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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

This paper studies 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 relied on depleting their international reserves as part of the adjustment mechanism. 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 courtiers that didn't, and find different patterns between the two groups. Trade related factors (trade openness, primary goods export ratio, especially large oil export) seem to be much more significant in accounting for the pre-crisis IR/GDP level of countries that experienced a sizable depletion of their 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 the crisis. Their reserves loses followed an inverted logistical curve – after a rapid initial depletion of reverses, they reached within 7 months a markedly declining rate of IR depletion, losing not more than one-third of their pre crisis IR. In contrast, for countries that refrained from a sizable depletion of their IR during the first crisis phase, financial factors account more than trade factors in explaining their initial level of IR/GDP. Our results indicate that the adjustment of Emerging Markets was constrained more by their fear of losing international reserves than by their fear of floating.

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

Overall, we find a mixed and complex picture. EMs with a large primary commodity export, especially oil export, tended to experience large IR losses in this global crisis. Countries with a medium level of financial openness and a large short term debt ratio also lost on average more of their initial IR holdings. Intriguingly, we find that only about half of the EMs relied on drawing down their international reserves as part of the adjustment mechanism. 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 didn't, and find differential patterns. Trade related factors are much more significant in accounting for the pre-crisis level of IR/GDP in countries that experienced a large depletion of their IR in the first phase of the crisis. For these countries, their trade openness and primary goods export ratio (especially a large oil export ratio) are much more important factors than for the group that refrained from sizable IR depletions. These findings suggest that countries that internalized their large exposure to trade shocks before the crisis, opted to deplete greater share of their initial IR during the first phase of the crisis. In contrast, for countries that

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

refrained from a sizable depletion of their IR during the crisis, financial factors seem to account more than trade factors in explaining their initial level of IR/GDP. This finding suggests also the possibility of greater 'fear of losing' international reserves on behalf of these countries.

Focusing more narrowly on the countries that lost significant reserves, we find that international reserves losses followed an inverted logistical curve – starting with a rapid initial depletion of reverses, they reached within 7 months the stage of a rapidly declining rate of depletion. Arguably, the patterns of using reserves by the first group, and refraining from using reserves 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, triggering a run on its remaining reserves. This fear is probably related to a country's apprehension that, as the duration of the crisis in unknown, depleting international reserves too fast may be sub-optimal -- it exposes the country to the risk of abrupt adjustment if the crisis turned out to be deeper and more enduring than its initial prior.

In section 1, we analyze impact of the recent financial crisis on international reserve holdings in EMs. After documenting that about half of the countries experienced a large decline of their international reserves, we look for factors explaining the international reserves declines. In section 2, we explain the factors determining the speed of drawing down international reserves. Section 3 concludes.

1. IR changes in all emerging markets

Our samples are selected from the countries listed in the FTSE and MSCI emerging market list. We did not include Singapore and Hong-Kong because of their special economic structure, specializing in entrepôt services.[2] Figure 1 presents the countries' international reserves holdings since January 2008 for the 21 emerging markets included in our sample. In Figure 1a, international reserves are measured as the ratio relative to the country's GDP size. In Figure 1b, international reserves are measured as the ratio relative to the highest IR level

[2] 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.

since January 2008. From Figure 1, we can see that more than half of the countries in our sample have lost their IR during the recent crisis. Most of the countries who suffered large international reserve losses started depleting their IR during the second half of 2008, and many of them still have not recovered their IR holdings back to the level before the crisis.

[Insert Figure 1]

We first ask what factors cause a country to have a large IR change during the recent financial crisis.

1.1 Data and explanatory variables

In our analysis, we use several measures of international reserve changes. Since most of the countries started to show large IR losses during the second half of 2008, and have regained most of the losses by the first quarter of 2009, we chose July 2008 to February 2009 as the time window for our case study. We measure the IR changes in two ways: international reserves changes as a ratio to a country's GDP; and as the ratio relative to a country's initial IR level in our sample period.[3]

We included both trade related factors and financial market related factors as possible explanatory variables accounting for the changes in IR patterns. The first variable we considered is trade openness (labeled as *topen* thereafter), 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, (labeled as *oilex/gdp*). It is measured as a country's net oil export level in 2005 (by 1000 Barrels per Day) divided by its GDP size (by billions USD). The third variable is the primary products export ratio (prim2export), which is the value of fuel and non-fuel primary products export, divided by its total export level.[4] We also consider historical export volatility (labeled as *xvolatile*) as our explanatory variable which is measured as the standard deviation of the monthly export growth rate (y-t-y) in the previous year. We expect those countries with large trade openness, a large net oil export, a large primary product

[3] 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.

