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International Reserve Management and Firm Investment in Emerging Market Economies

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Agenda

We study the effects of active international reserve management (IRM) conducted by central banks of emerging market economies (EMs) on firm investment in the presence of global financial shocks.

Using firm level data from 46 EMs from 2000 to 2018, we find:

1. Active IRM is associated with higher firms' investment. The effect strengthens with the magnitude of adverse external financial shocks.

2. Financially constrained firms, compared to unconstrained ones, are less responsive to active IRM.

3. We quantify the effect of IRM on firm investment and find that 30% of it is mediated through the country sovereign spread channel.

4. Capital controls and exchange rate management complement the IRM. It is beneficial to form a macro-management mix that includes IRM to safeguard firm investment against global financial shocks.

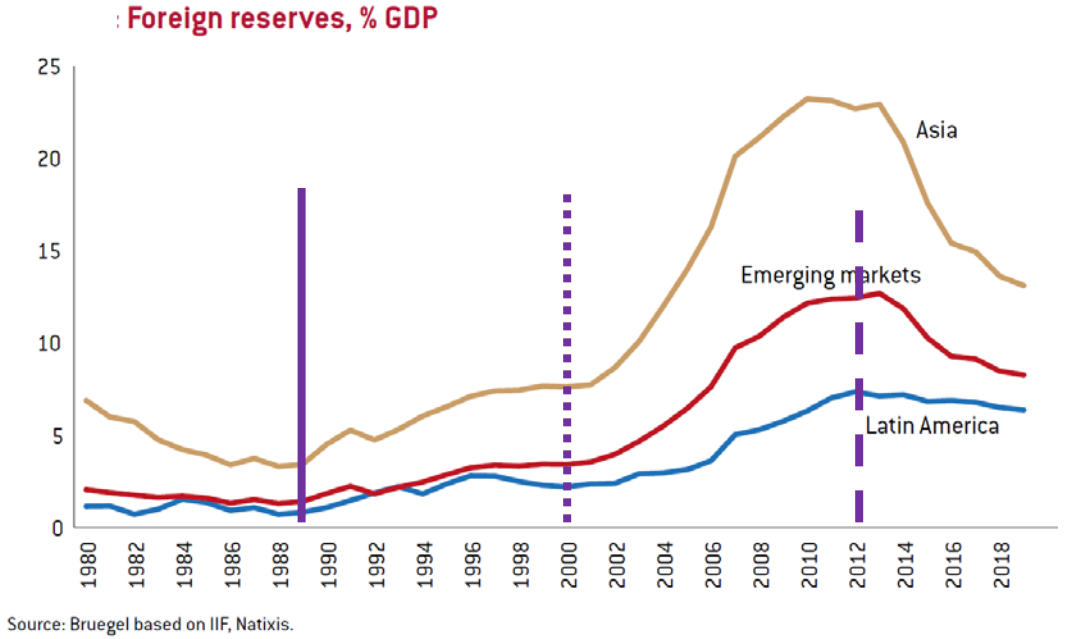
5. VAR country-level data affirms a significant ‘Granger causal’ effect of the IRM on investment at the macroeconomic level.

Background

- Sudden spikes of global financial risk may trigger capital flow reversals from EMs, credit supply crunches, widened credit spreads, plunges in investment, and heightened odds of debt crisis.

- In order to minimize the costs of risk-off capital flight crises, EMs’ central banks may implement IRM strategy akin to a ‘leaning against the wind’ policy – accumulating International reserves (IR) in good times and selling them in challenging or crisis periods to provide a buffer against financial instability.

The big picture: Active management of IR/GDP provides EMs with insurance services against external funding shocks.
Counter cyclical management of IR reduces the volatility of the REER, may increase growth, and may be used strategically for 'mercantilist' purposes, mitigating REER appreciations.

