchange regime index	-1.342	-0.540
	(1.342)	(1.428)
L2.trade openness	-0.0269**	-0.0300**
	(0.0128)	(0.0139)
oil dummy	-2.953**	-1.900
	(1.261)	(1.346)
Constant	-9.293***	-3.791
	(3.136)	(3.384)
Observations	82	80
R^2	0.214	0.207
Adjusted R^2	0.151	0.141
F-test capital controls	0.417	0.786
P-value	0.660	0.459
F-test reserves	4.309	3.345
P-value	0.0169	0.0407

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F Complementary results for Section 3.4

F.1 Results of the 1st-stage regressions

Table 18: First stage regression for 2SLS

	(1) L2.log rsv/std	(2) L2.log rsv/std	(3) L2.log rsv/std
L2.capital controls	0.107	0.101	0.0800
	(0.111)	(0.108)	(0.112)
L2.exchange regime index	0.591**	0.576**	0.650**
	(0.297)	(0.268)	(0.299)
L2.trade openness	-0.0109**	-0.0106**	-0.0119**
	(0.00447)	(0.00440)	(0.00467)
oil dummy	0.517	0.364	0.455
	(0.394)	(0.359)	(0.395)
financial center	3.095**	2.803*	3.194**
	(1.440)	(1.419)	(1.475)
L2.distance weighted index	0.0325**		0.0287*
	(0.0150)		(0.0149)
L2.Joneses		0.00228**	0.00209*
		(0.00111)	(0.00106)
Constant	5.749***	5.037***	4.646***
	(0.375)	(0.679)	(0.646)
Observations	112	112	112
R^2	0.132	0.143	0.164
Adjusted R^2	0.082	0.094	0.108

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: First stage regression, without outliers

	(1)	(2)	(3)
	L2.log rsv/std	L2.log rsv/std	L2.log rsv/std
L2.capital controls	0.199**	0.196**	0.177*
	(0.0909)	(0.0871)	(0.0918)
L2.exchange regime index	0.423	0.470*	0.491*
	(0.286)	(0.269)	(0.292)
L2.trade openness	-0.00735	-0.00744*	-0.00815*
	(0.00445)	(0.00447)	(0.00461)
oil dummy	0.537	0.421	0.491
	(0.369)	(0.342)	(0.372)
L2.distance weighted index	0.0255*		0.0227
	(0.0149)		(0.0151)
L2.Joneses		0.00157	0.00144
		(0.000989)	(0.000967)
Constant	5.683***	5.230***	4.921***
	(0.408)	(0.659)	(0.617)
Observations	102	102	102
R^2	0.149	0.154	0.169
Adjusted R^2	0.105	0.110	0.116

Standard errors in parentheses

Homoscedasticity not rejected according to the White test

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F.2 Results of the 2nd-stage regressions

Table 20: Second stage regression, without outliers

	(1) OLS	(2) distance weighted index	(3) Joneses	(4) both
L2.log rsv/std	0.937***	1.116	1.541	1.353
	(0.316)	(2.070)	(1.896)	(1.467)
L2.capital controls	0.220	0.180	0.0852	0.127
	(0.281)	(0.531)	(0.501)	(0.421)
L2.exchange regime index	-0.196	-0.266	-0.434	-0.360
	(1.311)	(1.507)	(1.490)	(1.402)
L2.trade openness	-0.0286**	-0.0274	-0.0247	-0.0259*
	(0.0113)	(0.0172)	(0.0164)	(0.0144)
oil dummy	-1.987	-2.070	-2.267	-2.180
	(1.211)	(1.510)	(1.476)	(1.358)
Constant	-1.830	-2.923	-5.524	-4.375
	(2.431)	(12.74)	(11.68)	(9.086)
Observations	102	102	102	102
R^2	0.201	0.198	0.170	0.186
Adjusted R^2	0.159	0.156	0.127	0.144
Hausman $p-value$	.	0.932	0.750	0.776

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$