[4] 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.

export ratio, and large export volatility will experience large reserve loss when facing a negative global shock.

As for the financial market factors, the first variable we include is financial openness using the Chinn-Ito capital market openness index (labeled as *Kopen*). The second variable is the historical exchange rate volatility or flexibility (*exstdev*), which is measured as the standard deviation of the monthly exchange rate growth rate (m-t-m). The last variable is the short term external debt relative to country's GDP (STdebt/gdp)[5]. 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 large foreign short term debt opt to suffer more IR loss during crisis. In the regressions we have included other control variables, such as previous year GDP's level (gdp07), per capita GDP (gdppc) and some interaction terms between these explanatory variables. Table 1 gives the summary statistics for these variables in our cross section analysis.

[Insert table 1]

1.2 Regression results

Table 2 and 3 present the regression results, accounting for the variation of our two IR change measures, using different explanatory variables. The dependent variable in table 2 is the reserves change from July 2008 to Feb 2009 as a ratio to its GDP; the dependent variable in table 3 is the reserve change in the same period as the ratio to its initial level, i.e. the reserve levels in July 2008. The explanatory variables generally are measured using 2007 data except for the short term debts and the oil export ratio.[6]

[Insert tables 2 and 3]

In Table 2, we first control for four trade factors in our regressions. Column 2 and 3 show that the primary product export, especially the oil exports, has significant impact on the IR changes. Since including the primary product export ratio gives similar results as those of the oil export ratio, we did not report in this table other regressions including primary export

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

[6] In table 2 and 3, short term debt are measured by June 2008 level. Due to data availability, the oil export level used here is taken from 2005 data.

ratios. Trade openness has some impact on IR losses only when we control for the primary product export or oil export. When including the trade openness, oil export, and their interaction term (labeled as *topenXoilex*), trade openness has negative impact on IR changes. The oil export ratio also has negative impact on IR, but only showing up in the interaction term (Column 4 reports this result, also see figure 2.a). However, export volatility does not have significant relationship with the IR changes, thus we do not report it in table 2.

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

In the last column we include the initial IR level (labeled Ini.IR, measured as the IR/GDP level in July 2008) as an explanatory variable. The significant negative sign of Ini.IR shows that large pre-crisis IR/GDP levels were associated with a large IR/GDP decline during the crisis. This higher pre-crisis IR/GDP encouraged countries to spend more IR to absorb the external shock during the global crisis (and possibly countries that faced large IR losses, will accumulate more IR after the crisis). Table 3 repeats 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 openness is insignificant, but the primary product export/GDP, oil export/GDP and the absolute value of financial openness index – all remain significant. The

[7] 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, hence we did not report them in the table.

last regression in table 3 also shows that the initial levels of IR no longer have a large impact on the relative reserve level changes. Since in the later analysis we find that trade openness is an important factor that decides countries' initial IR levels, one interpretation of these differences is that trade openness can affect the initial IR level, and thus affect the magnitude of the changes in IR/GDP ratio, but it does not have direct impact on the relative IR changes. While primary commodity, oil export ratio and financial openness will not only affect the initial IR level, but also affect the patterns of relative IR changes.

Based on results in Table 2 and 3, we find that countries which have a large primary commodity export, especially oil export, tended to have large IR loss in this global crisis. Countries with a medium level of financial openness and a large short term debts ratio will also lost more in their IR holdings. Trade openness can affect a country's initial IR level, but both trade openness and initial IR level will only affect the magnitude of IR changes relative to its GDP size, but not the changes relative to its historical IR level.