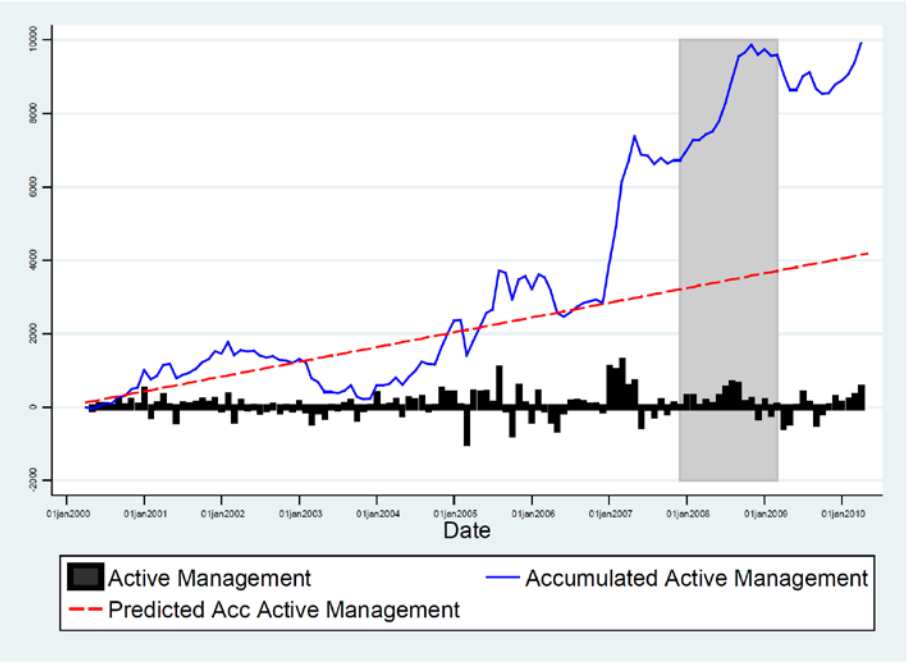


Source: Bruegel based on IIF, Natixis.

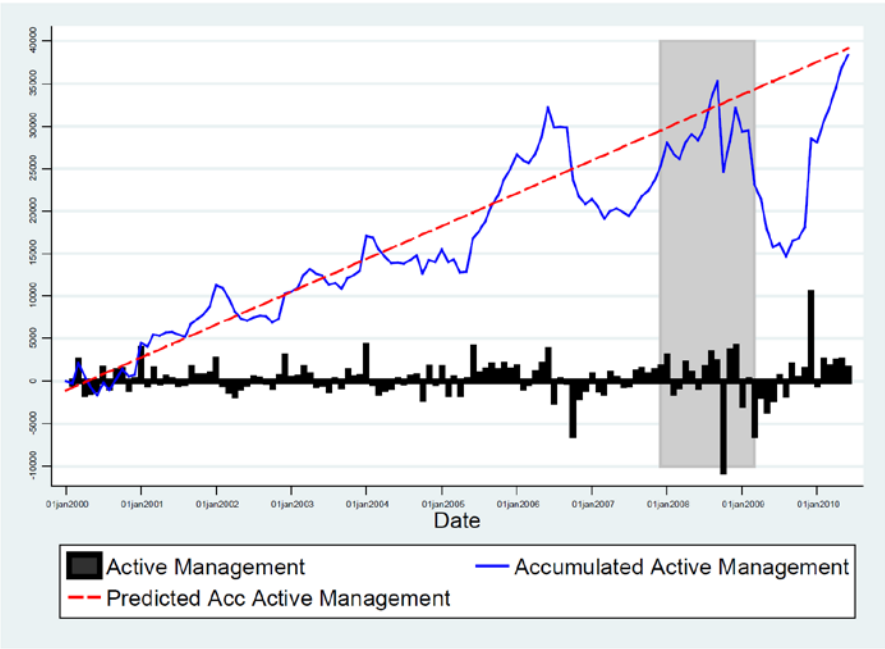
Methodology

- We apply a Tobin-Q investment framework and use annual data for 19,715 publicly listed firms in 46 EMs from 2000 to 2018.
- Because of the absence of official data, we construct 5 alternative measures of active IRM. Two measures are based on the simulation approach of Dominguez et al. (2012); Three measures are derived from the detrended official IR data from IMF.
- **Identifying active IR management** **Dominguez et al. (2012):**

A useful benchmark paper identifying active IR management, i.e., discretionary change of IR, see the black bars for Columbia and Mexico



Columbia



Mexico

- Changes in the VIX index (ΔVIX) are a proxy for global financial shocks. We use OLS regressions with several strategies to identify the causal effect of IRM on firm investment. One strategy is based on instrumental variable (IV).
- We find that one percentage increase in active IRM is associated with extra 2% firm investment in EMs.

- Next, multiplicative regression setup (Brambor *et al*., 2006) is used to study the individual and interaction effects of IRM and global financial shocks (ΔVIX) on firm investment. In the presence of an adverse global financial shock, the marginal IRM effect increases with the magnitude of the adverse shock. If the global financial shock is unfavorable, the marginal IRM effect increases with the magnitude of the bad shock.
- To assess the implications of a firm's financial conditions, we measure financial constrains in 3 way:

(1) Access to external financing (Rajan and Zingales, 1998),

(2) Tangible assets coverage (Claessens and Laeven, 2003),

(3) The shadow cost of external financing (Whited and Wu, 2006).

