# Banking Limits on Foreign Holdings
# Disentangling the Portfolio Balance Channel

## (Exchange Rate Effects of Financial Regulation)

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# Research Objective

Analyze the effects of financial constraints on the exchange rate.

- Construct a two-period model where constraints inhibit capital flows
  - Departures from UIP explain the effects of sterilized intervention
- Empirically test this channel by using a sharp policy discontinuity within Colombian regulatory banking limits
  - Effects of limits banking limits on foreign holdings

Findings: Effects on the exchange rate are small short-lived, but magnified in periods of Central Bank intervention

# Motivation

- The "*corner* or *bipolar hypothesis*" began to lose popularity after the East Asia crises (1997-98) and the failure of Argentina's currency board (2001)

  -Eichengreen (1994), Obstfeld and Rogoff (1995)

- Since then, many central banks have opted for monetary policy autonomy (but reluctant to relinquish control over currencies)

  - Concerted initiatives include: Smithsonian Agreement (1971), Plaza Accord (1985), Louvre Accord (1987), Chiang Mai Initiative (2000) and Pittsburg Agreement (2009)

# Motivation

- The impossible trinity (*trilemma*) indicates that a country cannot
  - Allow for free capital flows
  - Have autonomous monetary policy
  - Adopt a fixed or managed exchange rate

*Policymakers can only regain control of the exchange rate if they abandon monetary policy or enact capital controls*

- In the empirical literature, there is a lack of consensus regarding the effectiveness of Central Bank intervention
  - Menkhoff (2013) and Villamizar and Perez (2015): 15/25 and 16/32 studies find significant FXI effects

# Financial Rigidities

Financial Rigidities: Limits on foreign exposure

- Colombian Banks have limits on foreign holdings
  - *PPC -Assets minus Liabilities in USD relative to total capital (Jan 2004-Oct 2015)*
- Colombian Banks are key players in COP-USD market
- When limits bind, banks are no longer indifferent between holding different currency denominated assets

# Model

Two-period Small Open Economy (exogenous $r^*$)

- Representative household (Banks)
  - Receive exogenous endowment ($A_t$) and government transfer ($\tau_t$)
  - Choose whether to save in domestic or foreign assets
  - Face limits on the amount of foreign assets

- Government (Central Bank)
  - Issues domestic debt to buy foreign assets $B^*$ (Sterilized FXI)

# Findings

Multiple equilibria

- Constraints do not bind *-UIP holds*
  - Agents are indifferent between foreign and domestic assets
  - Exchange rate does not depend on foreign assets

- Constraints bind *-UIP does not hold*
  - Household wants to save in asset with higher return until limit binds
  - Exchange rate depends on
    - FX intervention
    - Regulatory limits
  - Intervention helps overcome wedge caused by departure from UIP

# Maximization Problem

## Households

$$\max_{c_0, c_1, B, B^*} \quad U(c_0, c_1) = \ln c_0 + \beta \ln c_1$$

$$\text{s. t.} \quad c_0 + B + e_0 B^* = A_0 + \tau_0$$

$$c_1 = (1+r)B + (1+r^*)e_1 B^* + A_1 + \tau_1$$

$$\underline{B} \leq \frac{e_0 B^*}{I} \leq \overline{B} \qquad \textit{where} \qquad I \equiv A_0 + \tau_0 + \frac{A_1 + \tau_1}{1+r}$$

## Government

Budget is balanced through lump-sum transfers

$$\tau_0 \equiv B_G - e_0 B_G^*$$

$$\tau_1 \equiv -(1+r)B_G + (1+r^*)e_1 B_G^*$$

We can only pin down $\frac{e_1}{e_0}$, so we assume $e_0 = 1$

# Maximization Problem

- From Household's maximization problem:

$$1 + r = e_1 (1 + r^*) - \frac{\overline{\lambda} - \underline{\lambda}}{\beta I} c_1$$

$\overline{\lambda}$ ($\underline{\lambda}$): Lagrange multiplier of upper (lower) bound on dollar exposure

- $1 + r < e_1 (1 + r^*) \iff \overline{\lambda} > 0$ and $\underline{\lambda} = 0$
- $1 + r > e_1 (1 + r^*) \iff \overline{\lambda} = 0$ and $\underline{\lambda} > 0$