Countries accumulate their IR for different reasons (to protect from trade shocks, to promote exports, etc.), thus they may use their IRs differently when facing the same external shock. Comparing the pre-crisis level of IR/GDP of countries that depleted a significant share of their IR during the crisis with that of countries that did not may provide further insights. We proceeded by dividing our sample into two groups: countries that have sizable IR losses; and countries that either have not lost IR or 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.[8]

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 table 2 and 3. The results show that both financial market related factors and trade related factors play important roles in accounting for the pre-crisis IR accumulation, but they have different weights between these two groups. For large IR depletion countries, all trade related factors have shown consistent expected signs in our regression: countries that

[8] 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).

have larger trade sectors, countries with large primary goods export ratio, and countries that used to face large trade shocks accumulated more IR. Compared with the second group (small or no IR depletion countries), trade related factors are more important for the first group. The R^2 of the regression on trade related factors for the first group (equation 1 in Table 4), exceeds that of the counter part regression for the second group by a factor of 4 [see the first and the forth 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 regressions for the first group. Financial factors, by contrast, are much more significant for the second group of countries. In that group, countries that have stricter financial controls tend to have a higher pre-crisis level of IR/GDP, and more flexible exchange rate countries 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 controlling for trade factors. Short term debts/GDP, however, shows different sign in regression with and without the trade factors.[9] In the last column of table 4, we run regressions for all 20 countries that have the relevant data. Trade openness and exchange rate flexibility are significant in accounting for the pre-crisis IR/GDP. Figure 3 provides a more detailed picture of these relationships.

Table 4b uses a longer time period panel data to further test this relationship. The dependent variable used in table 4b is the IR levels at the end of each year, from 2000 to 2007. The explanatory variables in the panel are measured using the data from the same years.[10] In table 4b we found similar results as those found in table 4a. For both groups, trade openness and exchange rate volatility have a consistent and significant impact on the reserve accumulation level. Countries with a larger trade sector and less exchange rate flexibility tend to hold more international reserves. When we include all the control variables, trade openness is statistically more significant in group 1 regression, and exchange rate volatility is more significant for group 2. Similar to table 4a, the primary product export ratio has shown

[9] One potential reason is the high correlation between trade openness and short term debts ratio. The correlation between these two variables is 0.51 in the cross section analysis dataset.

[10] 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 observation, since its exchange rate and short term debt have extraordinary change during the collapse of the currency board.

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 debts ratio is significant in both column 2 and 5 when we only include financial factors. When we include trade factors, the short term debt ratio turned out to be significant only for the first group countries.

Overall, trade related factors (especially the primary product export ratio) are more statistically significant for the first group, while financial factors (except for the short term debts ratio) are more important for the second group. Table 4c gives the results of an F test for the hypothesis that trade rated factors and financial factors play the same important role in the pre-crisis IR level determination. We include the group dummy and its interaction terms with each of the explanatory variables, and run regressions with the full sample. Table 4c report the F test values on the hypothesis that group dummy and all its interaction terms are jointly zeros. 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 in these two groups.

One possible interpretation is that countries that internalized their large exposure to trade shocks before the crisis, opted to deplete greater share of their initial IR during the first phase of the crisis. In contrast, countries that mostly ignored trade factors in hoarding IR before the crisis, refrained from using their IR, possibly due to the fear that depleting their IR may signal greater vulnerability down the road, inducing a deeper run on its 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 gaps in the pre-crisis IR/GDP between the two groups. To gain further insight, we study now the dynamics of IR for countries that experienced sizable IR depletion.

2. Countries with large IR Losses

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

2.1 Fitted logistic curves

Inspecting Figure 1b suggests that an inversed logistic curve may provide a good fit. Such a curve implies that that in the first part of the crisis the depletion of IR tends to gradually speeds up. Above a threshold, the depletion speed slows down, ultimately the IR regains stability. Thus, we fit to the IR/MaxIR path a logistical curve, applying a nonlinear least square regression to for the selected period, staring with the month when IR peaked:

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

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 sample ends, on Feb 09. The estimated parameters are: b_0, determining the long run value of 'desirable' IR /MaxIR (i.e., $IR(t)/\text{MaxIR} \xrightarrow[t\to\infty]{} 1-b_0$); b_1, providing information about the inflection point, determining when the speed of reserves losses starts to decrease; and b_2, measuring the speed of Reserves losses.

Figure 4 present the picture of relative IR changes, and the fitted logistic curves for the 9 large IR loss countries. Overall, the predicted line fits the data very well.