- We find that financial constraints weaken firm's response to IRM policy; the average positive effect of IRM on firm investment in financially constrained firms is 32% of unconstrained firm.
- About 30% of the IRM effect is channeled through sovereign spreads - A high level of IR supporting IRM alleviates the impact of global financial shocks on sovereign spreads.
- Countries with capital controls, compared to those without, display a higher IRM effect on firm investment.
- The combination of flexible exchange rate with capital controls substantially enhances the effect of IRM on firm investment -- a coordination among these macro-management measures provides more efficient insulation of investment from global shocks.

- Country-level VAR reveal the positive effect of active IRM on aggregate investment - EMs on average increase their aggregate investment per GDP by 0.3 percent in two years in response to a one-standard deviation increase in active IRM, consistent with Granger causal effect of IRM on firm investment.

Data Measurements for Key Variables

We use several methods for estimate active IRM.

1. Simulation method that follows Dominguez et al. (2012), who calculating IRM by subtracting the simulated passive management portion from the total change in international reserves. This simulated IRM, is scaled by GDP in current US $.

2. We extend Dominguez et al. approach by adjusting for the valuation effect estimated by the currency composition of IR to create the second IRM measurement.
3. We use regressions to detrend the international IR data; the remainder is the IRM active management components (a linear time trend; a time trend with a structure break at the 2008 GFC; and a time trend after the IR data has been adjusted for valuation effects. The detrended IR are then scaled by GDP).

Measurements for global financial shocks

1. ΔVIX, the percentage change of the VIX index.
2. Changes in the intra-annual volatility compiled from daily S&P 500 index, a measure for of perceived volatility, Merton (1980).
3. A more globalized “risk-on/risk off” (RORO), following Chari et al. (2020), by extracting the first principal component of the daily data across several major asset markets.
4. A percentage changes of the Federal fund rate as an alternative measurement for global financial shocks to EMs.
5. The US news-based index of monetary policy uncertainty (MPU) of Baker et al. (2016).

The base model to identify the IRM effects on firm investment

We apply a version of the Investment-Q framework (Hayashi, 1982; Eberly et al, 2009)

$$Invest_{i,t} = \alpha + \mu_j + \theta_t + \beta_1 IRM_{c,t} + \beta_2 \Delta VIX_t + \gamma X_{c,t} + \delta Z_{i,t} + \varepsilon_{i,t} \quad (1)$$

$Invest_{i,t}$ = firm investment. $\frac{Captial\ expenditure_{i,t}}{Total\ Assets_{i,t-1}}$, the ratio of firms' capital expenditure on plants, properties, and equipment to total assets at the beginning of the year; *c*, *i*, and *t* are index country, firm, and year, respectively. We control for time-invariant fixed effects: country, industry sector (SIC-3 digit), and firm effects (in

μ_j). We include year dummies for unobserved factors that vary across year but are fixed across firm. The year effect is θ_t.

Other controls: Real GDP growth rate ($RGDPG$); investment risk profile ($Risk\ profile$) for the institutional risk of domestic investment; ICRG "investment risk profile" index -- contract viability, profits repatriation, and payment delays.

- Firm specific factors affecting firm investment behaviors, in $Z_{i,t}$:

  1) Tobin's Q
  2) cash flow from operations (*CF*),
  3) firm size (*Size*), represented by total assets,
  4) sales growth rate (*Sales growth*).

- We estimate (1) on annual data using pooled OLS regression controlling for country, industry sector, firm and year effects.

- We exclude financial, insurance, real estate, public administration, non-classifiable industry sectors in SIC system, and countries that have less than 15 listed companies from the dataset. To minimize data errors and outliers we winsorize the investment variable at the 1st and 99th percentiles

Results

- Active reserve management ($IRM_{c,t}$) is positively associated with firm investment; one percentage increase in IRM is associated with 2% increase in firm investment in EMs.
- Higher real GDP growth and lower institutional risk promote firm investment in EMs. Firms characterized by high Tobin's Q, higher

cash flows generated from operations, larger size, and higher sales growth rate are found to invest more.