# Equilibrium

A competitive equilibrium in this economy consists of

- Prices $P = \{e_1, r\}$
- Allocations $X = \{c_0, c_1, B, B^*\}$
- Government policies $G = \{B_G, B_G^*\}$

such that

1. Given $P$, $X$ is a solution to the household's problem
2. Markets clear

# Proposition

- When constraints don't bind, $e_1$ does not depend on $B_G^*$

$$e_1 = \frac{1+r}{1+r^*} = \frac{A_1}{\beta A_0(1+r^*)}$$

- When constraints bind then FX intervention affects $e_1$

$$e_1 = \frac{1+r}{1+r^*}\left(1 \underbrace{- \frac{1}{\tilde{B}} - \frac{(1+\beta)A_0}{B_G^*}}_{\text{Wedge}}\right) \qquad \text{for } \tilde{B} \in \{\overline{B}, \underline{B}\}$$

# Empirical methodology

- Conduct a sharp RDD to study the effects of banking limits
  - Causal effects are identified in episodes of central bank intervention and non-intervention
- Findings
  - Banking limits have a short-lived effect on the exchange rate
  - Effects are greater in episodes when the central bank intervened
  - Effects on portfolio are significant (loans)

# RDD

- Assignment of treatment:

$$D_t = \mathbf{1}\{X_t \geq x_0\}$$

- Average Treatment Effect

$$\begin{aligned}
\text{ATE} =& E\left(Y_{1t} - Y_{0t} \mid X_t = x_0\right) \\
=& E\left(Y_{1t} \mid X_t = x_0\right) - E\left(Y_{0t} \mid X_t = x_0\right) \\
=& \lim_{\epsilon \downarrow 0} E\left(Y_t \mid X_t = x_0 + \epsilon\right) - \lim_{\epsilon \uparrow 0} E\left(Y_t \mid X_t = x_0 + \epsilon\right)
\end{aligned}$$

Last equality holds as long as conditional distribution of potential outcomes $\Pr\left(Y_{it} \leq y \mid X_t = x\right)$ is continuous at $X_t = x_0$, for $i \in \{0, 1\}$

# RDD

We estimate:

$$(1)\ \arg\min_{\theta} \sum_{j=1}^{J} \sum_{t=2}^{T-J} \left(y_{t+j} - a_j - b_j\left(X_t - x_0\right) - \theta_j D_t - \gamma_j\left(X_t - x_0\right) D_t\right)^2 K\left(\frac{X_t - x_0}{h}\right)$$

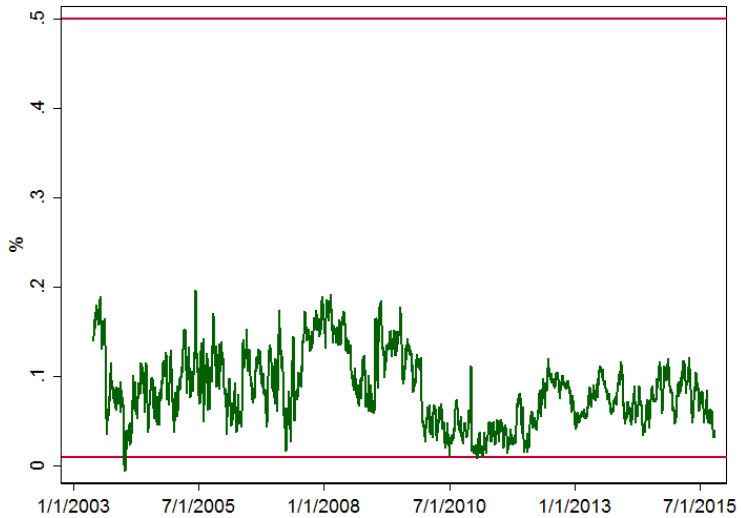
$$(2)\ \arg\min_{\theta} \sum_{j=1}^{J} \sum_{t=2}^{T-J} \left(y_{t+j} - a_j - b_j\left(X_t - x_0\right) - \theta_j D_t - \gamma_j\left(X_t - x_0\right) D_t - \psi_j Int_t - \delta_j D_t Int_t\right)^2 K\left(\cdot\right)$$

- $\theta = (\theta_1, ..., \theta_J)'$ are impulse-response coefficients for $D_t$
- $\delta = (\delta_1, ..., \delta_J)'$ are impulse-response coefficients for $D_t Int_t$
- $K(\cdot)$ is a kernel function
- $h$ is the bandwidth
- $b_j, \gamma_j$ are polynomials

