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THE FINANCIAL CRISIS AND SIZABLE INTERNATIONAL RESERVES DEPLETION: FROM 'FEAR OF FLOATING' TO THE 'FEAR OF LOSING INTERNATIONAL RESERVES'?

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The Financial Crisis and Sizable International Reserves Depletion: From 'Fear of Floating' to the 'Fear of Losing International Reserves'?

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Abstract

In this paper we study the degree to which emerging markets (EMs) adjusted to the global liquidity crisis by drawing down their international reserves (IR). Overall, we find a mixed and complex picture. Intriguingly, only about half of the EMs depleted their IR as part of the adjustment mechanism. To gain further insight, we compare the pre-crisis demand for IR of countries that experienced sizable IR depletion, to that of countries that did not, and find different patterns between the two groups. Trade related factors (such as trade openness, primary goods export ratio, especially large oil export) seem to play a significant role in accounting for the pre-crisis IR/GDP level of countries that experienced a sizable IR depletion during the first phase of the crisis. Our findings suggest that countries that internalized their large exposure to trade shocks before the crisis, used their IR as a buffer stock in the first phase of the crisis. Their reserves losses followed an inverted logistical curve. After a rapid initial depletion of reserves, within seven months they reached a markedly declining rate of IR depletion, losing not more than one-third of their pre-crisis IR. On the contrary, in the case of countries that refrained from a sizable IR depletion during the first phase of the crisis, financial factors seem more important than trade factors in explaining the initial IR/GDP level. Our results indicate that the adjustment of EMs was constrained more by their fear of losing IR than by their fear of floating.

Keywords: Trade Shocks, Deleveraging, International Reserves, Emerging Markets

JEL Classification: F15, F21, F32, F43

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The ongoing global financial crisis imposes daunting challenges to emerging markets (EMs). Earlier hopes of 'decoupling,' that would have allowed EMs to be spared the brunt of adverse adjustments have not materialized. The 'flight to quality', deleveraging and the rapid reduction of international trade began affecting EMs from mid 2008, putting to test their adjustment capabilities. During earlier crises episodes, EMs were forced to adjust mostly via rapid depreciation. However, the sizable hoarding of international reserves (IR) during the late 1990s and early 2000s, provided these countries with a relatively richer menu of choices. One primary explanation of hoarding IR has been the precautionary motive to deal with unanticipated sudden stops of capital flows and rapid contraction of international trade.[1] In this paper we study the degree to which earlier hoarding of IR 'paid off', by allowing EMs to buffer their adjustment by drawing down IR stocks. Specifically, we study the factors accounting for the depletion of IR during the crisis, and investigate the dynamics of drawing down of IR by EMs.

Overall, we find a mixed and complex picture. EMs with large primary commodity exports, experienced large IR losses during the current global financial crisis. EMs with a medium level of financial openness and a relatively large short-term debt ratio also lost a large share of their initial IR holdings on average. However, to our intrigue, we find that only about half of the EMs relied on drawing down their IR as part of their adjustment mechanism. To gain further insight, we compare the pre-crisis demand for IR/GDP of countries that experienced sizable IR depletion to that of countries that did not, and find differential patterns. Trade related factors such as trade openness and primary goods exports (especially oil exports) seem to play a significant role in accounting for the pre-crisis level of IR/GDP in countries that experienced a large IR depletion as opposed to the group that refrained from sizable IR depletions during the first phase of the crisis. These findings suggest that EMs that internalized their exposure to trade shocks before the crisis, opted to deplete a relatively greater share of their initial IR during the first phase of the crisis. On the contrary, in the case of countries that refrained from a sizable IR depletion during the crisis, financial factors seem to be more important than trade factors in explaining the initial level of IR/GDP. Our findings also suggest the possibility of a greater 'fear of losing' IR relative to the 'fear of floating' as exhibited by countries that did not experience a sizable IR depletion.

Focusing on EMs that lost significant amount of reserves, we find that IR losses followed an inverted logistical curve. Starting with a rapid initial depletion, within seven months, reserves reached the stage of a rapidly declining rate of depletion. Arguably, the patterns displayed of using reserves by the first group, and refraining from using reserves by the second group, are consistent with a 'fear of losing reserves'. Such a fear may reflect a country's concern that dwindling IR signal greater vulnerability and may trigger a run on its remaining stock of reserves. The fear of losing IR is perhaps related to a country's apprehension regarding the duration of the crisis. Since the duration is unknown, depleting IR too fast

[1] See Aizenman and Lee (2007) for precautionary versus mercantilist movies for hoarding IR, and Calvo (1998) for a model of sudden stops.

may be sub-optimal as it exposes the country to a risk of abrupt adjustment in the event that the crisis turns out to be deeper and longer lasting.

In Section 1, we analyze the impact of the recent financial crisis on IR holdings in EMs. After documenting that about half of the EMs experienced a large decline of their IR, we look for factors explaining the depletion of IR. In Section 2, we explain the factors determining the speed of drawing down IR. Finally we conclude in Section 3.

1. IR Changes in All Emerging Markets

Our sample consists of countries listed in the FTSE and MSCI emerging market list.[2] We have not included Singapore and Hong Kong because of their special economic structure, specializing in ***entrepôt*** services.[3] Figure 1 presents IR holdings since January 2008 of the 21 EMs included in our sample. In Figure 1a, IR are normalized by a country's GDP. In Figure 1b, IR are measured relative to the highest IR level since January 2008. From Figure 1, we can see that more than half of the EMs in our sample reduced their IR holdings during the current crisis. Most countries experiencing large IR losses began depleting their IR during the second half of 2008. We next look into the factors that may have caused a country to deplete its IR holdings during the current financial crisis.

1.1 Data and Explanatory Variables

In our analysis, we use several measures of IR changes. Most EMs began exhibiting large IR losses during second half of 2008, and regained most of their losses by the first quarter of 2009. Hence, we use July 2008 to February 2009 as the time window for our case study. We measure IR changes in two ways: IR changes relative to a country's GDP; and IR changes relative to a country's initial IR level in our sample period.[4]

We include both trade related factors and financial market related factors as potential explanatory variables accounting for changes in IR patterns. The first variable we consider is trade openness

[2] As of April 2009, MSCI Barra classified the following 22 countries as emerging markets: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, South Korea, Taiwan, Thailand, Turkey (see http://www.mscibarra.com/products/indices/equity/index.jsp). The FTSE emerging markets classification is similar to that of MSCI, adding Argentina, subtracting Israel (see http://www.ftse.com/Indices/FTSE_Emerging_Markets/index.jsp).

The list tracked by The Economist is the same as the MSCI, except with Hong Kong, Singapore and Saudi Arabia included (MSCI classifies the first two as developed markets).

[3] Considering the dramatic effect of the IMF's aid on Hungary's reserves changes, we excluded it from our sample. Following the IMF announcing its loan to Hungary in November 2008, Hungary's international reserves increased nearly by half in the following two months. Due to data availability, we did not include Morocco and Pakistan.

[4] We have tried other measures in our analysis, e.g. IR changes divided by the highest IR level during our sample period. However, the results were very similar to the results of the previous two measures, therefore we do not report those results here.

(henceforth labeled as *topen*), defined as the sum of imports and exports over GDP in the year before the crisis. The second trade variable is a country's oil export share, (*oilex/gdp*). It is measured as a country's net oil export level in 2005 (by 1000 barrels per day) divided by its GDP. The third variable is the primary products export ratio (*prim2export*), defined as the value of fuel and non-fuel primary products exports, divided by total exports.[5] We also consider historic export volatility (*xvolatile*) as an explanatory variable. It is measured as the standard deviation of monthly export growth rates of the previous year. We expect countries with relatively higher trade openness, larger net oil exports, larger primary product export ratio, and higher export volatility to experience a larger IR loss when faced with a negative global shock.

In the category of financial market factors, the first variable we include is financial openness. We use the Chinn-Ito capital market openness index (*Kopen*). The second variable is historic exchange rate volatility (*exstdev*), which is measured as the standard deviation of monthly exchange rate growth rate (month to month changes). The last variable in this category is the short-term external debt relative to a country's GDP (*STdebt/gdp*).[6] In general, the impact of financial openness on IR losses may be ambiguous. For countries that allow larger exchange rate volatility, we expect lower IR changes during the crisis, whereas countries with relatively large short-term external debt may opt to lose more IR during the crisis. In our empirical estimations, we have also included other control variables, such as previous year's GDP (*gdp07*), per capita GDP (*gdppc*), as well as some interaction terms involving these explanatory variables. Table 1 presents summary statistics for the variables used in our cross section analysis.

