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 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 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 reverses, 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 case of countries that refrained from a sizable IR depletion during the first phase of 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.

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The 2008-9 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. 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.

To recall, investigating the patterns of exchange rates, interest rates and IR during 1970-1999, Calvo and Reinhart (2002) inferred the prevalence of the "fear of floating". Countries claiming that they allow their exchange rates to float, mostly do not. Instead, the authorities frequently attempt to stabilize the exchange rate through direct intervention in foreign exchange market and open market operations. The fear of floating may also provide an interpretation for the massive hoarding of IR during the last ten years by EMs and other developing countries. Alternative explanations of IR hoarding however include the precautionary and/or mercantilist motives [Aizenman and Lee (2007, 2008)], and the Bretton Woods II interpretation [Dooley, Garber and (2003)]. This study looks at the factors accounting for the depletion of IR during the 2008-9 crisis, investigate the dynamics of drawing down of IR by EMs, and verify the degree to which the fear of floating dominated the use of IR during the crisis. We explore the adjustment of 21 EMs during the window of the crisis and reveal a mixed and complex picture. Regression analysis shows that EMs with large primary commodity exports, especially oil exports, experienced large IR losses during the 2008-9 global crisis. Countries with a medium level of financial openness and a large short term external debt to GDP ratio also on average lost more of their initial IR holdings. Most of the countries that suffered large IR losses, started depleting their IR during the second half of 2008. Quite intriguingly, only about half of the EMs relied on significant depletion of their IR as part of their adjustment mechanism.

We proceed by dividing the sample of EMs into two groups: countries that experienced sizable IR losses and countries that had either not lost IR or quickly recovered from their IR losses. The first group is defined as countries that lost at least 10 per cent of their IR during the period of July 2008 - February 2009 relative to their highest IR level.   Among 21 EMs, 9 countries belong to the first group.   To gain further insight, we compare the pre-crisis demand for IR/GDP of countries that experienced sizable depletion of their IR, to that of countries that did not, and find differential patterns across the two groups. Trade related factors (such as trade openness, and the primary goods export, especially large oil export) seem to be more significant in accounting for the pre-crisis IR/GDP levels of countries that experienced a sizable depletion of IR in the first phase of the crisis. These 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 crisis. The IR losses of these countries followed an inverted logistical curve. After a rapid initial depletion of IR, these countries reached within 7 months a markedly declining rate of IR depletion, and lost not more than one-third of their pre crisis IR.

In contrast, in case of countries that refrained from a sizable depletion of IR during the first crisis phase, financial factors seem more important than trade factors in explaining the initial level of IR/GDP.   These countries refrained from using IR altogether and achieved external adjustment through large depreciations of their currencies.   The patterns of using IR by the first group of countries, and refraining from using IR by the second group, are consistent with the 'fear of losing reserves.' Such a fear may reflect a country's concern that dwindling IR may signal greater vulnerability to run on its currency, thereby triggering such a run on its remaining reserves. This fear may be related to a country's apprehension that, as the duration of the crisis in unknown, depleting IR quickly may be suboptimal.

Our results suggest that the adjustment of EMs during the on-going global liquidity crisis has been constrained more by their *fear of losing IR* than by their *fear of floating*.   Countries' choice of currency depreciation instead of reserve depletion also suggests that some may opt to revisit the gains from financial globalization. Earlier research suggests that EMs that increased

their financial integration during the 1990s and mid 2000s, accumulated IRs due to precautionary motives, to obtain self insurance against sudden stops and deleveraging crises.[1] Yet, the 2008-9 global crisis suggests that the levels of IR required in order for this self-insurance to work may be comparable to that of a country's gross external financial exposure [see Park (2009) analyzing Korea's challenges during the crisis]. In these circumstances, prudential supervision that would tighten the link between short-term external borrowing and hoarding IR would mitigate the excessive exposure to deleveraging risks induced by short-term external borrowing.

In Section 1, we analyze the impact of 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

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[1] See Calvo (1998) for a model of sudden stops.

[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's announced its loan to Hungary in November 2008, Hungary's international reserves have increased nearly by half in the next two months.   Due to data availability, we did not include Morocco and Pakistan.

that more than half of the EMs in our sample reduced their IR holdings during the 2008-9 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 global 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 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 (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 export, 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 (year to year) of the previous year. We expect countries with greater trade dependence will be impacted more following a negative global shock that leads to rapid decline in international trade. Thus, 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. The larger IR losses may reflect dwindling revenue from export (reflecting lower demand for export, tighter trade credit,

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[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 did not report those results here.

[5] The data of primary products is 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.

deteriorating terms of trade, etc.), and possibly greater deleveraging of foreign positions in the economy, reflecting anticipation of lower future growth.

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 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. Dependent variable in Table 2 is the IR change from July 2008 to Feb 2009 measured as a ratio to a country's GDP. 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. IR level in July 2008. The explanatory variables are measured using 2007 data except for short term external debt and 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 significant impact on IR changes. Since including the primary product export ratio gives similar results as 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.

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[6] Short term debt data is based on the IMF debt statistics tables drawn from creditor and market sources.
[7] In table 2 and 3, short term debt are measured by June 2008 level. Due to data constraint, the oil export level used here is taken from 2005 data.

When we include trade openness, oil exports, and 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 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. 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 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 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 2.c). Exchange rate volatility turned out to be insignificant, and thus we do not include them 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 process of crisis management, maybe hypothesized to   accumulate more IR after the crisis).   Table 3 presents similar regressions for the case where 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

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[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.

openness is insignificant, but the primary product export/total export 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 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 a large primary commodity export, especially oil export, tend to experience relatively large IR loss during the 2008-9 global crisis. EMs with a medium 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 use their IRs differently as well 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- Feb 2009, relative to their highest IR level. Among 21 EMs, 9 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

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[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).

as in Tables 2 and 3.[10] 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 who 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. Short term debt/GDP, ratio however, shows different signs in regressions with and without the trade factors.[11] 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.