*Endogenous relationship are broken down: small variations in $X_t$ lead to small variations in the error term, which in turn generate a discontinuous jump in $D_t$*

# Data

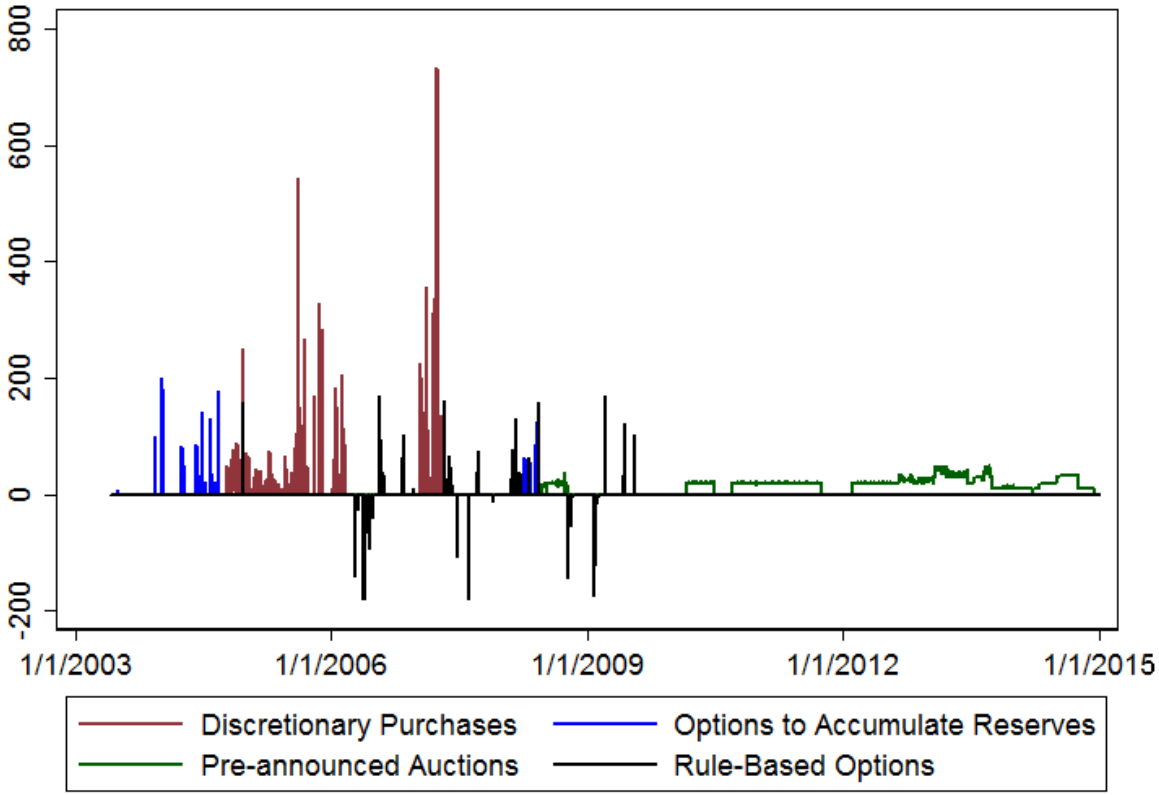
Figure: Financial System's Foreign Exposure as % of Equity




- Effective lower (1%) bound (Jan 23, 2004 - Oct 16, 2015)
- Total daily change in banks' foreign exposure (in terms of equity) was 1% between 2004-2015
- Running Variable: $\frac{1}{x_0} \frac{Net\ Short\ Term\ Assets\ (USD)}{Capital} < 1,$