1.2 Regression Results

Tables 2 and 3 present the regression results, accounting for the variation of our two IR change measures and using different explanatory variables. The dependent variable in Table 2 is the IR change from July 2008 to February 2009 measured as a ratio to a country's GDP. The dependent variable in Table 3 is the IR change over the same period measured as a ratio to a country's initial IR level, i.e. the IR level in July 2008. The explanatory variables are measured using 2007 data except for short-term external debt and the oil export ratio.[7]

In Table 2, we first control for four trade factors in our regressions. Columns 2 and 3 show that the primary product exports, especially oil exports, have a significant impact on IR changes. Since including the primary product export ratio gives similar results to those of the oil export ratio, we have not reported other regressions including primary export ratios. Trade openness affects IR changes only when we control for the primary product exports or oil exports. When we include trade openness, oil exports, and

[5] The data of primary products are collected from the United Nations Commodity Trade Statistics Database. Fuel and non-fuel primary products used in our sample are defined as the products in SITC 0, 1, 2, 3, 4 and 68 categories.

[6] Short-term debt data is based on the IMF debt statistics tables drawn from creditor and market sources.

[7] In Tables 2 and 3, short-term debt is measured by the June 2008 level. Due to data constraint, the oil export level used here is taken from 2005 data.

their interaction term (*topenXoilex*), trade openness is found to have negative impact on IR changes. The oil export ratio also has negative impact on IR, but shows up only in the interaction term (Column 4 reports this result, and also see figure 2.a). However, export volatility does not seem to have any significant relationship with IR changes, and so we do not report it in Table 2.

Next, we include financial openness, exchange rate volatility and the short-term debt ratio in our regression. Financial openness has some impact on IR changes. However, the relationship between IR changes and financial openness is non-linear. Low and high financial openness (i.e. an openness index value either close to -1 or close to 2 and 3) are related to a small IR loss, or to an increase in IR holdings. In contrast, countries with medium financial openness (i.e. with an openness index value close to 0) tend to experience larger IR losses (see figure 2b). In column 6, we add to the selected trade-related factors, the absolute value of the Chinn-Ito index, and find it to have a significant positive association with IR changes. We also find that short-term external debts have a negative impact on IR changes. Column 7 shows that countries with large short-term external debts tend to have relatively large IR losses during the crisis (also see figure 2c). Exchange rate volatility turned out to be insignificant, and thus we do not include it in the reported regressions.[8]

In the last column we include initial IR level (labeled *Ini.IR*, and measured as the IR/GDP level in July 2008) as an explanatory variable. The significant negative sign of *Ini.IR* shows that large IR/GDP levels during the pre-crisis period were associated with large IR/GDP declines during the crisis period. The higher pre-crisis IR/GDP level may have encouraged countries to spend more IR during the crisis to absorb the external shock (and countries that faced large IR losses in the process of crisis management, may be hypothesized to accumulate more IR after the crisis). Table 3 presents similar regressions for the case in which the IR change is calculated relative to its initial IR level, $((IR_{2009.2} - IR_{2008.7}) / IR_{2008.7})$. Overall, the results are similar. Trade openness is insignificant, but the primary product export/GDP ratio, oil export/GDP ratio and the absolute value of the financial openness index all remain significant as in Table 2. The last regression in Table 3 also shows that the initial levels of IR no longer have a large impact on the relative changes in the reserves level. In subsequent analysis we find that trade openness plays an important role in deciding countries' initial IR levels. Hence one interpretation of the differences in results of Table 2 and Table 3 could be that trade openness affects initial IR level, and thus the magnitude of changes in IR/GDP ratio, but it does not have any direct impact on the relative IR changes. On the other hand, primary commodity exports, oil exports and financial openness not only affect the initial IR level, but also affect the patterns of relative IR changes.

Based on results in Tables 2 and 3, we find that EMs with large primary commodity exports, especially oil exports, tended to experience relatively large IR loss during the current global crisis. EMs with a medium

[8] We have also tried other factors such as country size (*GDP2007*) and country income level (measured as the 2007 per capita GDP). Both turned out to be insignificant, and hence we do not report them in the table.

level of financial openness and a large short-term debt ratio also lost a larger share of their IR holdings. Trade openness affects a country's initial IR level. Trade openness and the initial IR level together affect the magnitude of IR changes relative to GDP, but do not have any impact on the IR changes relative to a country's historic IR level.

EMs accumulate IR for different reasons such as to protect from trade shocks, to promote exports, etc. Thus, they may also use their IRs differently when facing the same external shock. Comparing pre-crisis level of IR/GDP of EMs that depleted a significant share of their IR during the crisis with that of EMs that did not, may provide further insights. We next divide our sample into two groups: countries that have sizable IR losses, and countries that either have not lost IR or have quickly recovered from their IR losses. We define the first group as countries that lost at least 10% of their IR during the period of July 2008 – February 2009, relative to their highest IR level. Among 21 EMs, nine countries were selected to be included in the first group.[9]

Table 4 compares the motives of IR holdings between these two groups. We first regress the pre-crisis level of IR/GDP (i.e. the IR level in July 2008) on the same explanatory variables as in Tables 2 and 3. The results show that both financial market related factors and trade related factors are important in accounting for the pre-crisis IR accumulation. However, these factors have different weights between these two groups of countries. For EMs experiencing large IR depletion, trade related factors show consistent expected signs in our regressions. Countries with relatively larger trade sectors, countries with large primary goods export ratio, and countries that have faced large trade shocks accumulated more IR. Thus, compared with the second group (i.e. small or no IR depletion countries), trade related factors are more important for the first group. The R-Squared of the regression on trade related factors for the first group (equation 1 in Table 4), exceeds that of the corresponding regression for the second group by a factor of 4 (see the first and the fourth columns of Table 4). Even after controlling for the financial factors (column 3 in Table 4), trade related factors (trade openness, the primary product export ratio) are still the only significant variables in the regression for the first group. Financial factors, on the other hand, are much more significant for the second group of countries that have not lost much IR. In the second group, countries with relatively strict financial controls tend to have a higher pre-crisis level of IR/GDP whereas countries with more flexible exchange rates tend to have a lower per-crisis IR/GDP. Their coefficients have consistent signs in both regressions with and without the trade factors, and are statistically significant when trade factors are controlled for. The short-term debt/GDP, ratio however, shows different signs in regressions with and without the trade factors.[10] In the last column of Table 4, we run regressions for all 20 countries that have relevant data. Trade openness and exchange rate flexibility are significant in accounting for the pre-crisis IR/GDP level. Figure 3 provides a detailed picture of these relationships.

[9] Large IR loss countries include Brazil (BRA), India (IND), Indonesia (IDN), Malaysia (MYS), South Korea (KOR), Peru (PER), Poland (POL), Russia (RUS), and Turkey (TUR).

[10] One potential reason could be the high correlation between trade openness and the short-term debt ratio. The correlation between these two variables is 0.51 in the cross section dataset.

Table 4b presents results for regressions wherein we use a longer duration panel data to further test the above mentioned relationships. The time period is 2000 to 2007. The dependent variable used in Table 4b is the IR level at the end of each year and the explanatory variables in the panel are measured using the data from 2000 to 2007.[11] In Table 4b we found results similar to those in Table 4a. For both groups of countries, trade openness and exchange rate volatility have a consistent and significant impact on the IR accumulation level. Countries with a larger trade sector and lower exchange rate flexibility tend to hold more IR. When we include all the control variables, trade openness is statistically more significant for group 1, whereas exchange rate volatility is more significant for group 2. Similar to Table 4a, the primary product export ratio shows a significant impact for countries in the first group, but not for the second group. Capital market openness shows a significant negative sign in regressions for the second group but not for the first group. The short-term debt ratio is significant in both columns 2 and 5 when we include only the financial factors. When we include trade factors, the short-term debt ratio turned out to be significant only for the first group of countries.

Overall, trade related factors (especially the primary product export ratio) are more statistically significant for the first group, whereas financial factors (with the exception of short-term debt ratio) seem to be more important for the second group. Table 4c gives the results of an F-test for the hypothesis that trade rated factors and financial markets related factors play equally important roles in determining the pre-crisis IR level of EMs. We include a group dummy, interact it with each of the explanatory variables, and run regressions over the full sample. Table 4c reports the F-test values for the hypothesis that the group dummy and all the associated interaction terms are jointly zero. Five out of six results reject our hypothesis, confirming the hypothesis that trade and financial related factors played different roles in accounting for the pre-crisis IR accumulation across these two groups of EMs.

One possible interpretation could be that EMs internalizing their large exposure to trade shocks before the current crisis, opted to deplete a relatively larger share of their initial IR during the first phase of the crisis. In contrast, EMs that did not take into account trade factors while hoarding IR before the crisis, refrained from using their IR. This could possibly be owing to the fear that depleting IR may signal greater vulnerability and induce a deeper run on IR. Comparing the mean value of the conditioning variables in the two groups failed to reveal significant differences. Thus, we are unable (so far) to explain the sources of the differences in the pre-crisis IR/GDP levels between the two groups of EMs. To gain further insight, we next study the dynamics of IR accumulation for countries that experienced sizable IR depletion during the current crisis.

[11] We exclude Taiwan in our regression since we do not have data on the primary product export ratio. We also exclude Argentina's 2000-2004's observations, since its exchange rate and short-term debt exhibit extraordinary changes during the collapse of the currency board during these years.

2. Countries with Large IR Losses

In this section we focus on the first group of EMs, i.e. countries that experienced a sizable IR depletion during the crisis. We attempt to explain their IR/GDP patterns during the first phase of crisis.