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. Dependent

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[10] In order to address the possible role of outliers, we have applied the ROBUST OLS regression in Table 4. "Robust regression" is essentially a compromise between dropping the case(s) that are moderate outliers and seriously violating the assumptions of OLS regression.
[11] One potential reason could be the high correlation between trade openness and short term debt ratio. The correlation between these two variables is 0.51 in the cross section dataset.

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.[12] 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 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 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 significantly positive in both columns 2 and 5 when we include only the financial factors.[13] When we include trade factors, the short term debt ratio turned out to be significant only for the first group of countries.[14]

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 group dummy and all the associated interaction terms added to regressions in Tables 4a and 4b are jointly zero. Five out of six results reject our hypothesis, confirming the hypothesis that trade and financial related factors played

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[12] We exclude Taiwan in our regression since we do not have its data on 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.

[13] These findings, and the observation that EMs with a medium level of financial openness and a large short term debt ratio also lost a larger share of their IR holdings, are supportive of the view that part of the reserve accumulation can be explained by the EMs' desire to build their war-chest for defense against financial crisis.

[14] Our results should be taken with a grain of salt, as we have only 21 countries, and relatively low R^2.

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 2008-9 crisis, opted to deplete a relatively larger share of their initial IR during the first phase of 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 IRs. 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 2008-9 crisis.

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.[15] 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:

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

with the presumption that $b_0 > 0, b_1 < 0, b_2 > 0$. For each country, we select the data starting from

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[15] 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.

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 9 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 9 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 EMs, MTP is found to be around 8 to 10, implying that the turning point in the rate of IR depletion occurred between August to 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 oil price started falling only when the perception

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of 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 financial open economy has 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, 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.[16] 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 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 percentage of GDP (*tsurplusgdp*) and normalized exchange rate changes (*norexgrowth*)[17]. We use two measures for the independent variable: monthly

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[16] The positive association of *length* with the magnitude of the IR change, and the finding that EMs which had begun depleting their IR sooner had also an earlier turning point is consistent with the *fear of losing reserves* – this fear restrained Emerging Markets from more heavily drawing down their reserves, preserving at least two-thirds of their pre-crisis level of international reserves.
[17] Normalized exchange rate change is measured as monthly exchange rate growth minus the average

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 first and third column but not in the second, while monthly 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.   We have run regressions including an Asian dummy, added to verify if there a regional bias stemming from the fact that many emerging markets are from.   Overall, adding the Asian dummy does not affect the results of regressions that include both large and small IR loss countries. In the subgroup regressions in table 4, including Asian dummy does not affect results related to role of trade factors but will result in unstable results on financial factors. Since many Asian countries have strict capital controls, especially among the countries that don't lose IR, we cannot distinguish whether this result is driven by 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

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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 exchange rate, we use this variable to identify these unusual changes, and measure its effect on IR changes.

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.

2.4 Deleveraging and exchange rate pressure during the crisis.

Further insight is gained by looking at the association of short term external debt and IR changes. In the absence of monthly data of these variables, we apply quarterly data for 18 EMs during 2008 and the first quarter of 2009.   Figure 5 traces the average quarterly IR position and short term external borrowing of the two groups (sizable and non-sizable IR losses, 9 countries in each group), during 2008 and the first quarter of 2009.[18] Figure 5 shows that EMs that experienced sizable IR losses during the worst part of the crisis were exposed to a much larger deleveraging of short term external debt than other EMs. During Q4, 2008, the average IR losses were 28 Billion US$ for EMs in the sizable IR losses group, *half* of it funded the deleveraging of short-term external debt (14 Billion US$).   In contrast, IR losses and the deleveraging of short term debt were close to zero for countries experiencing non-sizable IR losses during Q4 2008 -- IR *increased* on average by 1 Billion $, short term external debt *declined* by 2 Billion.

Figure 6 reports the association between the quarterly changes of IR and short-term external debt (ST) during Q1 2008 and Q1 2009 for EMs, subject to data availability.   The darker (lighter) lines are the regression lines for the sizable (non sizable) IR losses group, respectively. During the peak of the crisis, Q4 of 2008 and the first quarter of 2009, there is a clear *positive* relationship between these variables for the sizable IR losses group.   Figure 7 plots the overall association of quarterly changes of reserves and the short-term external debt of all the EMs during the 5 quarters. The regression line confirms the importance of the balance sheet, inducing a positive and significant association of the two.

We close the section with an analysis of the way EMs, experiencing sizable IR losses, dealt

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[18] Sizable IR loss group includes: BRA IDN IND KOR MYS PER POL RUS TUR, Non-sizable IR loss group include: ARG CHL COL CZE EGY ISR MEX THA ZAF (quarterly data is not available for CHN PER and TWN). Due to the unavailability of monthly data we apply quarterly data.

with exchange market pressure. [19] First, we calculate the exchange market pressure, EMP, defined as the sum of the monthly exchange rate depreciation against the US$ plus the rate of IR depletion, measured by IR losses as a fraction of M1.[20]   For country i,

$EMP_i = \Delta E_{i/usd} / E_{i/usd} - \Delta IR / M1$.   We focus on EMs that experienced a large exchange market pressure -- a spell of at least three consecutive months with an exchange market pressure exceeding 0.05.   These countries are Brazil, Columbia, Indonesia, India, Korea, Malaysia, Poland, Russia, and South Africa.   A common pattern exhibited by most of these countries is that after experiencing large losses of IR during a few months in the first phase of the crisis, countries increased the weight of exchange rate depreciation, and reduced the weight of losing IR as a way of dealing with exchange market pressures. This pattern is consistent with the growing fear of losing IR.

Figure 8 illustrates these patterns for Russia, Korea, Poland and Malaysia.[21]   EMP is measured by the bars, using the left scales.   An EMP exceeding 0.05 is reported by the lighter bars. Note that these countries faced an EMP exceeding 0.05 after August 2008, the on-set of the worst phase of the crisis. The top broken line measures the IR/MaxIR ratio (MaxIR is the MaxIR level during 2008.1-2009), using the right scale.   The solid volatile line, IRER, measures the relative weight of IR in the exchange market pressure, using the right scale.   Focusing on the experience of Russia and Korea, their EMP increased rapidly from about 0.1 in August 2008 to about 0.4 in Russia within half a year, and 0.2 in Korea within four months.   During that period, Russia and Korea experienced rapid depletion of international reserves.   After three months of intensive IR losses, they started decelerating their IR depletion rate, increasing the weight of exchange rate depreciation in dealing with exchange market pressure.[22] Similar patterns are exhibited by the other EMs experiencing sizable IR losses.