[Insert Figure 4]

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 (BRA, PER), and Turkey (TUR) have lower values, (10% to 17%). Table 5 also reports the number of months since IR started to fall, reported as "length". Solving $b_1 + b_2 \times t^* = 0$ for t*, we find the time it takes to reach the deflection point (i.e., the number of months since the beginning of the drop of IR when the depletion rate starts declining). We label t* as the speed's turning point since the beginning of IR falls. Adding

t* to the beginning time of the IR falls, we find the time when the IR depletion start losing speed and slow down, labeling it "MTP". For most of the countries, MTP is around 8 to 10, which means that the turning point in the rate of IR depletion occurred between Aug to Oct. 2008.

[Insert tables 5]

2.2 Regression Results

Table 5 reveals that different countries start to lose IR from different times. We turn now to identify the factors that determine the starting time of IR loss for these large IR loss countries. We use length -- the number of months since the IR start to fall, as our dependent variable. Table 6 presents the regressions that have significant results in this analysis. For all the explanatory variables we tried, 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 will have a smaller "length" value, which means their IR loss started later. This is consistent with the fact that oil price started falling only when the perception of recession hit the market, around Aug. 2008. Exchange rate volatility has a significant negative sign with *length*, indicating the tradeoff between tolerating exchange rate movements and IR adjustment. Financial openness, trade openness and country size have significant sign when we include them all in the regression, but these relationships are not robust when we include only one of them.

[Insert tables 6]

Table 7 reports the regression results using MTP (IR depletion's turning point month) as our dependent variable. The table validate that countries that have earlier started depleting their IR sooner had an earlier turning point (see the negative sign on the coefficient of *length*). Capital market openness has a positive sign in our regression, indicating that more financial open economy will have a later turning point (but this coefficient is statistically significant only when we include country size in the regression). Other variables are mostly insignificant when we control for *length*.

[Insert table 7]

Tables 8 and 9 report the regression results on the size of IR loss.

[Insert tables 8 and 9]

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 loss, is positively related to the magnitude of IR changes. The earlier the countries start to loss IR, the larger are the total IR loss during our sample period. Table 9 presents the regression results on the relative IR position changes (d.rir). Similar to table 3, trade openness no longer show significance in our regression, but oil export ratio is still significant. Overall, trade related factors are the only significant factors in regressions for this small sample.

Table 10 reports panel data regressions of monthly reserve changes during the crisis. In addition to the variable used before, we add three new variables: monthly changes of oil price (d.oilprice), monthly percentage trade surplus/GDP (tsurplusgdp) and normalized exchange rate changes (norexgrowth)[11]. We use two measures of the independent variable: monthly changes in IR relative to a country's GDP size (md.ir_gdp) and the monthly changes in IR relative a country's highest IR level in the sample (md.rir).

[Insert table 10]

The first column is using the OLS method, and the second column reports the random effect regression. The third column reports the random effect regression, including the 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. Historical exchange rate volatility is significant in the third column but not in the first two, while trade surplus and changes in exchange rate are insignificant. In the next three columns we apply the same

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

methods to the monthly IR changes relative to the initial IR level at July 2008 (md.rir). Similar to 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 we got before. Trade related factors, especially those related to the oil export, have a huge impact on the size of reserve loss. Financial market related factors have some impact on IR losses, but not as significant as those related to trade.

3. Concluding remarks

Our paper suggests that there exist clear structural difference in the pre-crisis demand for IR between EMs that were willing versus those that were unwilling to spend a sizable share of their IR during the first phase of the 2008-9 crisis. Trade related factors seem to be much more significant in accounting for the pre-crisis IR level of the countries that experienced a sizable depletion of their IR in the first phase of the crisis, in line with the buffer stock interpretation of the demand for IR [see Frenkel (1983), Edwards (1983) for further discussion of this buffer stock view]. Financial factors seem to be more prominent in accounting for the pre-crisis IR level of countries that refrained from spending their IR in the first phase of the crisis.