2.1 Fitted Logistic Curves

Figure 1b suggests that an inverted logistic curve may provide a good fit to the data.[12] Such a curve implies that in the first part of the crisis the depletion of IR tends to gradually speed up. Once a threshold is reached, the depletion rate slows down, and ultimately the IR stock regains stability. Thus, we fit a logistic curve to the *IR/MaxIR* path. We apply a nonlinear least squares regression to the data for the selected period, starting with the month when IR peaked:

$$\mathrm{IR(t)/MaxIR} = (1-b_0) + b_0 \times \frac{1}{1+\exp(b_1 + b_2 \times t)} \qquad (1)$$

with the presumption that $b_0 > 0, b_1 < 0, b_2 > 0$. For each country, we select the data starting from the month with the highest IR position until the end of sample, i.e. February 2009. The estimated parameters are as follows: b_0, determining the long run value of 'desirable' IR (i.e., $IR(t) \xrightarrow[t\to\infty]{} 1-b_0$); b_1, providing information about the inflection point and determining the point when the rate of IR depletion starts decreasing; and b_2, measuring the rate of IR depletion.

Figure 4 presents the picture of relative IR changes, and the fitted logistic curves for the nine countries that experienced sizable IR depletion during the crisis. Overall, the predicted line fits the data very well. Table 5 reports the coefficients of fitted logistic curves for the nine EMs with sizable IR losses. Most Asian and Europe countries have a relatively large value of b_0 (15% to 36%), while Latin-American countries (BRA, PER), and Turkey (TUR) have relatively lower values, (10% to 17%). Table 5 also reports the number of months since IR started to decline, reported as 'length'. Solving $b_1 + b_2 \times t^* = 0$ for t*, we find the time it takes to reach the inflection point (i.e., the number of months from the beginning of the decline of IR to the point when the depletion rate itself starts declining). We label t* as the turning point or inflection point. Adding t* to the starting time of the IR decline, we find the time when the IR depletion starts losing speed and slows down, and label it 'MTP' (Month of IR depletion's Turning Point). For most

[12] The Logistic curve has been used in modeling the depletion of natural resources (applying the Hubbert model of exhaustible resources). While it lacks micro foundation in the context of depleting international reserves, the data suggests that it provides a very good fit.

EMs, MTP is found to be around 8 to 10, implying that the turning point in the rate of IR depletion occurred between August and October 2008.

2.2 Regression Results

Table 5 shows that different countries begin to lose IR from different starting points. We next turn to identify factors that determine the starting time of IR loss for these countries that have lost sizable amounts of IR. We use 'length', i.e. the number of months since the IR start to decline, as our dependent variable. Table 6 presents statistically significant regression results. Among all explanatory variables we attempted to include, exchange rate volatility and oil export ratio are the only two variables that consistently show a significant sign in our regression. The large oil export countries have a relatively small 'length' value, which means their IR loss started later. This is consistent with the fact that the oil price started falling only when the perception of a recession hit the market, i.e. around August 2008. Exchange rate volatility has a significant negative sign, indicating the tradeoff between tolerating exchange rate movements and IR adjustment. Financial openness, trade openness and country size come out to be significant when we include all of them in the regression, but these relationships are not robust when we include any one of them separately.

Table 7 reports the regression results using MTP as our dependent variable. The results validate that EMs that had begun depleting their IR sooner had an earlier turning point (see the negative sign on the coefficient of *length*). Financial openness has a positive sign in our regression indicating that more financially open economies have a later turning point. However this coefficient is statistically significant only when we include country size in the regression. Other variables are mostly insignificant when we control for *length*.

Tables 8 and 9 report the regression results on the size of IR loss. Similar to what we find in Table 2, large trade openness, and large primary goods and oil export ratios are associated with large IR loss during the crisis. Other trade or financial market related factors are insignificant in the regressions for this small sample. As expected, *length* – the duration of IR depletion – is positively related to magnitude of IR changes. The earlier the countries begin to lose IR, the larger are the total IR loss during the sample period. Table 9 presents the regression results for the relative IR position changes (*d.rir*). Similar to Table 3, trade openness no longer comes out significant in our regression, but the oil export ratio is still significant. Overall, trade related factors are the only significant determinants in our regressions for this small sample.

Table 10 reports panel data regressions of monthly reserve changes during the crisis. In addition to the variables used before, we add three new variables: monthly changes of oil price (*d.oilprice*), monthly trade

surplus as a percentage of GDP (*tsurplusgdp*) and normalized exchange rate changes (*norexgrowth)*.[13] We use two measures for the independent variable: monthly changes in IR relative to a country's GDP (*md.ir_gdp*) and monthly changes in IR relative to a country's highest IR level in the sample (*md.rir*).

The first column of Table 10 presents results from ordinary least squares regressions, and the second column reports results from random effect regressions. The third column reports random effect regression results, including time dummies for each month. Trade openness and oil price changes have significant effects on monthly IR/GDP changes, in line with our cross section analysis. Historic exchange rate volatility is significant in the third column but not in the first two, while trade surplus and exchange rate changes are insignificant. In the next three columns we apply the same methods to the monthly IR changes relative to the initial IR level at July 2008 (*md.rir*). As in Tables 3 and 9, trade openness is insignificant. Exchange rate depreciation (*norexgrowth*), however, has a negative impact on IR changes. Over all, our panel data regressions confirm the results obtained before. Trade related factors, especially those related to oil exports, have a significant impact on the size of IR depletion. Financial market related factors have some impact on IR losses, but not as significant as trade related determinants.

2.3 Robustness Analysis

We conducted several robustness tests.[14] We have run regressions including an Asian dummy, added to verify if there is a regional bias stemming from the fact that many emerging markets are from Asia. Overall, adding the Asian dummy does not affect the results related to the role of trade factors. However, since many Asian countries have strict capital controls, especially among the countries that don't lose IR, we cannot conclude whether our results are driven by the Asian dummy or by the financial factors. The choice of the threshold for losing IR in our base regression is 10% (i.e., we take a 10% threshold of reserve losses to differentiate the high versus low losses). The main results are not impacted by varying the threshold to be 5% or 15%. Moving the threshold to 20% reduces the group or countries that lost IR to 3, not allowing us to run a meaningful regression. We leave for future research attempts to understand better the factors that account for the differential behavior of the two groups, and the role of exchange rate volatility. With more data, we hope to test the possibility that differences in the nature of trade and deleveraging shocks and balance-sheet exposures of countries may account for the observed choices of adjustment via larger exchange rate depreciation or deeper depletion of international reserves.

[13] Normalized exchange rate change is measured as monthly exchange rate growth minus the average monthly exchange rate growth rate in 2007, divided by the standard deviation of monthly exchange rate change in 2007, i.e. $(e_t - e_{avg})/std.dev(e)$. Since Central Banks may use IR to stabilize unusual changes in the exchange rate, we use this variable to identify these unusual changes, and measure its effect on IR changes.

[14] These results are available upon request.

3. Concluding Remarks

Our paper suggests that there exists a clear structural difference in the pre-crisis demand for IR by EMs that were willing versus those that were unwilling to spend a sizable share of their IR during the first phase of the 2008-09 global financial crisis. Trade related factors seem to be much more significant in accounting for the pre-crisis IR level of EMs that experienced a sizable depletion of their IR in the first phase of the crisis. This finding is in line with the buffer stock interpretation of demand for IR.[15] Financial factors come across as more important in accounting for the pre-crisis IR level of countries that refrained from spending IR in the first phase of the crisis.

Prior to the current crisis, observers viewed hoarding IR as reflecting several motives, including the 'fear of floating' (Calvo and Reinhart 2002) as well as the precautionary and/or mercantilist motives (Aizenman and Lee 2007, 2008). However, during the 'flight to quality', and deleveraging from EMs observed in the first phase of crisis, 'fear of losing IR' seem to have played a key role in shaping the actual use of IR by EMs. Countries that depleted their IR in the first phase of the crisis, refrained from drawing their IR below one-third of the pre-crisis level. The majority of the EMs used less than one-fourth of their pre-crisis IR stock. Countries whose pre-crisis demand for IR was more sensitive to financial factors, refrained from using IR altogether, preferring to adjust through larger depreciations of exchange rate. Both patterns may reflect the fear that dwindling IR may induce more destabilizing speculative flows.

These findings raise new questions. Apart from short-term external debt, it would also be important to include the stock of foreign holdings of portfolios as explanatory variables in the model, given that these are potentially reversible too, as witnessed in Korea, India and elsewhere during this crisis. This exercise requires data that is not available for some of the countries in our sample. More work is needed to understand why countries differ in the weight assigned to financial versus trade factors, in accounting for their demand for IRs. Intriguingly, the average exchange rate depreciation rate from August 2008 to October 2009 was about 30% in EMs that depleted and those that refrained from depleting their IR, alike. A hypothesis that can explain this observation is that the shocks affecting the EMs that opted to deplete their IR were larger than the shocks impacting EMs that refrained from using their IR. Testing this possibility requires more data, not available presently, including the deleveraging pressures and balance sheet exposures during the crisis. This hypothesis, if valid, implies that countries prefer to adjust to bad shocks first via exchange rate depreciation, supplementing it with partial depletion of their IR only when the shocks are deemed to be too large to be dealt with only via exchange rate adjustment.