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[19] See Girton and Roper (1977) and Frankel (2009) for further discussion of exchange market pressure.
[20] Due to data limitation, we don't have monthly data of the monetary base, thereby we deflate ΔIR by M1.
[21]   These are the countries experiencing spells of four or more consecutive months with EMP > 0.05.
[22] Note that the FED swap line advanced to Korea in November 2008 was associated with the large drop in exchange market pressure shortly after.

3. Concluding remarks

Our paper suggests that 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 crisis. This finding is in line with the buffer stock interpretation of demand for IR.[23] Financial factors come across as more important in accounting for pre-crisis IR level of countries that refrained from spending IR in the first phase of crisis. 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 crisis, refrained from drawing their IR below one-third of the pre-crisis level. 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. 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.[24] 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.

Our findings raise new questions. Apart from short-term external debt, it would also be important to include 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

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[23] See Frenkel (1983), Edwards (1983) for further discussion of this buffer stock view
[24] See Cheung and Qian (2009) for evidence on the "keeping up with the Joneses' IRs" hypothesis in context of East Asia.

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. This hypothesis implies that countries prefer to adjust to bad shocks first via exchange rate depreciation, supplementing it with partial depletion of their IR when the shocks are deemed to be too large to be dealt only with exchange rate adjustment. The case for using reserves tends to be stronger for countries with a significant balance sheet exposure at times of deleveraging. The case for depreciation tends to be stronger for countries with a limited balance sheet exposure, at times of global recessionary pressure. Deflationary shocks (drops in commodity prices, collapsing export demands, etc.) mitigate fears from the inflationary consequences of depreciation, increasing the perceived gain of depreciation as a form of demand switching policy, thereby improving the competitiveness of a country.

Overall, our study confirms the benefits of hoarding reserves as a war chest dealing with deleveraging and collapsing trade, finding that half of the countries relied heavily on depleting reserves during the most acute stages of the 2008-9 crisis. Yet, our study also confirms important limitations of the efficacy of hoarding reserves – in deep crises; reserves may not suffice to quell market sentiments if they don't cover the external debt exposure of a country. Consequently, the 2008-9 crisis suggests that in order for the self insurance provided by international reserves to work, a country may require levels of IR comparable to its external financial gross exposure.[25] Under such circumstances, countries may benefit by invoking the proper Pigovian taxes.[26]

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

[26] These policies may take the form of non linear taxes on external borrowing, where inflows of external borrowing above a threshold may be taxed at an increasing rate, reflecting the resultant higher exposure of the central bank to a possible future bailout of the banking system [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.

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Figure 1.   Emerging Markets International Reserves (IR)

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

Emerging Market IR position (IR/GDP)
(from Jan.2008 to Feb.2009)
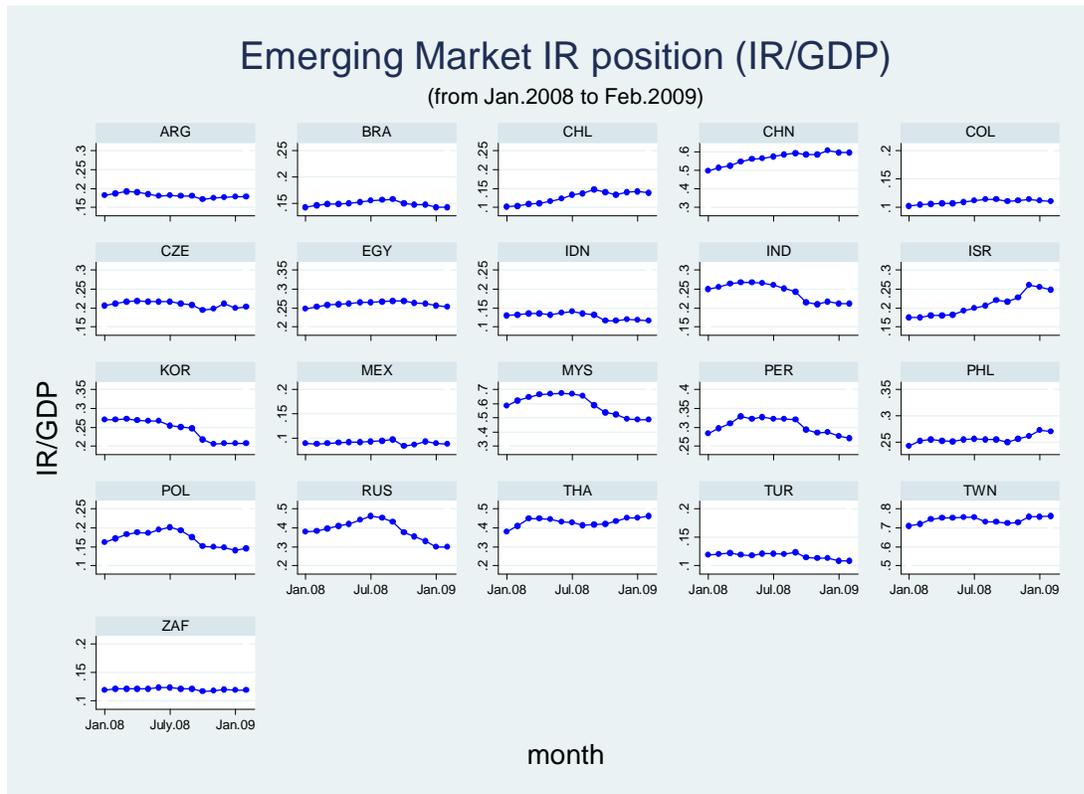
The countries abbreviations are