- (1) may estimate the correlation between IRM and firm investment, rather than the causal effect of IRM due to endogeneity issues. **We address these issues in 3 ways.**

1. We lag the IRM variable one year to create a predetermined IRM variable to run the regression.
2. We generate IRM variable purged of plausible common factors that affect both IRM and investment simultaneously (relative income levels, net capital inflows, competitive depreciation to maintain exports advantage). The re-estimated IRM is significant and higher.

3. We adopt the IV approach to isolate the causal effect of IRM on firm investment from other factors. The IRM effect is larger compared to that of the OLS regression.

- The positive effect of IRM is robust to the use of predetermined IRM, the IRM purged common factors, and the IV approach that addresses endogeneity.

The interaction between IRM and global financial shocks

We augment Equation (1) with $IRM_{c,t} \times \Delta VIX_t$, specifying a multiplicative regression (Brambor et al., 2006):

$$Invest_{i,t} = \alpha + \mu_j + \theta_t + \beta_1 IRM_{c,t} + \beta_2 \Delta VIX_t + \beta_3 IRM_{c,t} \times \Delta VIX_t + \gamma X_{c,t} + \delta Z_{i,t} + \varepsilon_{i,t} \quad (2)$$

Both β_1 and β_3 are positively and significantly. The marginal effect of IRM is 0.02+0.056*ΔVIX_t, hence IRM is positively associated with firm investment, and the total effect depends on global financial shocks.

In the presence of a one-standard-deviation adverse financial shock (0.28), a one percent increase in IRM is associated with about 3.6% higher firm capital expenditure to total assets ratio.

Example For the median size firm in the median GDP country, The Philippines, a one billion US dollar active IR accumulation is associated with about 1.07 million more firm investment in the presence of one standard deviation VIX shock. For the 222

Philippines firms in our data sample, the aggregate effect of one billion IRM is about 238 million more investment.

Firm heterogeneity in financial frictions

Next, we augment Equation (2) with a firm level financial constraint variable, $FinCnstr_{i,t}$, and its interaction terms with IRM, ΔVIX, and $IRM_{c,t} * \Delta VIX_t$.

The estimated equation is

$$Invest_{i,t} = \alpha + \mu_j + \theta_t + \beta_1 IRM_{c,t} + \beta_2 \Delta VIX_t + \beta_3 IRM_{c,t} * \Delta VIX_t + FinCnstr_{i,t} * \left(\theta_1 + \theta_2 IRM_{c,t} + \theta_3 \Delta VIX_t + \theta_4 IRM_{c,t} \times \Delta VIX_t\right) + \gamma X_{c,t} + \delta Z_{i,t} + \varepsilon_{i,t} \quad (3)$$

Financial constraint measures:

1. ***external financing / capital expenditure*.** A dummy is assigned value 1 is when this ratio is **smaller** than the average ratio of the SIC-3-digit-sector. Otherwise, value 0.

2. **the ratio of tangible assets / long-term liabilities**. A dummy is assig 1 if this ratio is less than the country-industry sector (SIC 3-digit) average ratio. Otherwise, 0.

3. **The shadow cost of external financing,** Whited and Wu (2006)'s financial constraint index. A dummy is assign 1 if firm's the shadow cost is higher than the country-industry sector (SIC 3-digit) average level; otherwise 0.

Results.

The investments of financially constrained firms are less responsive to IRM than those of unconstrained firms. A financially

constrained median size firm invests **0.6 million** in response to a 1 billion US dollar increase in IRM when there is a one standard deviation global financial shock. The median size unconstrained firm responds to IRM by investing as much **1.9 million** US dollars. Similar results are estimated with the other two measures.

A plausible causal channel – IRM and sovereign spreads

Active IRM may lower country spread, a component of a firm's finance cost. We adopt the mediation analysis approach (Krull and MacKinnon, 2001; Imai et al., 2010). We estimate the mechanism through which 'an intervention' (the active IRM) affects an 'outcome' (firm's investment).