Prior to the crisis, observers viewed hoarding IR as reflecting several motives, including the "fear of floating" [Calvo and Reinhart (2002)]; precautionary and/or mercantilist motives [Aizenman and Lee (2007, 2008)]. Yet, during the "flight to quality," and the deleveraging from EMs observed in the first phase of the crisis, "fear of losing IR" played a key role in shaping the actual use of IR by EMs. Countries that depleted their reserves in the first phase of the crisis, refrained from drawing their IR below a 1/3 of the pre-crisis level, with the majority using less than a ¼ of their pre crisis IR. Countries whose pre crisis demand for IRs was more sensitive to financial factors, refrained from using IR altogether, preferring to adjust through larger deprecations. Both patterns may reflect the fear that dwindling IR may induce more destabilizing speculative flows.

These findings raise new questions. More work is needed to understand why countries differ in the weight assigned to financial versus commercial factors, in accounting for their demand for IRs. Intriguingly, the average exchange rate depreciation rate from 8-08 to 2-09

was about 30% in both EMs that depleted their IR and those that refrained from depleting IR. 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 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 using only 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-mid 2000s, hoarded IRs due to precautionary motives, as self insurance against sudden stops, and deleveraging crises. Yet, the crisis suggests that for this self insurance to work, it may require levels of IR comparable to a country's external financial gross exposure [see Park (2009) analyzing Korea's challenges during the crisis]. In these circumstances, countries may benefit by invoking "soft capital controls" in the form of Pigovian taxes.[12] A possible interpretation for the fear of losing IR is the "keeping with the Joneses IRs" motive – the apprehension of a country that by reducing its IR/GDP below the average of its reference group, might increase its vulnerability to deleveraging and sudden stops [see Cheung and Qian (2009) for "keeping with the Joneses IRs" evidence dealing with East Asia]. These factors suggest a greater demand for regional pooling arrangements and swap lines (see 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.

[12] 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.

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Figure 1. Emerging Markets International Reserves (IR)