Argentina (ARG), Brazil (BRA), Chile (CHL), China (CHN), Colombia (COL), Czech Republic (CZE), Egypt (EGY), Indonesia (IDN), India (IND), Israel (ISR), South Korea (KOR), Mexico (MEX), Malaysia (MYS), Morocco , Peru (PER), Philippines (PHL), Poland (POL), Russia (RUS), Thailand (THA), Turkey (TUR), Taiwan (TWN), South Africa (ZAF)

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

Emerging Market IR Position (IR/MaxIR)
(from Jan.2008 to Feb.2009)

Relative IR Position

Month
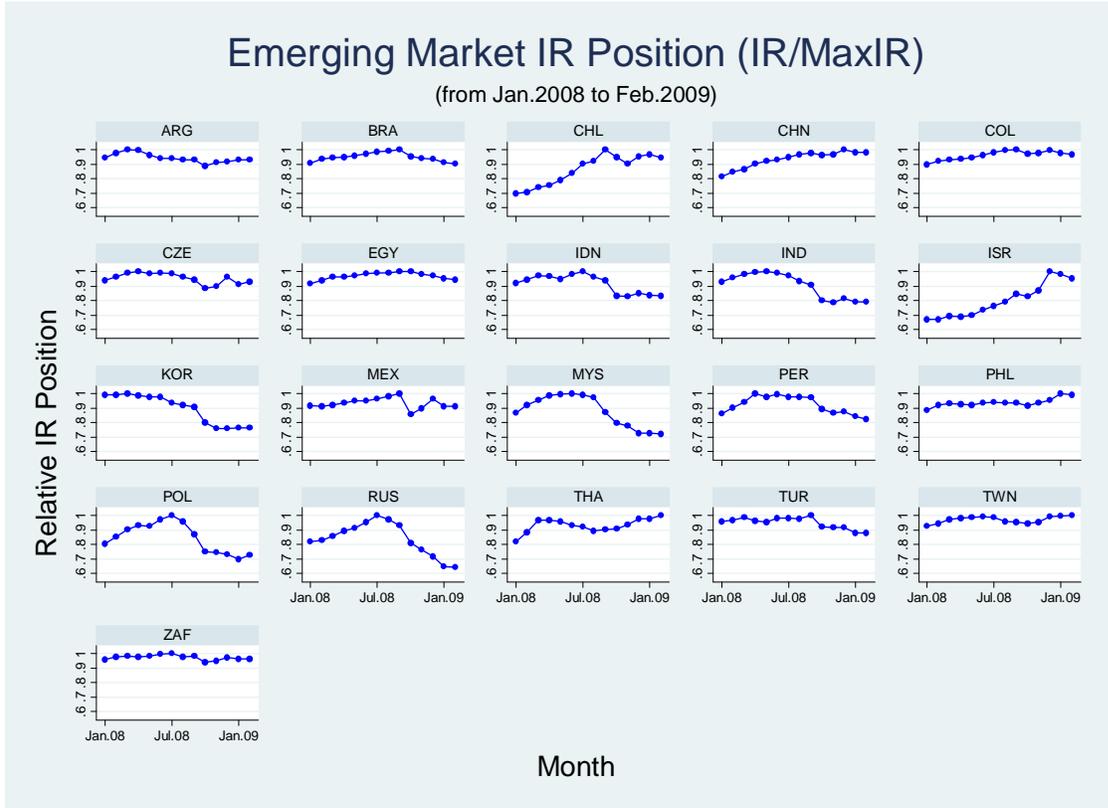
Figure 2 Regression on IR/GDP changes since July 2008

2.a
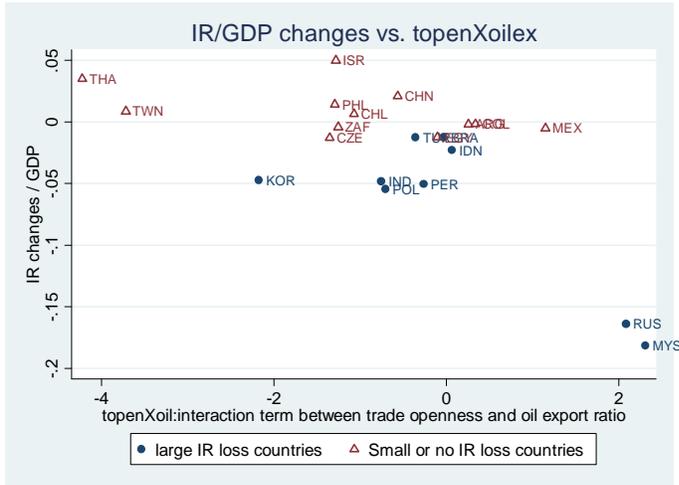
2.b
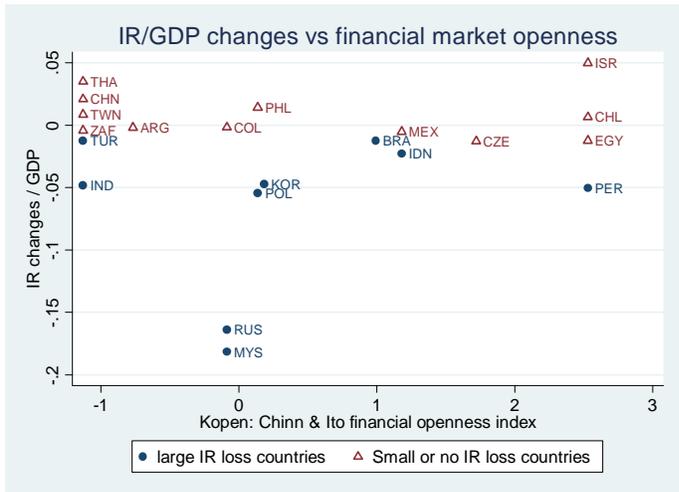
2.c
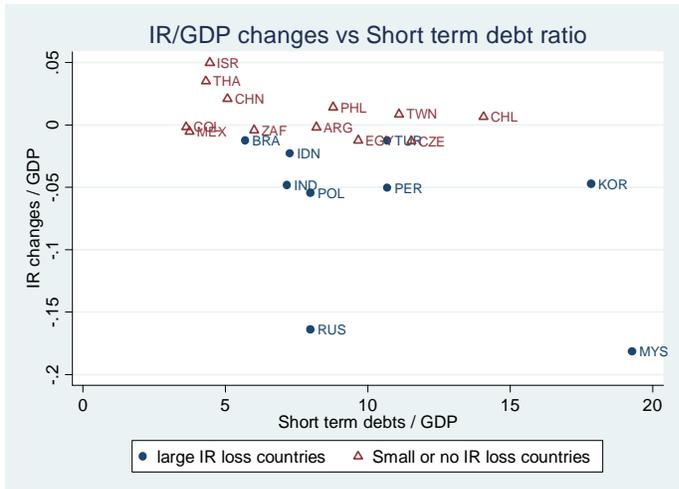
Figure 3 Regression on IR/GDP level at July 2008

3a.

