Unveiling the Effects of Foreign Exchange Intervention: A Panel Approach

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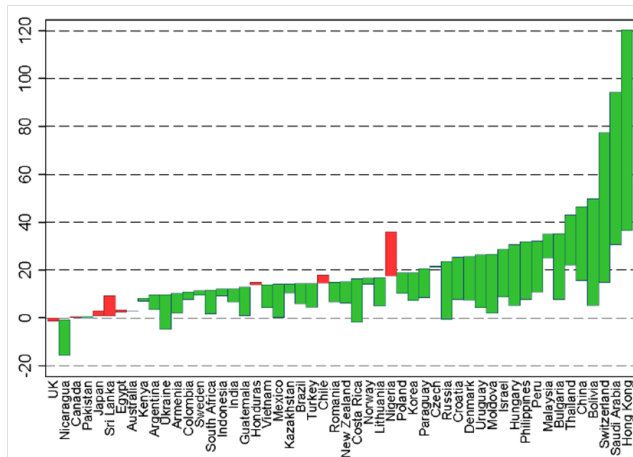[*] International Monetary Fund   [†] European University Institute

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Central Banks have accumulated large FX positions

Central Bank Net Foreign Asset Position, 1996-2013
(*percent of GDP*)

Green (red) bars indicate an increase (drop) in the NFA position during the period. The lower end of the bar indicates the initial position, and the upper end the final position, for the cases of NFA increases; and the opposite for NFA decreases.

FXI Literature: clear channels, mixed evidence

- Theoretical channels are well identified
  - Portfolio balance: Henderson and Rogoff (1982), Kouri (1983), Kumhof (2010), Gabaix and Maggiori (2015)
  - Signaling: Mussa (1981), Sarno and Taylor (2001)
  - Microstructure: Lyons (2006) and Reitz and Taylor (2006)

- Empirical evidence mixed, macro-relevance? [Sarno and Taylor (2001) and Menkhoff (2013)]
  - Early focused on AEs: limited, short-lived effect - Dominguez (1990 and 1998); Dominguez and Frankel (1990, 1993a,b,c), and Ghosh (1992)
  - Later focused on EMEs: Mixed evidence - recent examples are Dominguez, Fatum and Vacek (2013); Daude et al (2014); Fratzscher et al (2015)
  - Mostly based on high frequency data, event studies

This paper: Question and Main Findings

Question: **Is FX intervention effective in moving the level of the exchange rate in a macro-relevant sense?**

1. Robust evidence that intervention affects the level of the exchange rate in a large panel of countries
   - buy 1% of GDP in FX $\Rightarrow$ local currency depreciates 1.4-2.0%
2. Importantly, effects are somewhat persistent
   - half-life of 12-23 months, though less than generic shock to exchange rate

This paper: Approach

Different empirical approach with advantages but also key challenges

1. Build large macro-panel to generalize results, recognize that FXI is now more widespread – but FXI data not widely available, use proxy

2. Look at lower frequency: monthly, focus on macro-relevant effects – endogeneity?

Challenge 1: Build Macro-Panel

- 52 countries: 39 EMDE, 13 AEs

- Monthly frequency, 1996-2013

- **Need proxy of FXI for such a large panel**
  - use the change in Central Bank's net foreign assets
  - adjusted for: valuation, income effects (like Dominguez 2012) and off-balance sheet operations
  - normalized by: GDP (others, robust findings)
  - defined as: positive FXI = $ purchase (local currency sale)

- Log exchange rate, increase=appreciation
  - here: real bilateral exchange rate vis-à-vis USD
  - paper: also looked at nominal bilateral exchange rate and real effective exchange rate

Challenge 2: Endogeneity
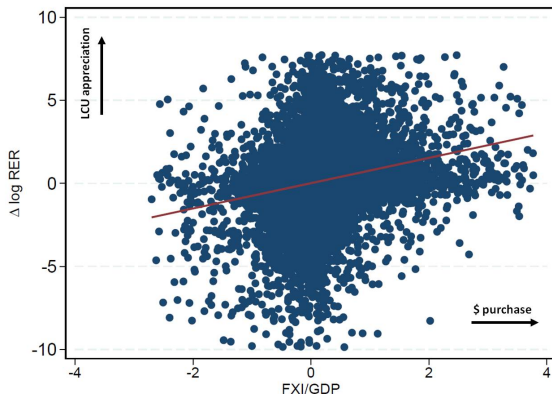
- FXI may just be responding to changes in exchange rates ("leaning against the wind")
- In that case expect a positive bias: $ purchase correlated with LCU appreciation
- Problem more serious at lower frequency