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

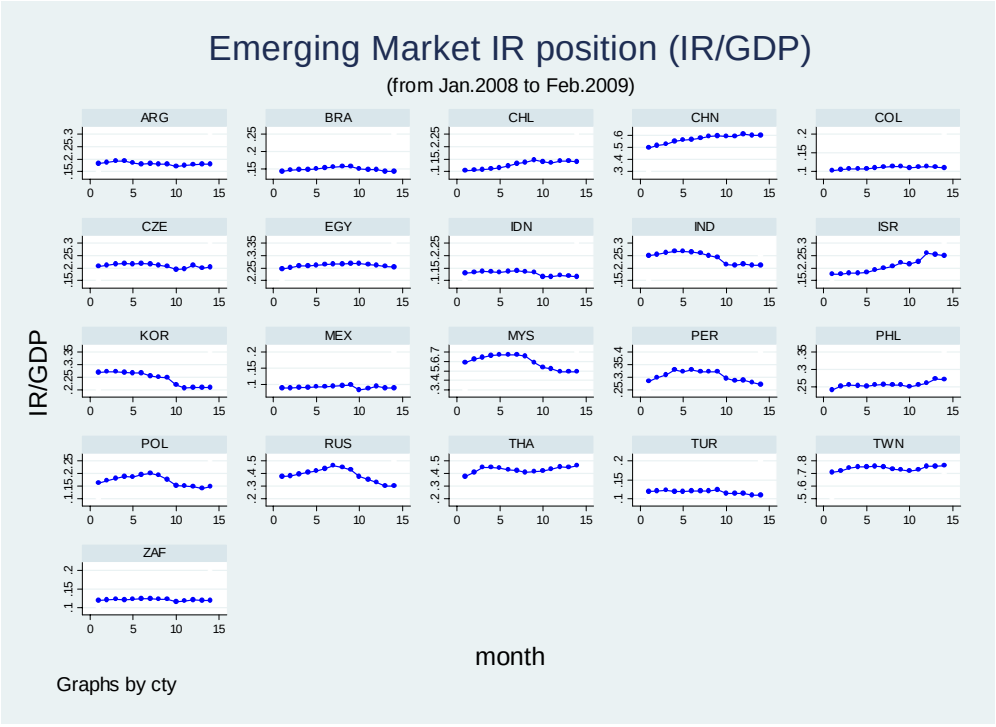


Figure 1.b IR/MaxIR, identical scale for all countries

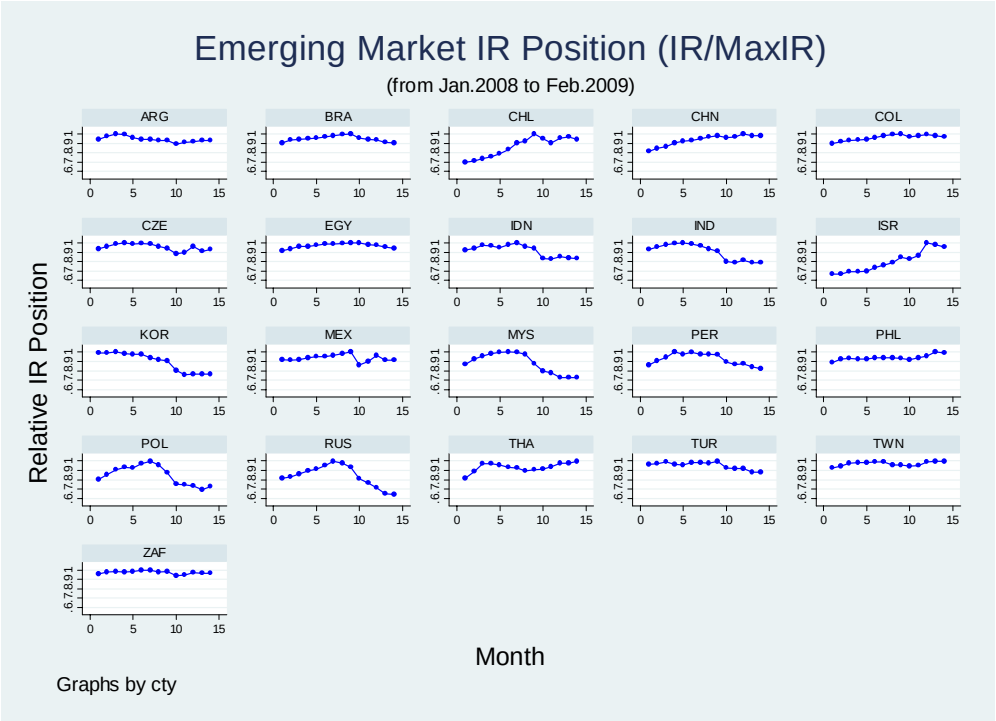
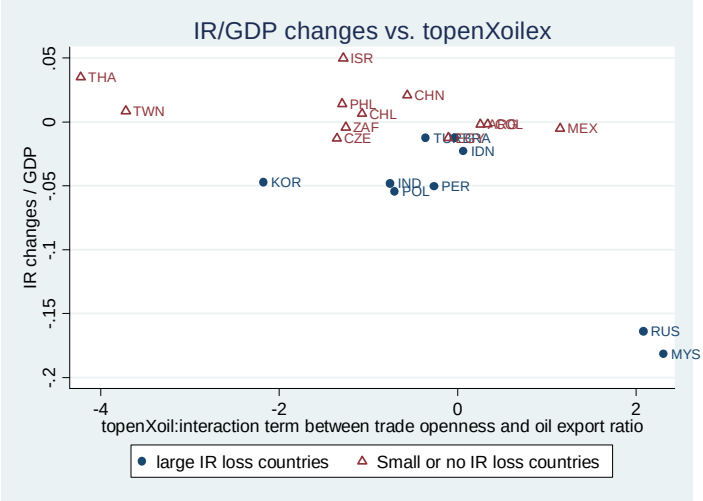
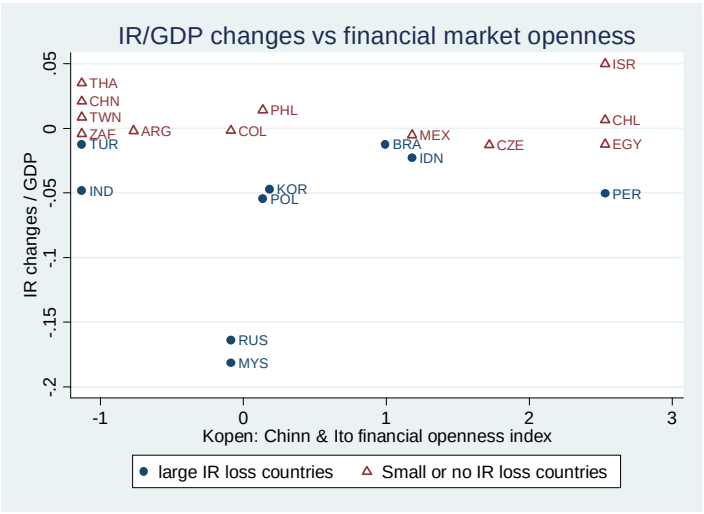