3.b

3c

Figure 4.

Relative IR level with fitted logistic curves
for large IR loss countries (Jan.08-Feb.09)
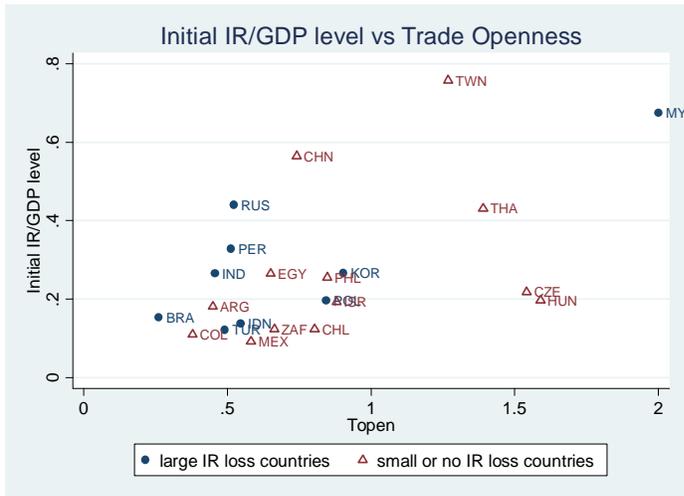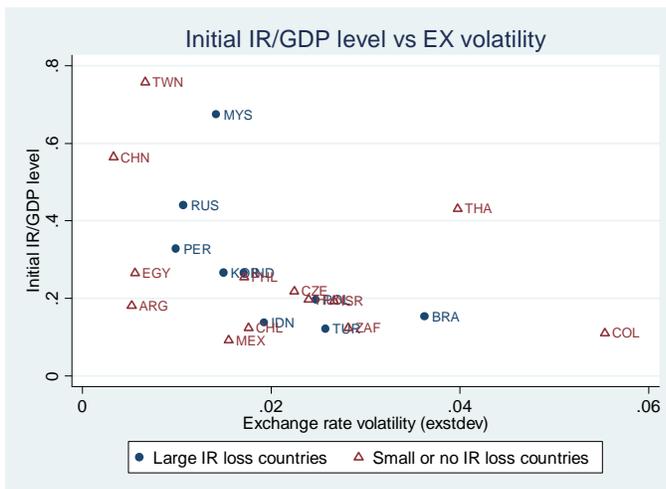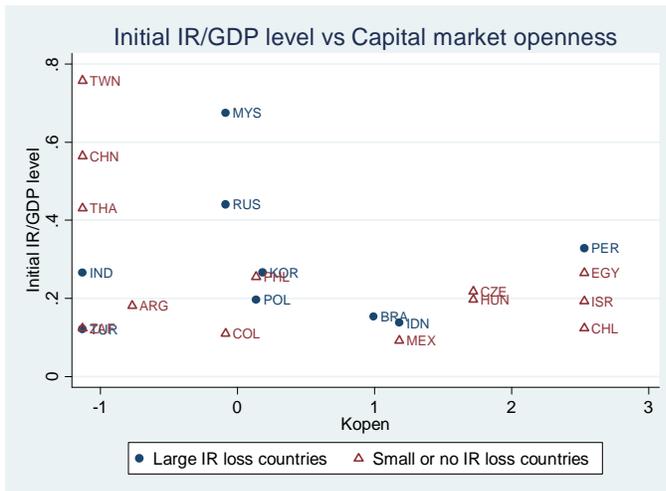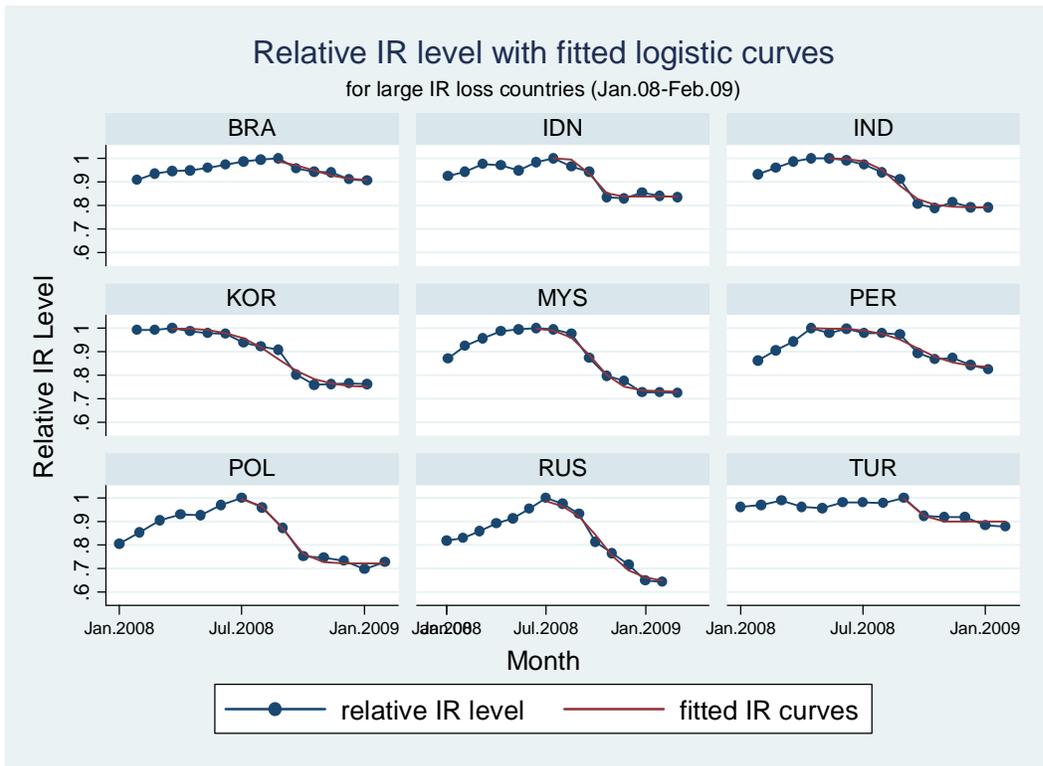
Figure 5: Average IR and short terms external debt, quarterly data, Q1, 2008-Q1, 2009 [levels (left panel) and changes (right panel)]