The fear of using IR also suggests that some countries opt to revisit the gains from financial globalization. Earlier research suggests that EMs that increased their financial integration during the 1990s through the mid 2000s, hoarded IRs due to precautionary motives, as self insurance against sudden stops, and

[15] See Frenkel (1983), Edwards (1983) for further discussion of this buffer stock view.

deleveraging crises. Yet, the current crisis suggests that in order for this self insurance to work, a country may require levels of IR comparable to its external financial gross exposure.[16] Under such circumstances, countries may benefit by invoking 'soft capital controls' in the form of Pigovian taxes.[17] A possible interpretation for the fear of losing IR is the 'keeping up with the Joneses' IRs' motive alluding to the apprehension of a country that a reduction of its IR/GDP level below the average of its reference group might increase its vulnerability to deleveraging and sudden stops.[18] These factors suggest a greater demand for regional pooling arrangements and swap lines (Rajan *et al*. 2005), as well as possible new roles for International Financial Institutions. A better understanding of these issues is left for future research.

[16] See Park (2009) analyzing Korea's challenges during the crisis.

[17] These policies may take the form of non linear taxes on external borrowing (Aizenman 2009), varying reserves requirements of the Chilean type (see Edwards 2000 and Cowan and De Gregorio 2005), and changing reserve ratios in the banking system. See Rodrik (2006) for further discussion of policy options facing emerging markets that are concerned with exposure to sudden stops.

[18] See Cheung and Qian (2009) for evidence on the 'keeping up with the Joneses' IRs' hypothesis in the context of East Asia.

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Table 1. Summary for Variables in Cross Section Analysis

Variable	Obs	Mean	Std. Dev.	Min	Max	Data Source
d.ir_gdp	21	-0.024	0.057	-0.182	0.050	IMF and CB
d.rir	21	-0.072	0.139	-0.355	0.250	IMF and CB
Topen	21	0.797	0.430	0.262	2.001	WEO
prim2export	20*	0.324	0.226	0.039	0.675	Comtrade
oilexgdp	21	-0.546	1.658	-3.039	3.992	EIA
Xvolatile	21	0.098	0.046	0.041	0.222	IFS
kopen	21	0.374	1.375	-1.131	2.532	Chinn & Ito
exstdev	21	0.020	0.013	0.003	0.055	GFD
STdebt/gdp	21	8.817	4.298	3.623	19.283	JEDH
GDP07	21	616382	721885	107298	3205507	WEO
GDPpc	21	8353	6536	940	23579	WEO

Variables definition: (also see descriptions in the paper for details)
IR changes / GDP (d.ir_gdp) = $(IR_{2009.2} – IR_{2008.7})$/GDP
IR changes / Ini.IR (d.rir) = $(IR_{2009.2} – IR_{2008.7}) / IR_{2008.7}$
Trade openness (Topen) = (export + import)/GDP
Primary product export ratio (prim2export) = (primary product export value) / (total export value)
Oil export ratio (oilex/gdp) = net oil export volume / GDP (1000 Barrels per day / billion USD)
Export volatility (xvolatile) = standard.deviation (monthly export growth rate during 2006-07)
Capital Market Openness (Kopen) = Chinn-Ito Capital market openness index in 2007 (Chinn-Ito index does not have data for Taiwan. Hence, we assume that Taiwan has the same financial openness level as China).
Exchange rate volatility (exstdev) = standard.deviation (monthly exchange rate growth during 2007)
Short term debts ratio (STdebt/gdp) = Short term Loan and debt security / GDP (as %)
GDP in 2007 (GDP07) and per capita GDP (GDPpc)

Data source: IMF and CB: data are based on IMF and central banks of selected countries. WEO: IMF World economic outlook database; Comtrade: United Nations Commodity Trade Statistics Database; ChinnIto: Chinn and Ito (2007); GFD: Global financial database; JEDH: Joint BIS-IMF-OECD-WB Statistics on External Debt.
* Comtrade database do not have data for Taiwan.

Table 2. Regressions on IR/GDP Changes (All Emerging Markets)

	(1) d.ir_gdp	(2) d.ir_gdp	(3) d.ir_gdp	(4) d.ir_gdp	(5) d.ir_gdp	(6) d.ir_gdp	(7) d.ir_gdp	(8) d.ir_gdp
Topen	-0.0299	-0.0667**	-0.0541**	-0.0548**	-0.0540**	-0.0490**	-0.0204	-0.000332
	(-1.02)	(-2.13)	(-2.40)	(-2.54)	(-2.58)	(-2.45)	(-0.97)	(-0.01)
Prim2export		-0.126**						
		(-2.13)						
Oilexgdp			-0.0238***	-0.00469				
			(-4.07)	(-0.37)				
topenXoilex				-0.0224	-0.0269***	-0.0245***	-0.0216***	-0.0221***
				(-1.66)	(-4.67)	(-4.37)	(-4.28)	(-4.64)
Kopen.abs						0.0177*	0.0182*	0.0157*
						(1.77)	(2.06)	(1.87)
STdebts/gdp							-0.00498**	-0.00487**
							(-2.45)	(-2.55)
Ini.IR								-0.0810*
								(-1.78)
_cons	0.00000225	0.0669	0.00635	0.00354	0.00274	-0.0196	0.00278	0.0110
	(0.00)	(1.72)	(0.32)	(0.19)	(0.15)	(-0.92)	(0.13)	(0.55)
N	21	20[+]	21	21	21	21	21	21
R-sq	0.052	0.269	0.506	0.575	0.571	0.638	0.737	0.783

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

[+] Because we do not have prim2export data for Taiwan, we do not include Taiwan in the regression of column 2.

We do not report the regressions include exchange rate volatility and trade volatility to save space, since these variables did not show significant sign and did not change our results on other variables.

Table 3. Regressions on Relative IR Position Changes (All Emerging Markets)

	(1) d.rir	(2) d.rir	(3) d.rir	(4) d.rir	(5) d.rir	(6) d.rir	(7) d.rir	(8) d.rir
Topen	0.00762	-0.0567	-0.0370	-0.0381	-0.0367	-0.0192	0.0638	0.0899
	(0.10)	(-0.66)	(-0.54)	(-0.55)	(-0.55)	(-0.31)	(0.95)	(1.14)
Prim2export		-0.221						
		(-1.37)						
Oilex/gdp			-0.0437**	-0.00887				
			(-2.46)	(-0.22)				
topenXoilex				-0.0408	-0.0492**	-0.0408**	-0.0327*	-0.0332*
				(-0.95)	(-2.70)	(-2.34)	(-2.02)	(-2.02)
Kopen.abs						0.0620*	0.0633**	0.0600*
						(1.99)	(2.25)	(2.07)
STdebts/gdp							-0.0145**	-0.0143**
							(-2.23)	(-2.17)
Ini.IR								-0.105
								(-0.67)
_cons	-0.0785	0.0387	-0.0669	-0.0720	-0.0735	-0.152**	-0.0867	-0.0759
	(-1.17)	(0.36)	(-1.12)	(-1.20)	(-1.26)	(-2.27)	(-1.30)	(-1.09)
N	21	20[+]	21	21	21	21	21	21
R-sq	0.001	0.099	0.252	0.290	0.288	0.422	0.559	0.572

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

[+] Because we do not have prim2export data for Taiwan, we do not include Taiwan in the regression of column 2.

Table 4. IR Accumulation Determination between Two Groups

Table 4a. Robust OLS regression using cross section data

Dependent Var	IR level (Jun 2008)						
	Large IR loss countries			Less IR loss countries			All countries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Topen	0.359**		0.266**	0.0852		0.421**	0.283**
	(12.00)		(4.89)	(0.45)		(4.45)	(4.15)
Prim2export	0.307*		0.514*	-0.125		-0.0953	0.182
	(2.06)		(3.29)	(-0.38)		(-0.53)	(1.09)
xvolatile	1.916		1.416	-0.349		2.842**	0.0197
	(1.60)		(0.70)	(-0.55)		(2.82)	(0.03)
Kopen		-0.00834	-0.0408		-0.0745	-0.0877*	-0.0418
		(-0.29)	(-1.75)		(-1.73)	(-2.16)	(-1.59)
Exstdev		-9.197	-0.00143		-4.432	-6.620*	-5.349*
		(-1.49)	(-0.00)		(-1.43)	(-2.67)	(-1.83)
STdebt/gdp		0.0154	0.0128		0.00972	-0.0376**	-0.00557
		(0.89)	(0.99)		(0.59)	(-3.28)	(-0.77)
_cons	-0.253*	0.304	-0.336	0.239	0.325*	0.0764	0.154
	(-2.08)	(1.33)	(-0.84)	(0.92)	(2.10)	(0.49)	(1.04)
N	9	9	9	11	12	11	20
R-sq	0.883	0.533	0.938	0.204	0.422	0.799	0.603

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

Table 4b. OLS regression using panel data (2000-2007)