Figure 2 Regression on IR/GDP changes since July 2008

2.a



2.b



2.c

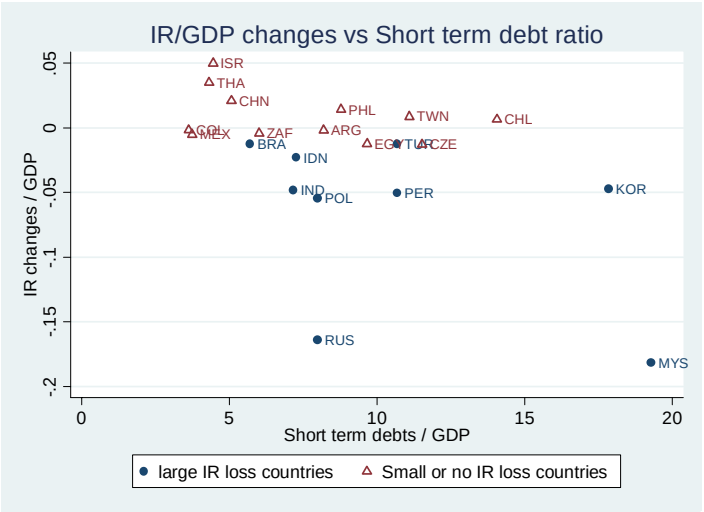
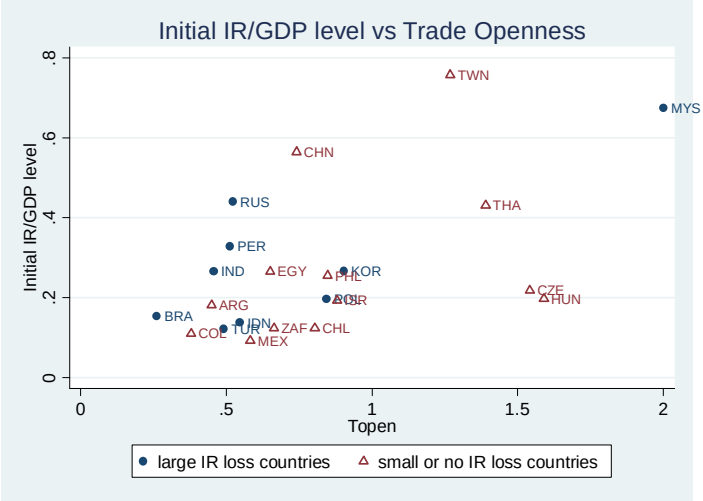
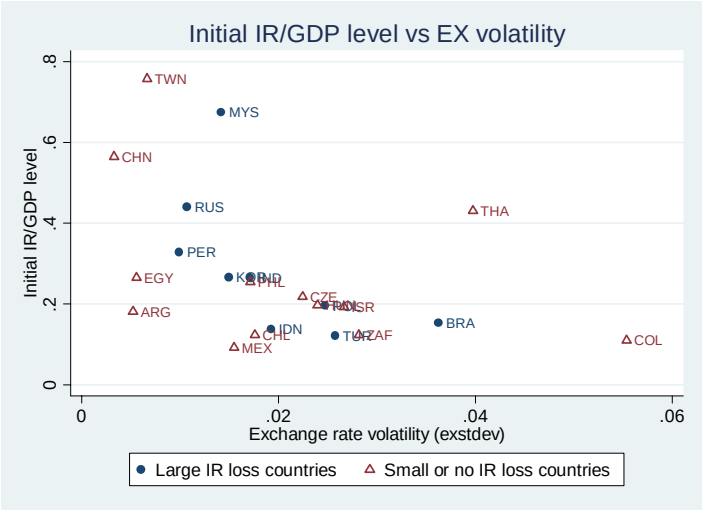


Figure 3 Regression on IR/GDP level at July 2008

3a.