Small (or no) IR loss group: ARG CHL COL CZE EGY ISR MEX THA ZAF (quarterly data not available for CHN PER TWN)

Sizable IR loss group includes: BRA IDN IND KOR MYS PER POL RUS TUR
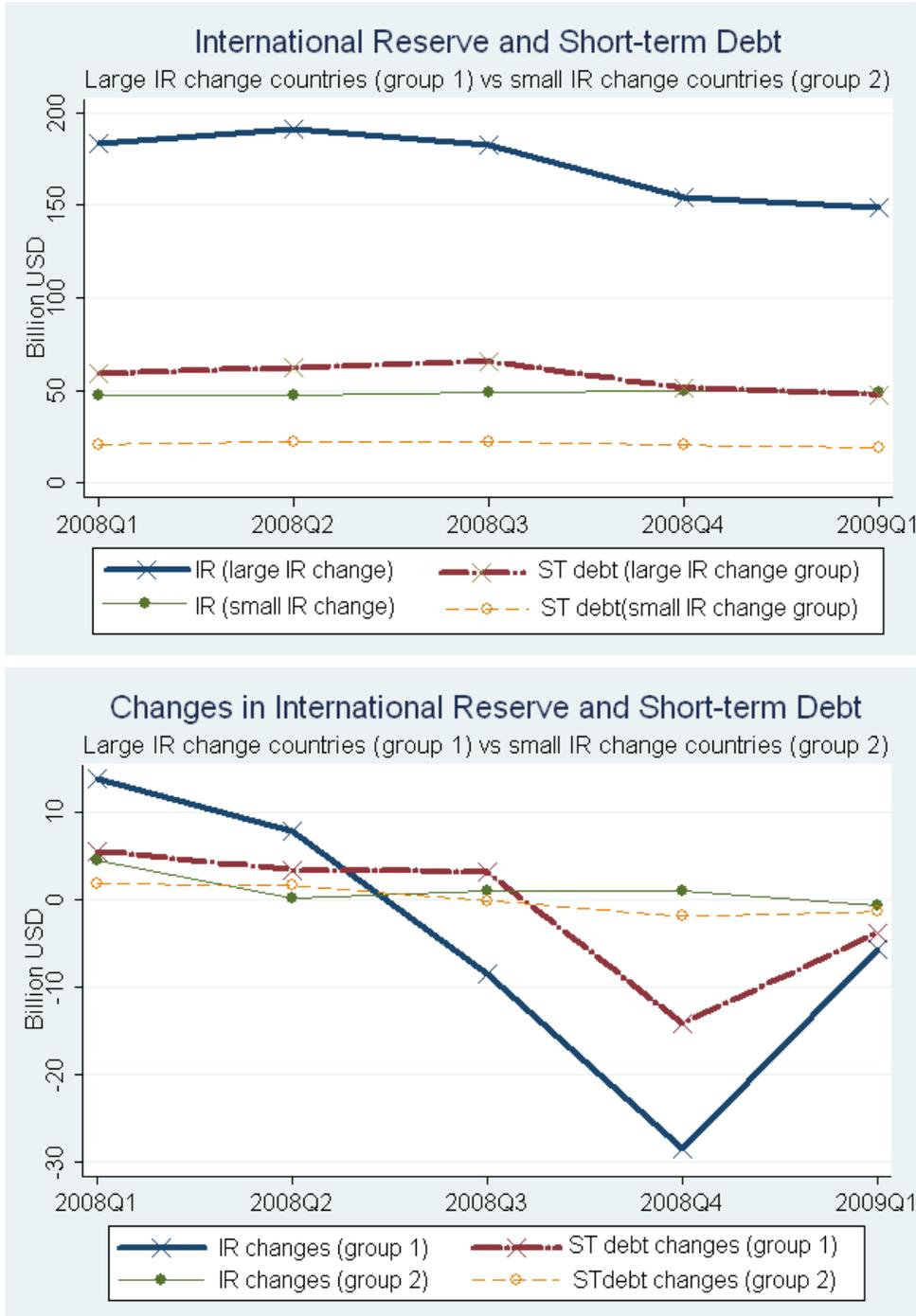
Figure 6: The association of ST debt and IR during Q1, 2008 and Q1, 2009.
The bold (solid) line is the regression line in the group of large (small) losses, respectively.
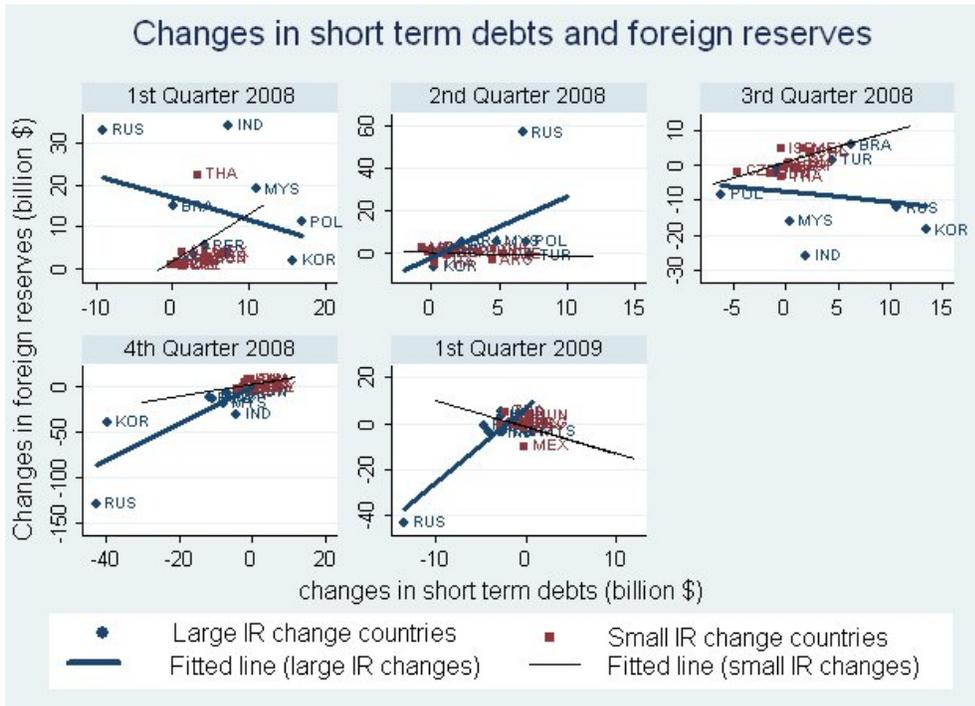
Figure 7: The association of ST debt and IR during Q1, 2008 and Q1, 2009 for all 5 quarters.
[the regression line is -0.4 + 0.8X without Russia]
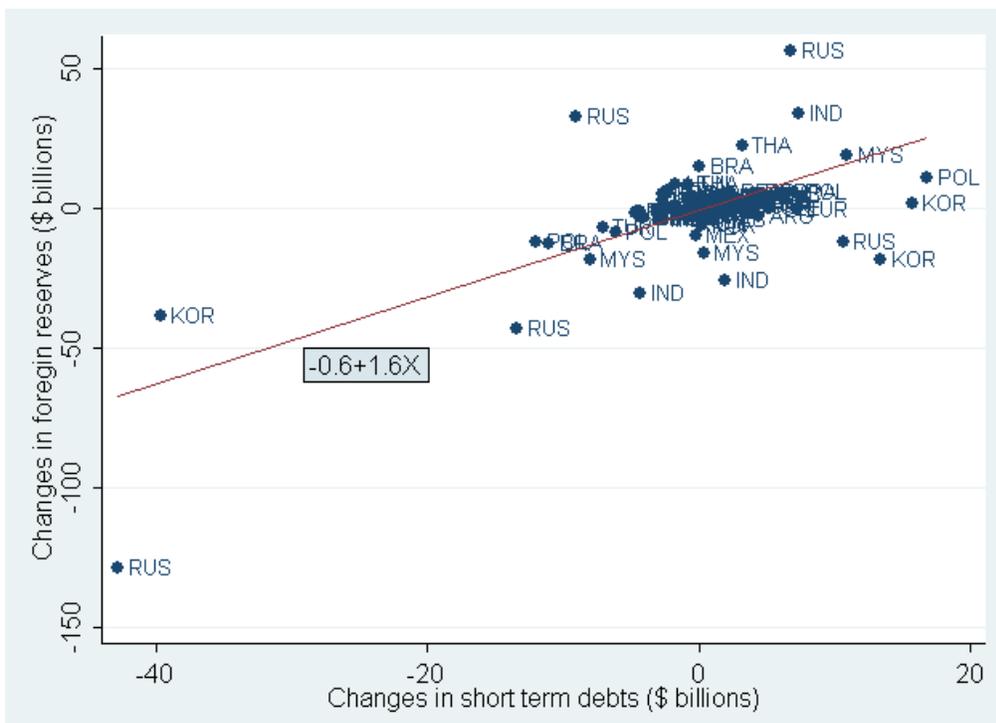
Figure 8: Exchange market pressure, IR/Max IR and the weight of IR in Exchange market pressure during the crisis, Russia, Korea, Poland and Malaysia