Dependent Var	IR at the end of each year (2000-2007)						
	Large IR loss countries			Less IR loss countries			All countries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Topen	0.178***		0.156***	0.142***		0.172***	0.161***
	(12.12)		(9.34)	(5.33)		(6.17)	(11.22)
Prim2export	0.110***		0.0763*	-0.0115		0.0334	0.0369
	(2.70)		(1.83)	(-0.28)		(0.84)	(1.35)
xvolatile	-0.429*		-0.224	-0.0460		0.0670	-0.0370
	(-1.85)		(-0.95)	(-0.42)		(0.67)	(-0.41)
Kopen		0.00765	-0.00218		-0.0150**	-0.0131***	-0.0114***
		(0.78)	(-0.33)		(-2.56)	(-2.84)	(-3.00)
Exstdev		-2.078***	-0.807**		-1.863***	-1.692***	-1.144***
		(-4.45)	(-2.34)		(-2.99)	(-3.41)	(-4.02)
STdebt/gdp		1.597***	0.481*		0.458*	-0.286	0.0740
		(4.86)	(1.95)		(1.81)	(-1.20)	(0.45)
_cons	0.0733**	0.114***	0.0622*	0.0897***	0.206***	0.102***	0.0892***
	(2.47)	(3.85)	(1.81)	(2.88)	(9.72)	(3.60)	(4.64)
N	72	72	72	82	82	82	154
R-sq	0.726	0.401	0.756	0.361	0.194	0.529	0.632

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

Table 4c. F test of the difference between groups

Null hypothesis: coefficients are the same between the regressions on two groups of countries

	Cross section regression (table 4a)			Panel regression (table 4b)		
Equations compared with	(1) vs (4)	(2) vs (5)	(3) vs (6)	(1) vs (4)	(2) vs (5)	(3) vs (6)
F value	3.56**	1.16	5.29**	2.10*	2.28*	1.93*
Prob>F	0.0390	0.3714	0.0297	0.0839	0.0630	0.0699
Degree of freedom	(4, 12)	(4, 13)	(7, 6)	(4,146)	(4,146)	(7, 140)

* p<0.1, ** p<0.05, *** p<0.01

Table 5. Estimated Coefficients for Fitted Logistic Curves

	BRA	IND	IDN	KOR	MYS	PER	POL	RUS	TUR
b0	0.10	0.21	0.16	0.25	0.27	0.17	0.28	0.36	0.10
b1	-2.59	-6.59	-8.88	-5.74	-5.88	-6.49	-5.76	-4.29	-8.72
b2	0.93	1.36	2.83	0.83	1.39	0.93	1.89	1.01	4.91
Length	6	10	8	12	9	11	8	8	6
t*	-2.78	-4.84	-3.14	-6.90	-4.24	-6.95	-3.05	-4.25	-1.78
MTP	10.78	8.84	9.14	8.9	9.24	9.95	9.05	10.25	9.78

Countries include Brazil, India, Indonesia, South Korea, Malaysia, Peru, Poland, Russia, and Turkey.

Note:
Length is the number of months from the time with the highest IR level to the last month of our sample (i.e. Feb. 2009); t* is the value of t that satisfied b1+b2*t=0; MTP=14-length-t*, which give the month when the IR losing speed start to slow down. If MTP value equals 10, it means the turning point is at the 10^{th} month of 2008.

Table 6. Regressions on the Starting Time of IR Falls (For Large IR Loss Countries)

	(1) length	(2) length	(3) length	(4) length	(5) length
Oilex/gdp	-0.663**	-0.664**	-0.664**	-0.698**	-0.790***
	(-3.70)	(-3.66)	(-3.39)	(-3.75)	(-9.66)
exstdev	-215.4***	-210.7***	-212.5***	-228.5***	-216.8***
	(-5.51)	(-5.28)	(-4.72)	(-5.40)	(-11.82)
Kopen		0.261			0.697**
		(0.93)			(4.66)
Topen			0.142		1.365**
			(0.20)		(3.72)
gdp07				6.63e-7	2.09e-6**
				(0.90)	(4.84)
_cons	11.73***	11.57***	11.58***	11.50***	9.035***
	(14.58)	(13.87)	(9.77)	(13.40)	(13.47)
N	9	9	9	9	9
R-sq	0.856	0.877	0.858	0.877	0.987

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

Table 7. Regressions on the Time of Speed Turning Point

	(1) mtp	(2) mtp	(3) mtp	(4) mtp	(5) mtp	(6) mtp
Length	-0.178	-0.216*	-0.198*	-0.249	-0.178	-0.195
	(-1.71)	(-2.25)	(-2.38)	(-1.66)	(-1.70)	(-1.84)
Kopen		0.285	0.389*	0.288	0.262	0.260
		(1.67)	(2.44)	(1.55)	(1.50)	(1.41)
gdp07			6.73e-7			
			(1.74)			
Exstdev				-11.12		
				(-0.31)		
Oilex/gdp					0.106	
					(0.93)	
Topen						-0.259
						(-0.62)
_cons	9.087***	9.334***	8.665***	9.838***	9.029***	9.355***
	(9.83)	(11.13)	(10.56)	(5.27)	(9.93)	(10.56)
N	9	9	9	9	9	9
R-sq	0.294	0.518	0.700	0.527	0.589	0.552

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

Table 8. Regression on IR/GDP Changes for Large IR Loss Countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	d.ir_gdp	d.ir_gdp	d.ir_gdp	d.ir_gdp	d.ir_gdp	d.ir_gdp	d.ir_gdp	d.ir_gdp	d.ir_gdp
topen	-0.0735***	-0.0308	-0.0861**	-0.0717**	-0.0719**	-0.0828**	-0.0638**	-0.0554	-0.0620***
	(-3.93)	(-1.94)	(-3.98)	(-3.44)	(-3.57)	(-3.67)	(-3.81)	(-1.49)	(-4.21)
Oilex/gdp	-0.0218***	-0.0853**	-0.0206**	-0.0223**	-0.0219**	-0.0193**	-0.0198***	-0.0232**	-0.0260***
	(-4.15)	(-3.08)	(-3.91)	(-3.81)	(-3.93)	(-3.11)	(-4.31)	(-3.81)	(-6.06)
topenXoilex		0.0139							
		(0.61)							
gdp07			-2.61e-08						
			(-1.11)						
gdppc				-6.40e-07					
				(-0.36)					
kopen					0.00484				
					(0.54)				
xvolatile						-0.355			
						(-0.80)			
exstdev							1.914		
							(1.82)		
STdebt/gdp								-0.00229	
								(-0.58)	
length									-0.00946*
									(-2.40)
_cons	-0.0150	-0.00772	0.0133	-0.0113	-0.0176	0.0239	-0.0586*	-0.00432	0.0581
	(-0.92)	(-0.37)	(0.44)	(-0.55)	(-0.98)	(0.46)	(-2.11)	(-0.17)	(1.77)
N	9	9	9	9	9	9	9	9	9
R-sq	0.861	0.870	0.888	0.864	0.868	0.876	0.916	0.869	0.935

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

Table 9. Regressions on Relative IR Level Changes for Large IR Loss Countries

	(1) d.RIR	(2) d.RIR	(3) d.RIR	(4) d.RIR	(5) d.RIR	(6) d.RIR	(7) d.RIR	(8) d.RIR
Oilex/gdp	-0.0273*	-0.0300*	-0.0324*	-0.0298*	-0.0327*	-0.0238	-0.0313*	-0.0380**
	(-2.04)	(-1.98)	(-2.24)	(-2.04)	(-2.03)	(-1.82)	(-2.19)	(-2.90)
topen	-0.0646							
	(-1.35)							
gdp07		1.85e-08						
		(0.31)						
gdppc			-4.08e-06					
			(-0.94)					
kopen				0.0158				
				(0.68)				
xvolatile					0.550			
					(0.52)			
exstdev						4.679		
						(1.64)		
STdebt/gdp							-0.00514	
							(-0.95)	
length								-0.0211
								(-1.81)
_cons	-0.00616	-0.214***	-0.168***	-0.205***	-0.251**	-0.290***	-0.147*	-0.0185
	(-0.21)	(-4.24)	(-3.99)	(-7.80)	(-2.54)	(-4.95)	(-2.37)	(-0.18)
N	9	9	9	9	9	9	9	9
R-sq	0.460	0.395	0.465	0.429	0.412	0.576	0.465	0.602