Specification

$$\log RER_{it} = \alpha + \beta \log RER_{it-1} + \gamma FXI_{it} + \delta' \mathbf{X}_{it} + \mu_i + \epsilon_{it}$$

Control variables **X**:

- VIX
- Interest rate differential vis-a-vis US
- Commodity prices (food, metal, energy) with country-specific coefficients
- Additional controls in another specification
  - GDP per capita differential vis-à-vis US
  - One-year-ahead expectations of GDP growth vis-a-vis US
  - Trade Balance and Openness
  - Exogenous EPFR capital flows

Simple FE regression: endogeneity, upward bias

	FE
FXI/GDP	**0.740*****
	(0.123)
log RER (lagged)	0.975***
	(0.004)
VIX	-0.025***
	(0.006)
Interest rate (differential)	0.212
	(0.138)
Commodity prices	Yes
Country FE	Yes
Observations	9149
Countries	52

Standard errors in parentheses corrected for heteroskedasticity, constant included not but shown

IV approach

$$\log RER_{it} = \alpha + \beta \log RER_{it-1} + \gamma \widehat{FXI}_{it} + \delta' \mathbf{X}_{it} + \mu_i + \epsilon_{it}$$
$$FXI_{it} = a + b \log RER_{it-1} + c' \mathbf{Z}_{it} + d' \mathbf{X}_{it} + u_i + \xi_{it}$$

Related to precautionary motive for reserves accumulation
(Obstfeld et al. 2010, Jeanne and Ranciere 2011)

- In general
- reserves or NFA to GDP, imports, external debt, M2
- in levels and relative to others ("Keeping up with the Joneses")
- level or change of imports, M2, external debt
- Balance sheet currency mismatches $\Rightarrow$ heterogeneous responses to exogenous shocks
- Financial dollarization (Levy-Yeyati 2006) interacted with VIX, EMBI, EPFR flows

IV approach

$$\log RER_{it} = \alpha + \beta \log RER_{it-1} + \gamma \widehat{FXI}_{it} + \delta' \mathbf{X}_{it} + \mu_i + \epsilon_{it}$$
$$FXI_{it} = a + b \log RER_{it-1} + c' \mathbf{Z}_{it} + d' \mathbf{X}_{it} + u_i + \xi_{it}$$

Criteria for inclusion

1. 1st stage coefficient sign consistent with theory when introducing each instrument separately
2. IV mitigates 2nd stage endogeneity bias
3. Specification must pass standard IV tests: over-identification (J-test) and weak instruments (Stock and Yogo (2002))

Main Results: First stage

	FXI
log RER (lagged)	-0.003**
	(0.001)
VIX	-0.005**
	(0.002)
Interest rate (differential)	-0.095**
	(0.037)
Change in M2/GDP	0.104***
	(0.022)
Findol $\times$ VIX	-0.011**
	(0.005)
Import coverage (lagged)	-0.25*
	(0.14)
Low import coverage (lagged)	0.035
	(0.042)
Broad money coverage (lagged)	-0.021
	(0.14)
Commodity prices	Yes
Country FE	Yes
Observations	9149
Countries	52
F stat	8.18

Constant included but not shown. Standard errors robust to heteroskedasticity in parentheses.

$\Rightarrow$ Expected sign on IVs

Main Results: Second stage, FE vs. IV

	FE	IV FE
FXI/GDP	0.740***	-1.430***
	(0.123)	(0.318)
log RER (lagged)	0.975***	0.966***
	(0.004)	(0.003)
VIX	-0.025***	-0.043***
	(0.006)	(0.006)
Interest rate (differential)	0.212	0.014
	(0.138)	(0.108)
Commodity prices	Yes	Yes
Country FE	Yes	Yes
Observations	9149	9149
Countries	52	52
J p-value		0.29
Stock & Yogo stat		24.25

Standard errors in parentheses corrected for heteroskedasticity,
constant included not but shown

$\Rightarrow$ IV mitigates bias, "cleans" up relation to other variables (VIX here)