We use the J.P. Morgan Emerging Market Bond Spread Index (EMBI+). Since our data have two levels, the country and the firm, we use Krull and MacKinnon's (2001) multilevel mediation regression that allows firm data to cluster at the country level and accounts for within-country homogeneity in the error terms:

$$Country\ spread_{c,t} = \alpha + \mu_c + \theta_t + \beta_1 IRM_{c,t} + \beta_2 \Delta VIX_t + \beta_3 IRM_{c,t} * \Delta VIX_t + \gamma_1 X_{c,t} + \varepsilon_{c,t} \quad (4)$$

We include IRM, ΔVIX, their interaction terms; two macro factors, *RGDPG* and *Risk profile*; and the country (μ_c) and year effects (θ_t) as the determinants of country spreads.

$$Investment_{i,t}$$

$$= \alpha + \mu_j + \theta_t + \beta_4 IRM_{c,t} + \beta_5 \Delta VIX_t + \beta_6 IRM_{c,t} * \Delta VIX_t$$

$$+ \tau \widehat{Country\ spread}_{c,t} + \gamma_2 X_{c,t} + \delta Z_{i,t} + \varepsilon_{i,t} \qquad (5)$$

Equation (5) augments Equation (2) with the mediator variable, $\widehat{Country\ spread}_{c,t}$. Due to endogeneity concerns, we do not directly include the $Country\ spread_{c,t}$. Rather, we obtain the error terms of Equation (4) that are orthogonal to $IRM_{c,t}$, ΔVIX_t, and $IRM_{c,t} * \Delta VIX_t$, label it as $\widehat{Country\ spread}_{c,t}$ and add it to Equation (5). Other variables, as well as the country, industry sector, firm and year effects are same as in Equation (2). The average causal mediation effect (ACME) that mediated through country spreads is

captured by $\beta_1 * \tau$. The percentage of total effect of IRM on firm investment is explained by the ACME is $\beta_1 * \tau / (\beta_4 + \beta_1 * \tau)$.

Results (Table 4) We find a significant causal effect of IRM on firm investment through country spreads, about 30% of the total effect.

Additional Analyses

We test the sensitivity of our results to:

1) alternative measurements of IRM.

2) alternative measurement for global financial shocks

3) different data samples.

Overall, these results do not materially change.

Extraordinary shocks: The 2008 global financial crisis and the Federal Reserve's "taper tantrum"

Both the 2008 global financial crisis and the Federal Reserve's "taper tantrum" triggered substantial global financial uncertainty.

We evaluate the impact of the 2008 financial crisis and the Fed's taper tantrum in 2013 on firm investment by creating an index variable, *Crisis&Taper* (= 1 if year = 2007, 2008, 2009, 2013, 2014; otherwise, 0) and repeat regressions (2) to examine the effect of IRM in the presence of extraordinary financial shock events.

The results are remarkably similar to those in other columns. We show that IRM positively affect firm investment in non-2008 crisis and taper tantrum periods. This positive effect is substantially higher during, more than doubled during the 2008 financial crisis

and the Fed's taper tantrum when the global financial risk level was extraordinarily high.

Possible sample selection bias

- We include all firm samples from any available emerging economies in the Worldscope database.
- We run regressions with 50 largest firms (largest average total assets in sample periods) of each country to reduce the dominance of countries that have a large number of publicly listed firms.
- We identify 4304 non-survivor firms and run a regression on them to test the robustness of our previous results.

Overall, regressions using different firm samples yield results comparable to that of Table 2.

- Notably, large firms are less responsive to IRM as they might have more tools to hedge financial instability.
- Non-survivor firms do not significantly respond to active IRM as the IRM. Perhaps due to firm's specific dire situation, these firms have to reduce investment even when the financial system is stable and the economic outlook is good.
- For firms that only invest domestically, we find that these firms are highly responsive to active IRM.
- Commodity country firms seem to be more responsive to active IRM and global financial shocks than other firms. Adding ΔCTOT amplifies the buffer stock role of IRM.

Coordination with Capital Controls & Exchange Rate Regimes

We examine how the effect of IRM on firm investment in EMs may differ among countries that manage capital controls or adopt a flexible exchange rate regime from those do not have capital

controls or with a pegged exchange rate regime. We augment Equation (2) with capital controls or/and exchange rate regimes:

$$Invest_{i,t} = \alpha + \mu_j + \theta_t + \beta_1 IRM_{c,t} + \beta_2 \Delta VIX_t + \beta_3 IRM_{c,t} \times \Delta VIX_t + MacroMNGM_{c,t} * (\varphi_1 + \varphi_2 IRM_{c,t} + \varphi_3 \Delta VIX_t + \varphi_4 IRM_{c,t} \times \Delta VIX_t) + \gamma X_{c,t} + \delta Z_{i,t} + \varepsilon_{i,t} \quad (6)$$

where $MacroMNGM_{c,t}$ includes variables that measure whether a country has capital controls or adopts flexible exchange rate regime, or both. Other independent variables are the same as in Equation (2). We follow the heterogeneity-based difference-in-difference methodology and use dummy variables that categorize

countries with capital controls or the implement flexible exchange rate regimes.