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01

Table 10. Panel Data Regressions on Size of IR Changes

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.	md.ir_gdp	md.ir_gdp	md.ir_gdp	md.rir	md.rir	md.rir
Method	OLS	Random Effect	Random Effect	OLS	Random Effect	Random Effect
Month Dummies	No	No	Yes	No	No	Yes
Topen	-0.0166*	-0.0166*	-0.0176**	-0.0340	-0.0340	-0.0330*
	(-1.96)	(-1.96)	(-2.15)	(-1.49)	(-1.49)	(-1.70)
oilexgdp	-0.00176	-0.00176	-0.00240	0.0000563	0.0000563	-0.00126
	(-1.05)	(-1.05)	(-1.50)	(0.01)	(0.01)	(-0.33)
Kopen	-0.000589	-0.000589	-0.000803	-0.00131	-0.00131	-0.00120
	(-0.28)	(-0.28)	(-0.41)	(-0.23)	(-0.23)	(-0.26)
Exstdev	0.347	0.347	0.371*	0.854	0.854	0.940*
	(1.44)	(1.44)	(1.69)	(1.32)	(1.32)	(1.81)
STdebt/gdp	0.000301	0.000301	0.000253	0.00175	0.00175	0.00154
	(0.41)	(0.41)	(0.37)	(0.88)	(0.88)	(0.96)
gdp07	-5.25e-09	-5.25e-09	-6.90e-09	-7.77e-09	-7.77e-09	-1.10e-08
	(-0.96)	(-0.96)	(-1.33)	(-0.53)	(-0.53)	(-0.90)
D.oilprice	0.000517***	0.000517***	0.000759*	0.00158***	0.00158***	0.00346***
	(3.38)	(3.38)	(1.81)	(3.86)	(3.86)	(3.48)
tsurplusgdp	0.0129	0.0129	0.0221	0.0536	0.0536	0.0618
	(0.35)	(0.35)	(0.63)	(0.54)	(0.54)	(0.74)
norexgrowth	-0.000512	-0.000512	0.000215	-0.00292**	-0.00292**	-0.000733
	(-1.21)	(-1.21)	(0.44)	(-2.57)	(-2.57)	(-0.63)
_cons	0.00438	0.00438	n.a.	-0.00472	-0.00472	n.a.
	(0.39)	(0.39)	(.)	(-0.16)	(-0.16)	(.)
N	66	66	66	66	66	66
R-sq	0.448			0.395		

Notes: t statistics in parentheses. For confidence level, * p<0.1, ** p<0.05, *** p<0.01
Definition of new variables in panel data analysis: (also see descriptions in the paper for details)
md.ir_gdp: monthly change of IR position (ΔIR/GDP2007)
D.oilprice: monthly oil price changes.
Tsurplusgdp: trade surplus relative to GDP, equals (monthly export – monthly import)×12÷GDP2007
Norexgrowth: normalized exchange rate growth rate. See foot note 11.

Figure 1. Emerging Markets International Reserves (IR)