Back to Challenges: Instrumentation, excluding one instrument at a time

	(1)	(2)	(3)	(4)	(5)	(6)
				Dropping from instruments:		
	Baseline	Import cov.	Broad money cov.	Fin. Dollar. $\times$ VIX	Change in M2/GDP	Change in M2 & broad money cov.
$\widehat{FXI}$	-1.430***	-1.468***	-1.424***	-1.395***	-1.771***	-1.753***
	(0.318)	(0.339)	(0.318)	(0.321)	(0.678)	(0.677)
log RER (lagged)	0.966***	0.966***	0.966***	0.966***	0.965***	0.965***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
VIX	-0.043***	-0.043***	-0.042***	-0.042***	-0.045***	-0.045***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.008)	(0.008)
Interest rate (diff)	0.014	0.011	0.015	0.018	-0.017	-0.015
	(0.108)	(0.109)	(0.108)	(0.107)	(0.122)	(0.122)
Commodity prices	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9149	9149	9149	9149	9149	9149
Countries	52	52	52	52	52	52
J p-value	0.29	0.53	0.29	0.19	0.25	0.21
Stock-Yogo stat	24.25	34.33	30.09	28.08	7.53	9.92

Standard errors robust to heteroskedasticity in parentheses

Back to Challenges: Instrumentation, only one instrument at a time

Instrumenting only with:	(1) Change in M2/GDP	(2) Fin. Dollar. $\times$ VIX	(3) Import coverage	(4) Broad money coverage
$\widehat{FXI}$	-1.310***	-1.995	-1.614**	-2.454**
	(0.359)	(1.355)	(0.741)	(1.231)
log RER (lagged)	0.967***	0.964***	0.966***	0.962***
	(0.003)	(0.006)	(0.004)	(0.006)
VIX	-0.042***	-0.047***	-0.044***	-0.051***
	(0.006)	(0.012)	(0.008)	(0.011)
Interest rate (diff)	0.025	-0.037	-0.002	-0.079
	(0.108)	(0.166)	(0.123)	(0.158)
Commodity prices	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Observations	9149	9149	9149	9149
Countries	52	52	52	52
Stock-Yogo stat	85.44	9.94	11.28	8.91

Standard errors robust to heteroskedasticity in parentheses

Main robustness tests

- FXI proxies
  - adjusting for valuation and income effects
  - adding off-balance sheet operations
- FXI normalization
  - Is GDP the "right" denominator? Size of financial sector? Market size? M2?
  - Magnitudes are comparable, but different measures don't drive-out FXI/GDP
- Other policy responses
  - Excluding periods with changes in capital controls
  - Instrumenting interest rate changes
- Dropping small FXI

Additional robustness tests

- Sample adjustments:
- dropping outliers,
- dropping the crisis period (June 2008 to May 2009),
- starting in January 2000,
- excluding de jure, de facto pegs, crawling bands, wide bands

- Controls: REER gap, country-specific coefficients for VIX, IR differential

FXI effects seem to be persistent

Add lagged values of FXI to baseline specification, up to 3 lags (based on statistical significance)

(a) NER

(b) RER

(c) REER
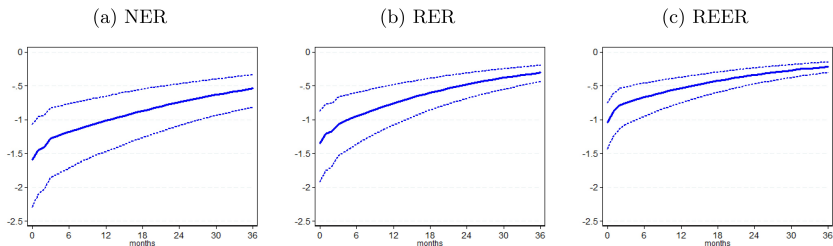
- Half Life: NER 21 months; RER 16 months; REER 13 months
- Lower persistence than average exchange rate shock: half life of 18-29 months

Final Thoughts

1. Robust evidence that FXI affects the level of exchange rate: 1% GDP $\Rightarrow$ 1.4% RER depreciation
2. Persistent effects: half-life 12-23 months
3. Panel IV setup: departure from most of the literature, advantages and disadvantages

$\Rightarrow$ showed effects on exchange rate
   - what for? lower volatility? Competitiveness?
   - or just a side product? crash insurance?