Results

- Countries that impose capital controls are found to invest more.
- The effect of IRM in the presence of global financial shock impact is stronger in countries with capital controls than in those without.
- IRM has a positive effect on firm investment in countries with a pegged exchange rate system. There is more firm investment in countries with flexible exchange regimes. Perhaps IRM plays an important role in maintaining financial stability regardless of exchange rate arrangements.

- A flexible exchange rate help to insulate adverse global financial shocks on firm investment.
- IRM effect, when together with capital controls, they substantially enhance the roll of IRM to promote firm investment. These results may imply that a well-coordinated macro-management tool mix is more effective in insulating adverse global financial shocks.

Macroeconomic Significance and the Granger Causality

We use a structural VAR model to study the Granger causal effect among IRM, external shocks, country spreads, and investment in country-level annual data of 55 EMs, 2000 – 2018. Aggregate investment is proxied by gross fixed capital formation/GDP. The VAR model is:

$$Y_{c,t} = \{\Delta VIX_t, IRM_{c,t}, Country\ spread_{c,t}, Aggregate\ investment_{c,t}\} \quad (7)$$

where $Country\ spread_{c,t}$ is EMBI+ spread. The order of the variables follows Bloom (2009). We find a positive effect of active IRM on aggregate investment - EMs on average increase their aggregate investment per GDP by 0.3 percent in two years in response to a one-standard deviation increase in active IRM. The results confirm a Granger causal effect of active IRM on investment at the macroeconomic level.

Concluding Remarks

We confirm that IRM provides useful stabilization services, increasing private investment. This effect can be asymmetric; a high level of IRs probably more relevant during crisis periods than normal ones, and a low level can limit the ability to conduct active IRM during a crisis. Yet, hoarding excessive IR in good times may backfire, leading to moral hazard concerns, at significant opportunity costs. These and other related issues are left for future research.

Thanks for your attention!

VAR results: The country spread responds to the VIX spike by widening about 1.5 percent of interest rate spreads. By contrast, the aggregate investment does not respond to the VIX shock immediately; rather, it takes the aggregate investment two years to respond to a one-S.D. spike of global financial shocks by reducing investment about 0.4% of GDP.

In response to a one-S.D. increase in active IRM, EMs boost their aggregate investment by 0.3% in two years. In responding to a positive shock in active IRM, country spreads are found to narrow about 0.9% immediately. These results suggest that adverse global shocks and active IRM impose opposite effects on country spreads and that IRM offsets the adverse effect of global financial shocks in determining the level of country spreads, other things being equal.

EMs reduce about 0.2% aggregate investment in response to a one-S.D. widening shock in their country spreads.

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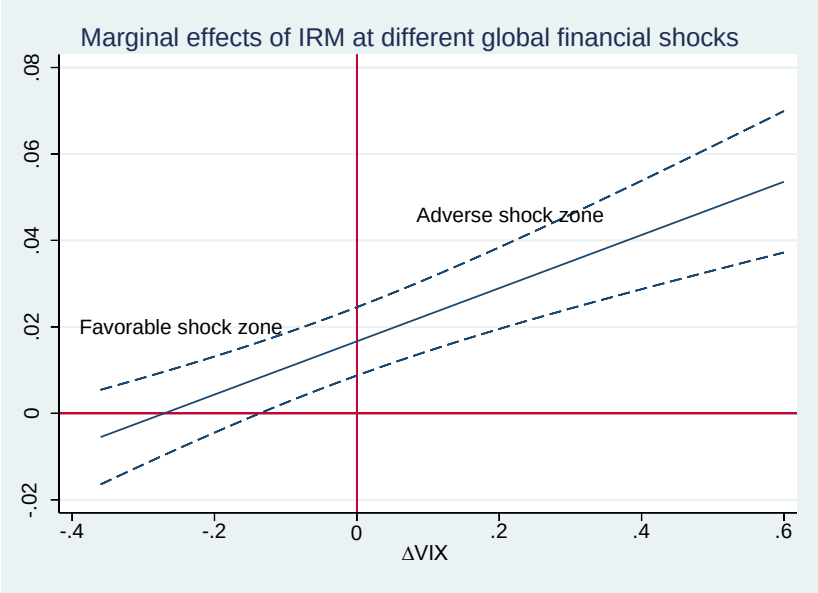
Figure 1: The marginal effects of IRM and ΔVIX on firm investment in the multiplicative model