Figure 1a. IR/GDP, scales are different for each country

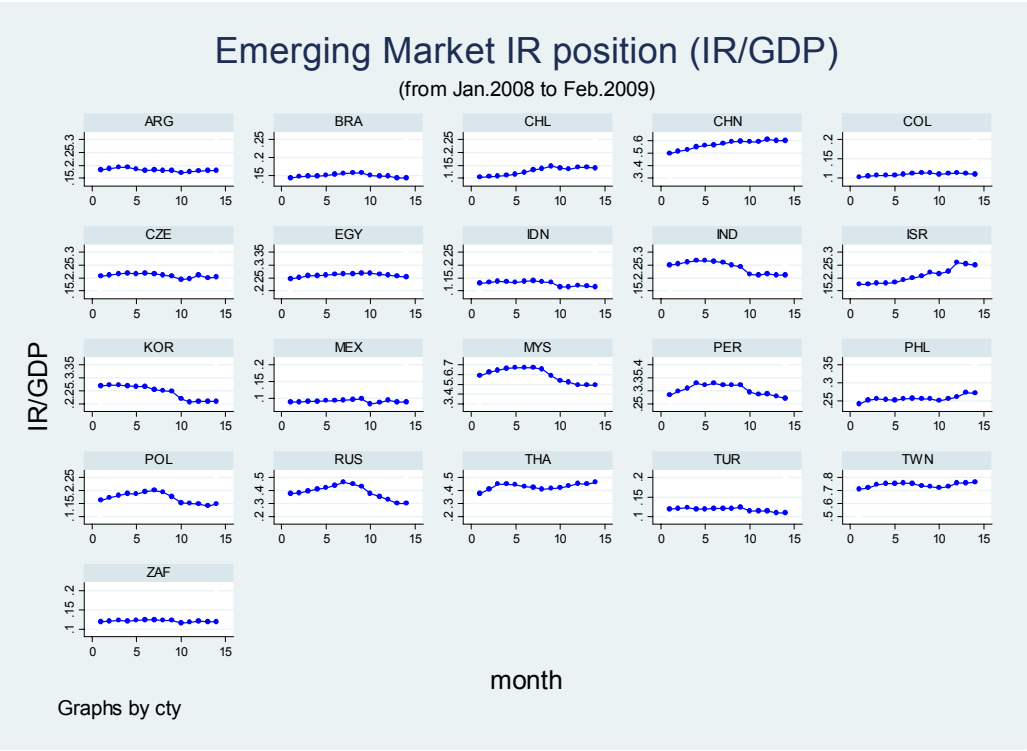


Figure 1b IR/MaxIR, identical scale for all countries

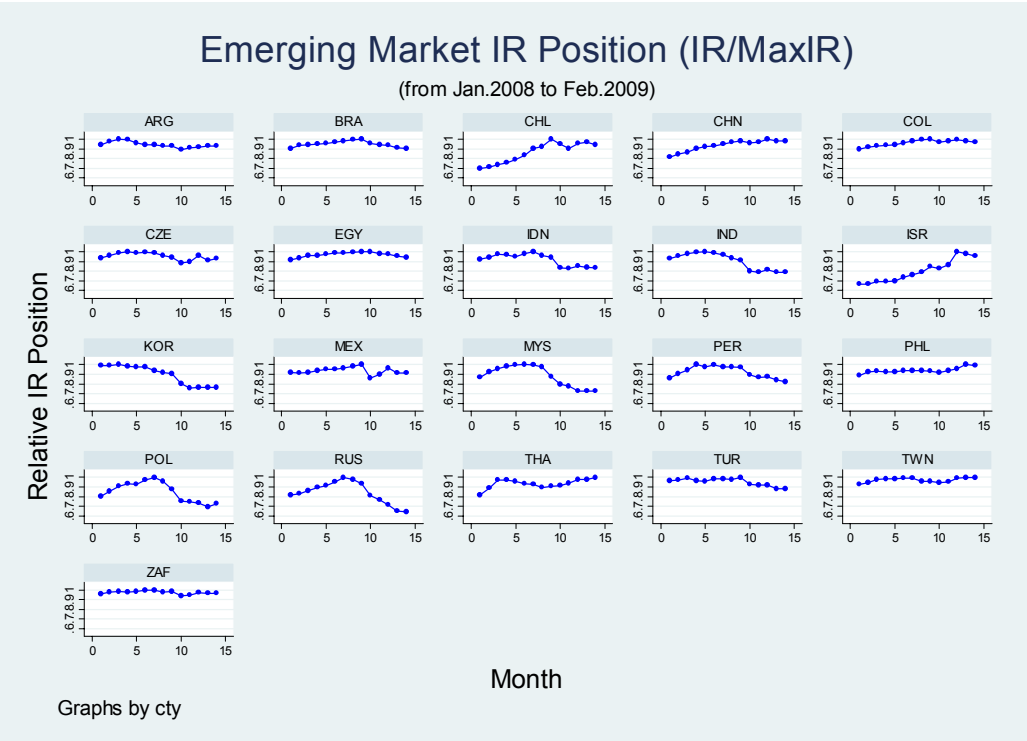


Figure 2. Regression on IR/GDP Changes Since July 2008

Figure 2a

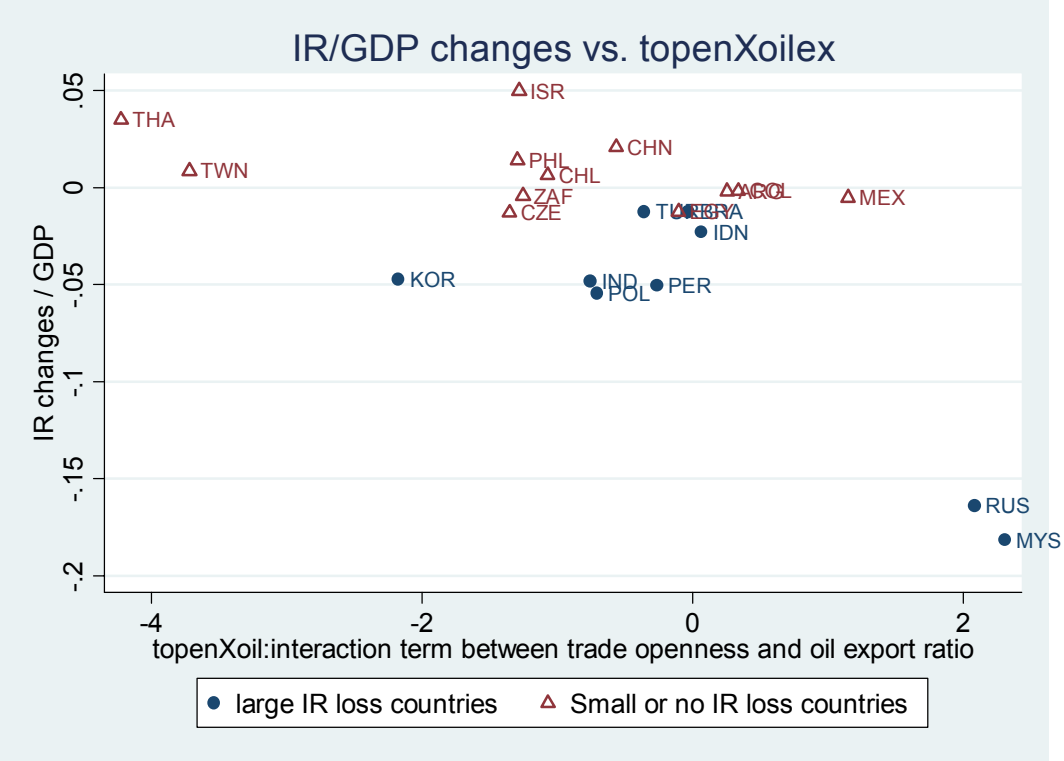


Figure 2b

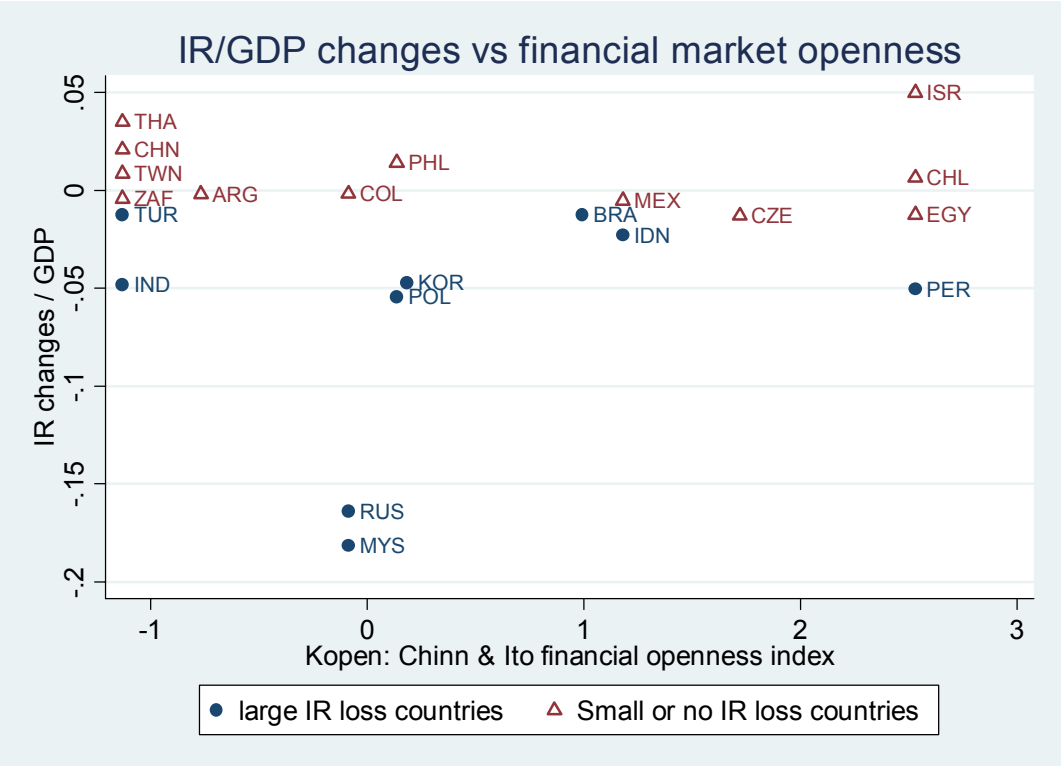


Figure 2c

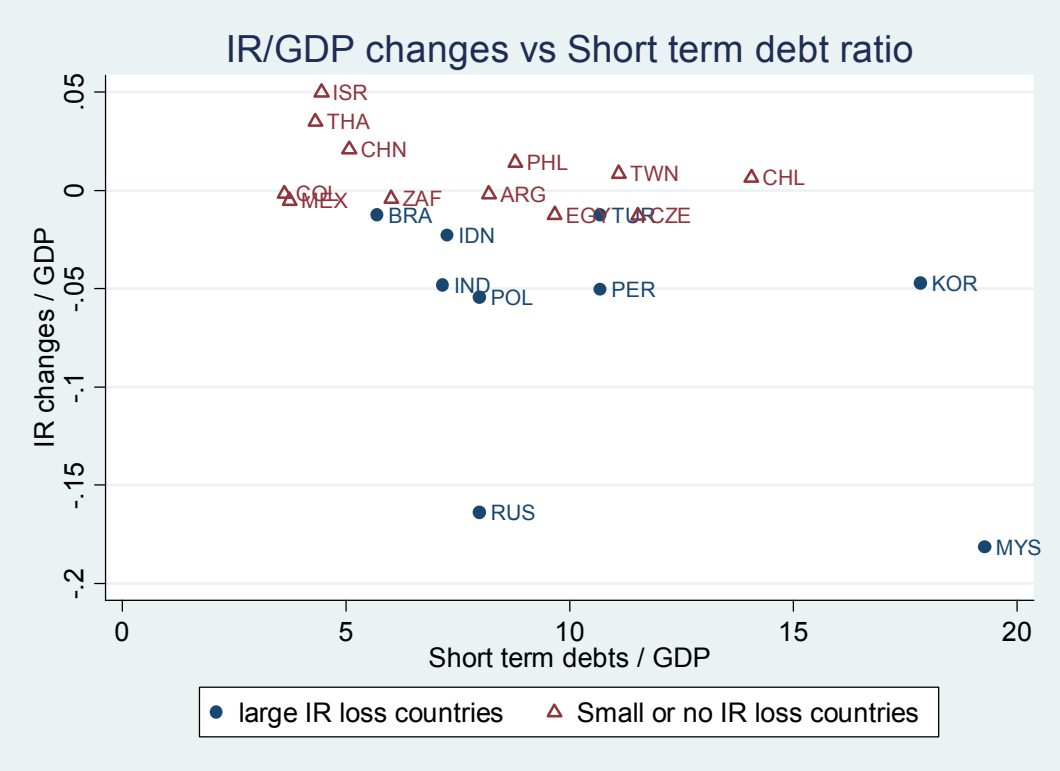

IR/GDP changes vs Short term debt ratio
IR changes / GDP
.05
0
-.05
-.1
-.15
-.2
0
5
10
15
20
Short term debts / GDP
ISR
THA
CHN
PHL
TWN
CHL
COL
MEX
ZAF
ARG
BRA
IDN
IND
POL
PER
KOR
RUS
MYS
large IR loss countries
Small or no IR loss countries