3.b



3c

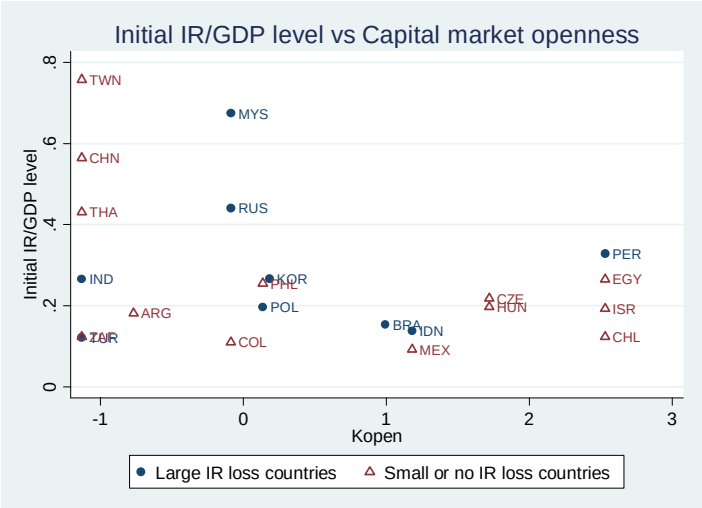


Figure 4.

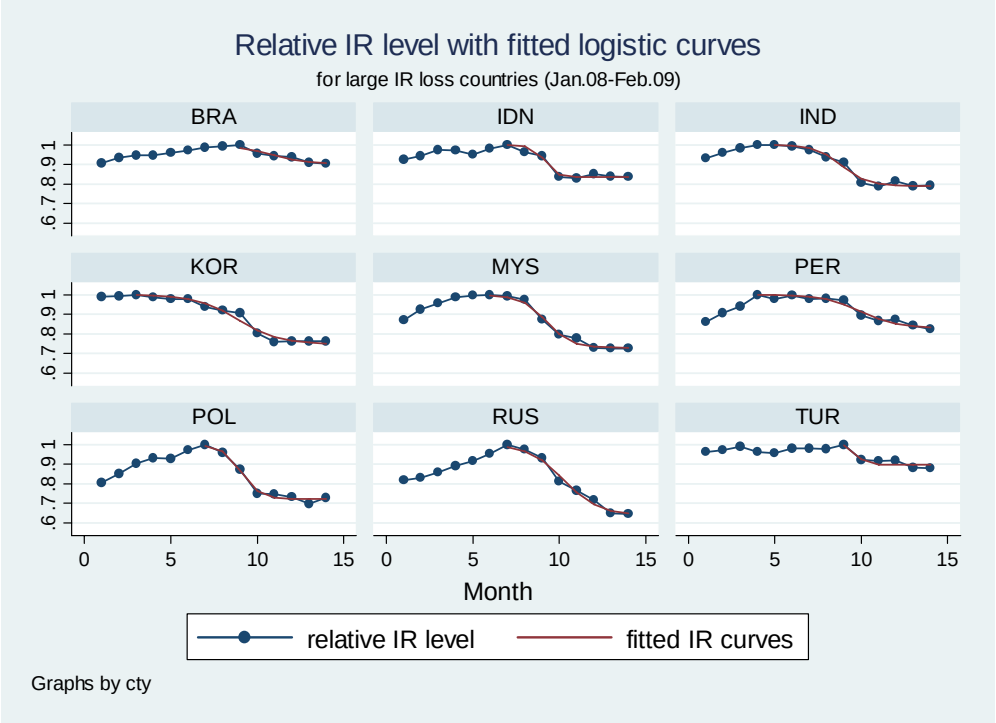

Relative IR level with fitted logistic curves
for large IR loss countries (Jan.08-Feb.09)
BRA
IDN
IND
KOR
MYS
PER
POL
RUS
TUR
.6 .7 .8 .9 1
0 5 10 15
Month
relative IR level
fitted IR curves
Graphs by cty

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.

Figure 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) 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*	-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.