Notes: The upper figure shows the marginal effects of IRM on investment (y scale) at various level of ΔVIX (x scale). Dashed lines plot 95% confidence intervals.
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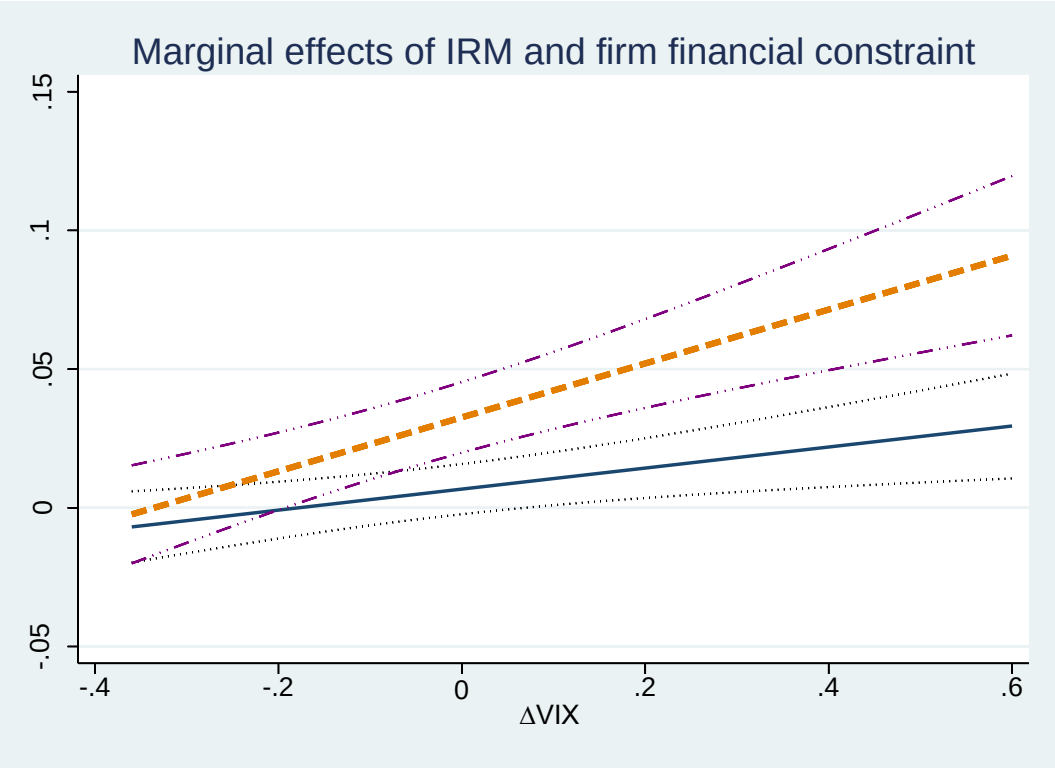
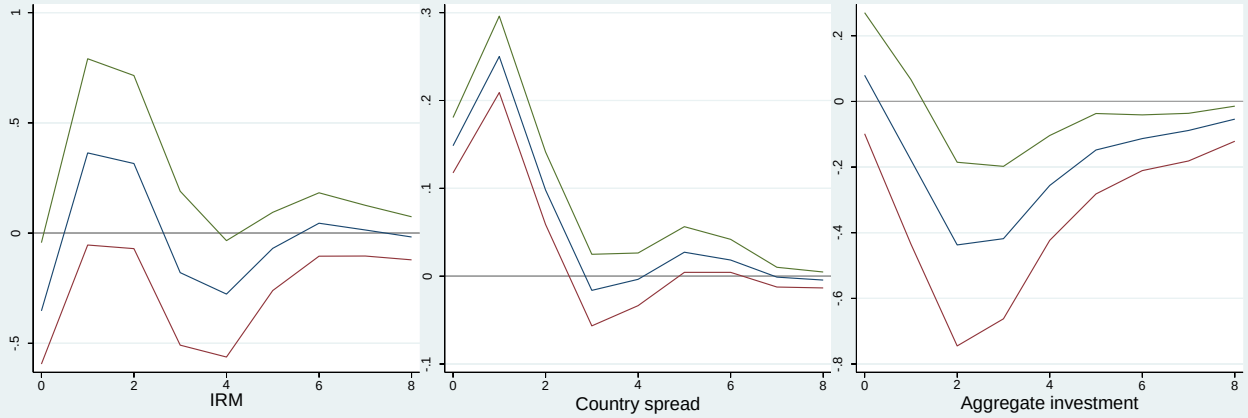
Figure 2: The differed marginal effects of IRM and ΔVIX - financially constrained versus unconstrained firms