Figure 3. Regression on IR/GDP Level at July 2008

Figure 3a

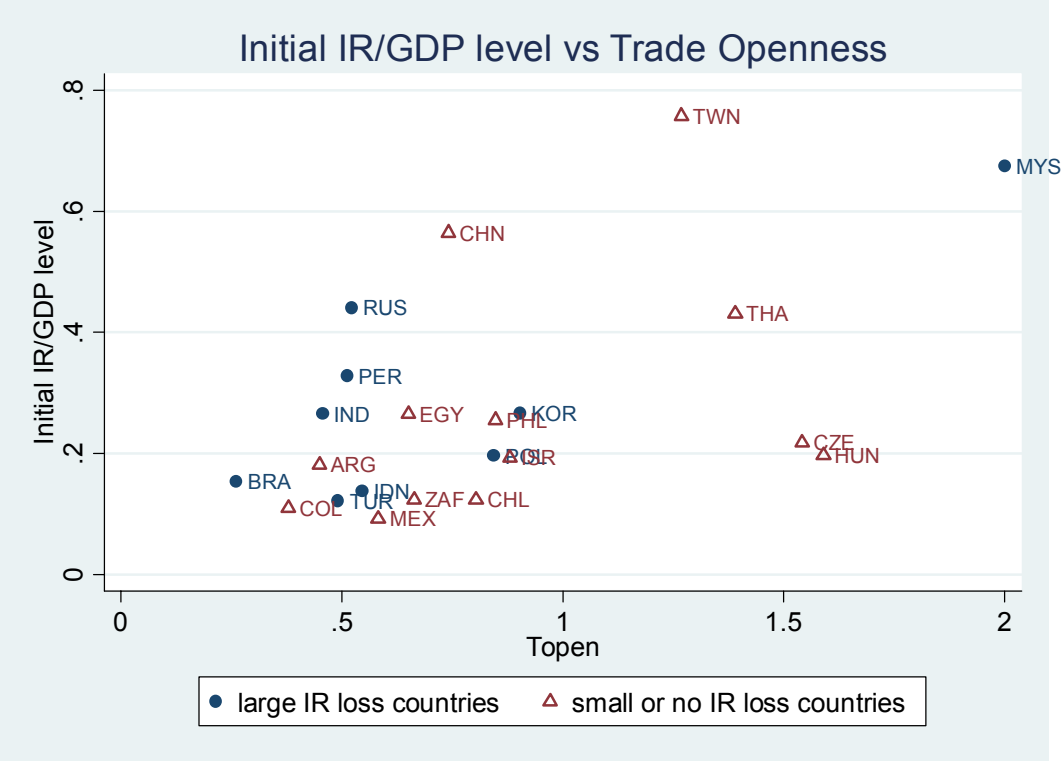


Figure 3b

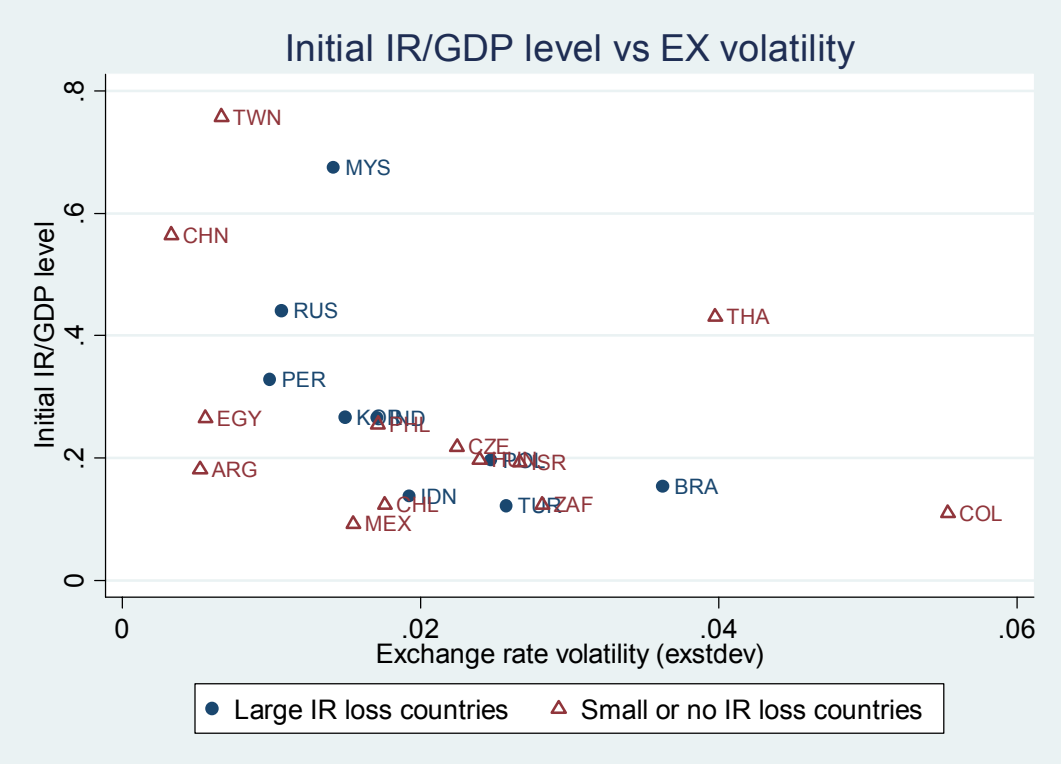


Figure 3c

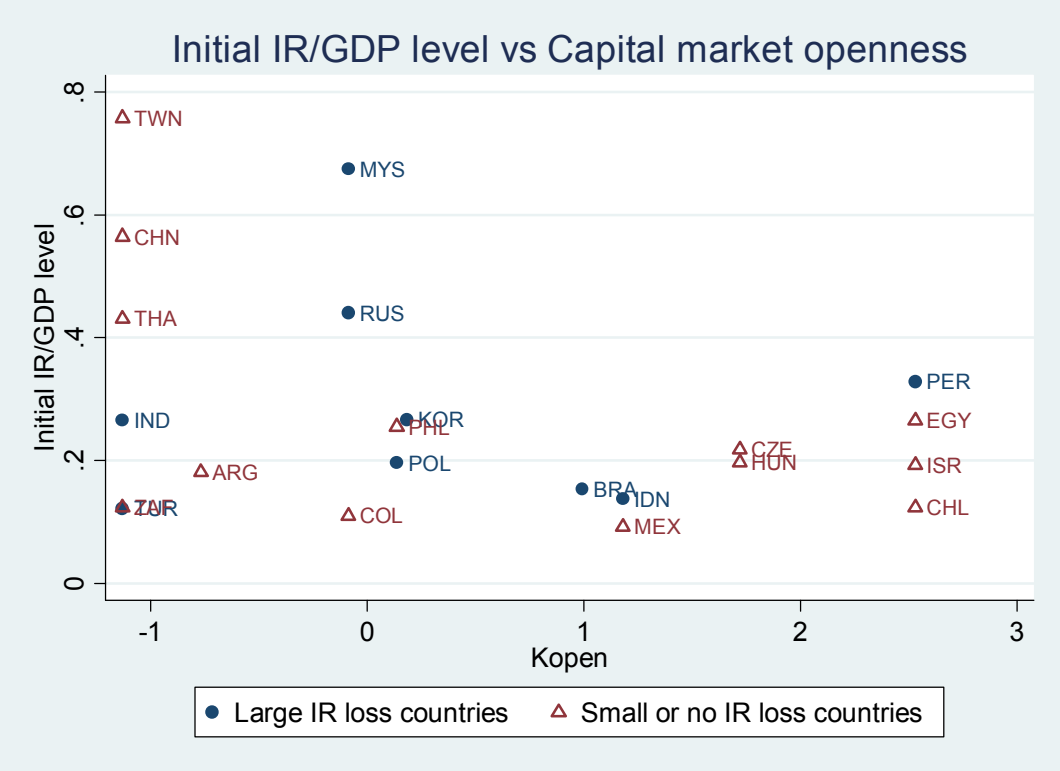
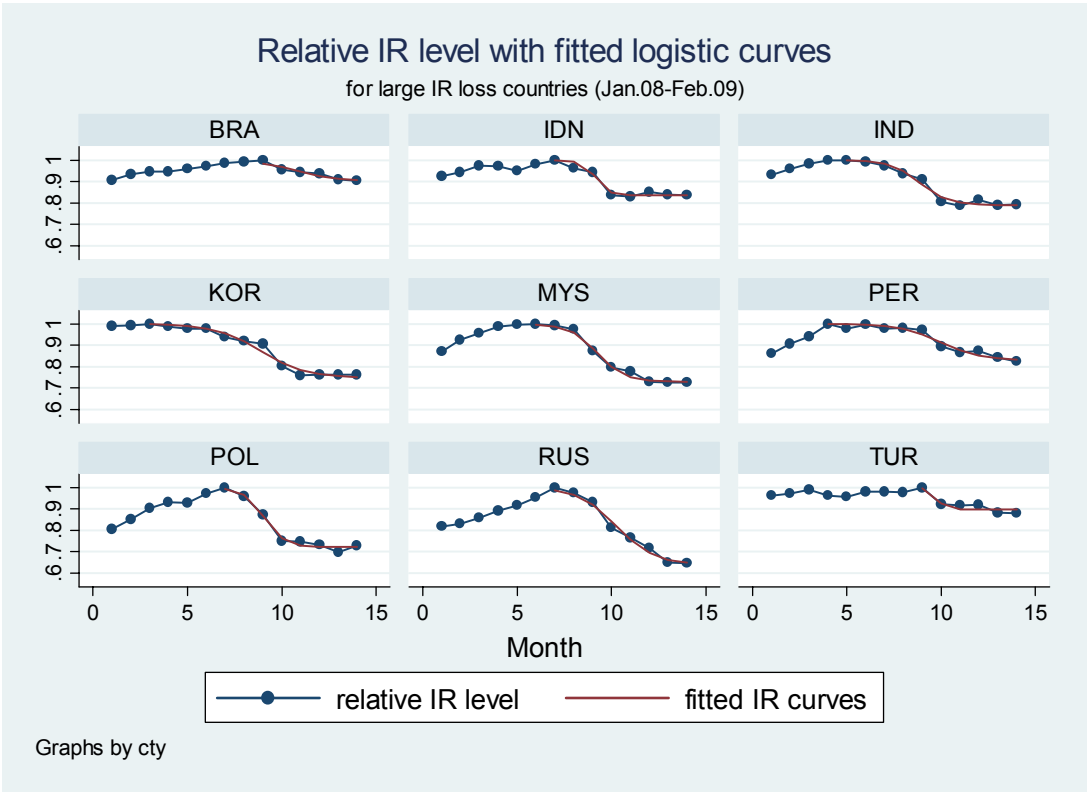

Initial IR/GDP level vs Capital market openness
Initial IR/GDP level
0
.2
.4
.6
.8
TWN
MYS
CHN
THA
RUS
PER
IND
KOR
PHL
EGY
CZE
HUN
ARG
POL
ISR
BRA
IDN
CHL
ZAF
COL
MEX
-1
0
1
2
3
Kopen
Large IR loss countries
Small or no IR loss countries

Figure 4.


Relative IR level with fitted logistic curves
for large IR loss countries (Jan.08-Feb.09)
BRA
IDN
IND
KOR
MYS
PER
POL
RUS
TUR
.6 .7 .8 .9 1
0 5 10 15
Month
relative IR level
fitted IR curves
Graphs by cty