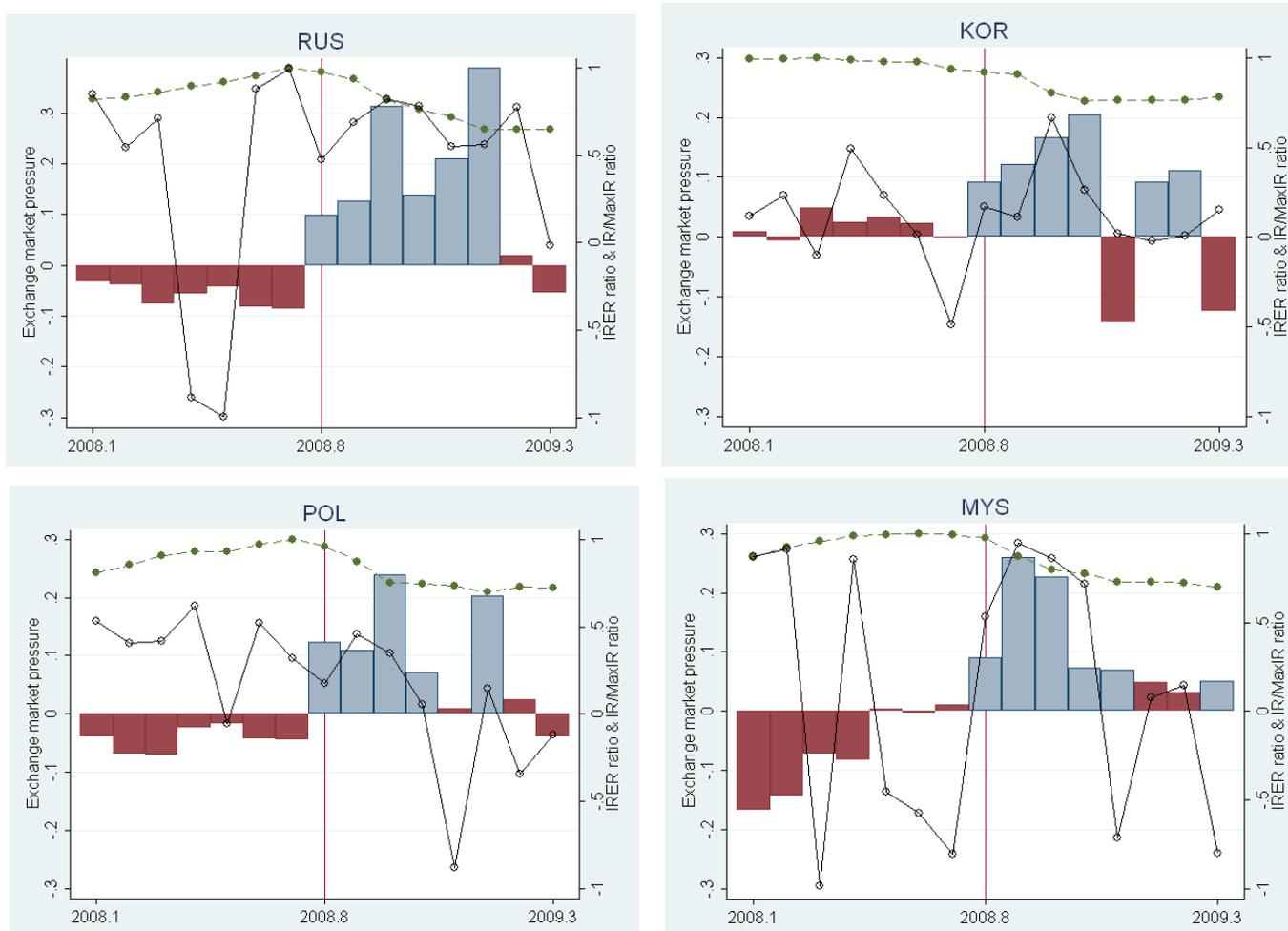
Notes: EMP is measured by the bars, using the left scales.   EMP exceeding 0.05 is reported by the lighter bars. Note that these countries faced EMP exceeding 0.05 after August 2008, the on-set of the worst phase of the crisis. The top line (broken line) measures the IR/MaxIR ratio, where MaxIR is the MaxIR level during 2008.1-2009, using the right scale.   The solid volatile line, IRER, measures the relative weight of IR in the exchange market pressure, using the right scale.   The definition of IRER is = sign(- ΔIR / M1* $\Delta E_{i/usd}$ / $E_{i/usd}$) * abs((- ΔIR / M1)/[abs(- ΔIR / M1)+abs($\Delta E_{i/usd}$ / $E_{i/usd}$)]