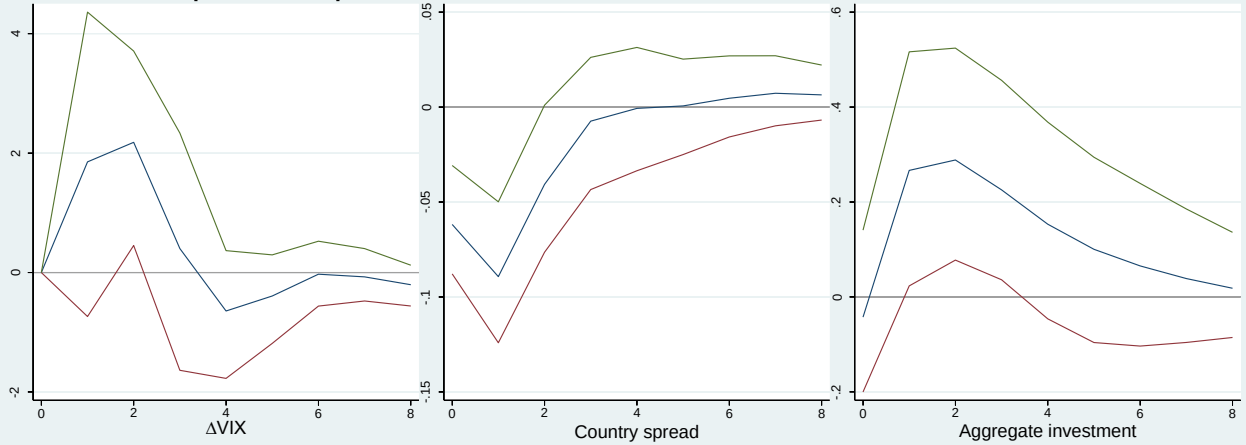
Notes: Solid lines plot marginal effects in financially constrained firms and dashed lines plot marginal effects in financially unconstrained firms. Dot lines are 95% confidence intervals.

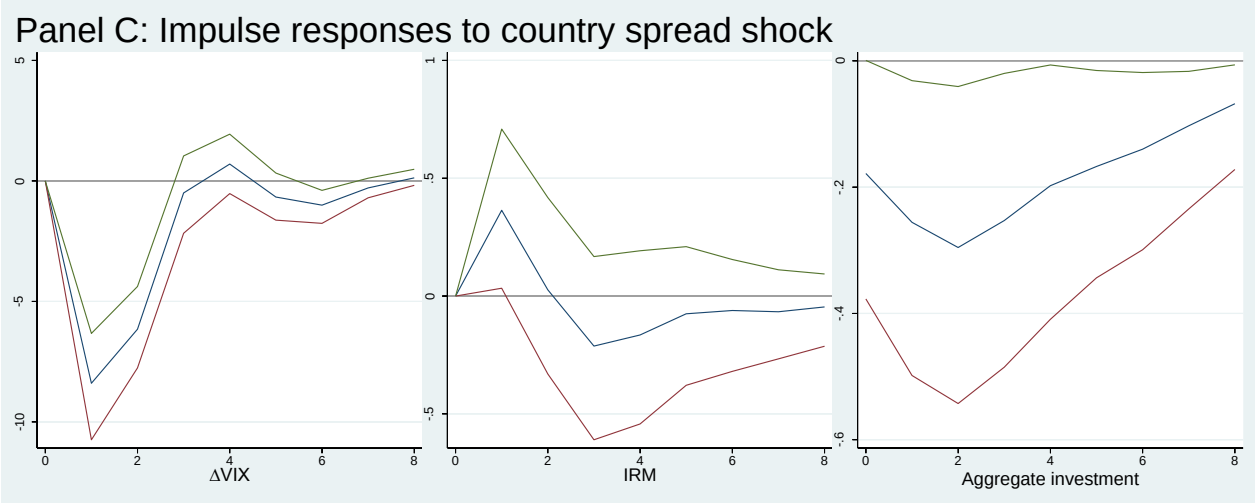
Figure 3: The IRF of ΔVIX, IRM, country spreads, and aggregate investment

Panel A: Impulse responses to ΔVIX shock



Panel B: Impulse responses to IRM shock





Notes: This figure reports impulse response to one standard deviation of Cholesky shock with 95% confidence intervals.