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.

** We replicated our regression results for the case where Taiwan has the same financial openness level as Korea, finding that the main results are not affected by using Korean's openness instead of China's openness for the missing value of Taiwan's openness. Results are available upon request.

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.

Figure 3. Regressions on Relative IR position changes (all emerging markets)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	d.rir	d.rir	d.rir	d.rir	d.rir	d.rir	d.rir	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 reported in 4a and 4b

Equations compared with	Cross section regression (table 4a)			Panel regression (table 4b)		
	(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 10th 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	12.73***	12.57***	12.58***	12.50***	10.03***
	(15.82)	(15.07)	(10.62)	(14.56)	(14.96)
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	11.09***	11.33***	10.67***	11.84***	11.03***	11.36***
	(11.99)	(13.51)	(13.00)	(6.34)	(12.13)	(12.82)
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) 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	(9) 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* (-2.04)	-0.0300* (-1.98)	-0.0324* (-2.24)	-0.0298* (-2.04)	-0.0327* (-2.03)	-0.0238 (-1.82)	-0.0313* (-2.19)	-0.0380** (-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	-0.154** (-3.67)	-0.214*** (-4.24)	-0.168*** (-3.99)	-0.205*** (-7.80)	-0.251** (-2.54)	-0.290*** (-4.95)	-0.147* (-2.37)	-0.0185 (-0.18)
N	9	9	9	9	9	9	9	9
R-sq	0.529	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	Robust OLS	Random Effect	Random Effect	Robust 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*
	(-2.50)	(-1.96)	(-2.15)	(-1.51)	(-1.49)	(-1.70)
oilexgdp	-0.00176	-0.00176	-0.00240	0.0000563	0.0000563	-0.00126
	(-1.02)	(-1.05)	(-1.50)	(0.01)	(0.01)	(-0.33)
kopen	-0.000589	-0.000589	-0.000803	-0.00131	-0.00131	-0.00120
	(-0.33)	(-0.28)	(-0.41)	(-0.24)	(-0.23)	(-0.26)
exstdev	0.347*	0.347	0.371*	0.854	0.854	0.940*
	(1.89)	(1.44)	(1.69)	(1.39)	(1.32)	(1.81)
STdebt/gdp	0.000301	0.000301	0.000253	0.00175	0.00175	0.00154
	(0.56)	(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
	(-1.26)	(-0.96)	(-1.33)	(-0.54)	(-0.53)	(-0.90)
D.oilprice	0.000517***	0.000517***	0.000759*	0.00158***	0.00158***	0.00346***
	(3.16)	(3.38)	(1.81)	(3.73)	(3.86)	(3.48)
tsurplusgdp	0.0129	0.0129	0.0221	0.0536	0.0536	0.0618
	(0.31)	(0.35)	(0.63)	(0.54)	(0.54)	(0.74)
norexgrowth	-0.000512	-0.000512	0.000215	-0.00292***	-0.00292**	-0.000733
	(-1.49)	(-1.21)	(0.44)	(-3.10)	(-2.57)	(-0.63)
_cons	0.00438	0.00438	n.a.	-0.00472	-0.00472	n.a.
	(0.46)	(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.Note: Only D.oilprice (oil price changes), tsurplusgdp (trade surplus ratio) and norexgrowth (normalized exchange rate changes) are using monthly data; other variables are using the initial value before the crisis. The 2007 GDP level is used to remove the country size effect in calculating the trade surplus. Using monthly GDP can be an option, but that data is not available and may also subject to seasonal patterns.