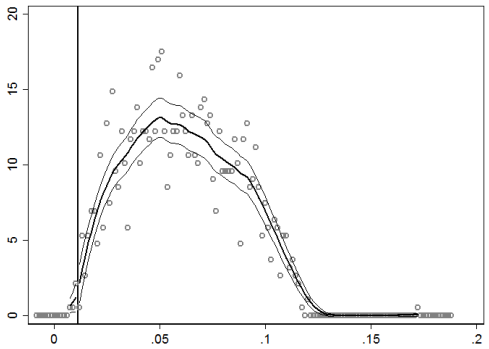
# FX intervention

Figure: Official Foreign Exchange Intervention

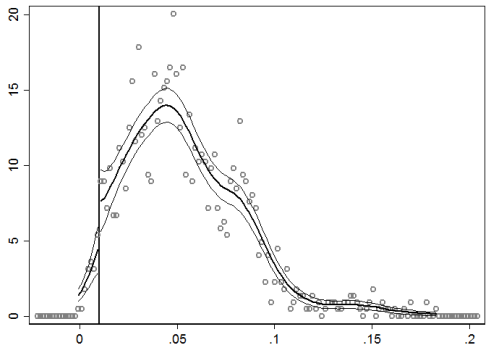


# No manipulation at cutoff

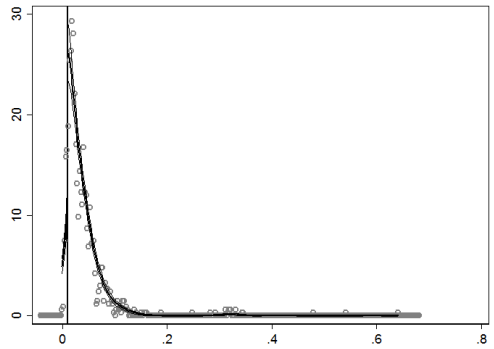
Figure: McCrary's (2008) Test



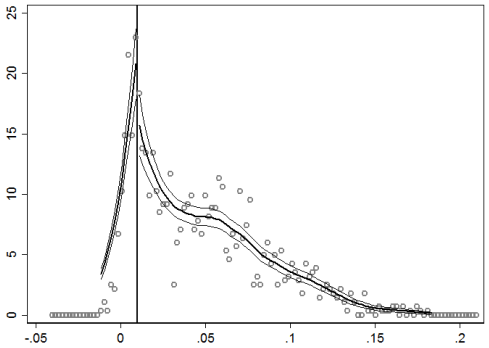

(a) Financial System



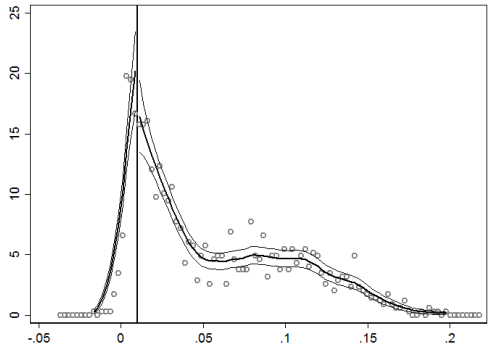

(b) Bank 1




(c) Bank 3




(d) Bank 4




(e) Bank 5

# IRF's of Exchange rate ($\Delta e_t$)

Table: Correlation of Fundamentals with Treatment

| VARIABLES | (1) All | (2) All | (3) BW=0.1 | (4) BW=0.06 | (5) BW=0.03 |
|---|---|---|---|---|---|
| *Running Variable* ($X_t$) | | -0.346** | -0.941** | -4.329*** | -23.91*** |
| | | (0.145) | (0.380) | (1.475) | (4.001) |
| $\pi_t - \pi^*$ | -0.712** | -1.218** | -1.703** | 0.0778 | 3.407 |
| | (0.311) | (0.514) | (0.701) | (0.658) | (16.84) |
| $e_t - \bar{e}$ | 0.394** | 0.257** | 0.242** | 0.582* | 2.432 |
| | (0.169) | (0.110) | (0.107) | (0.347) | (3.080) |
| $i_t^{1y} - i_t^{1y*}$ | 0.318** | 0.878** | 1.275** | -0.744 | -8.507 |
| | (0.141) | (0.370) | (0.524) | (0.660) | (7.865) |
| $\Delta y_t$ | -0.148** | -0.188** | -0.246** | -0.295** | -0.125 |
| | (0.0636) | (0.0787) | (0.101) | (0.141) | (0.762) |
| *FX Vol*$_t$ | -0.402** | -0.252** | -0.238* | -0.940* | -3.044 |
| | (0.173) | (0.109) | (0.128) | (0.567) | (5.765) |
| $i_t^*$ | -0.661** | 0.303 | 0.749* | -3.285* | 0.343 |
| | (0.306) | (0.195) | (0.398) | (1.714) | (16.83) |
| *Embi* | -0.0172** | -0.0133** | -0.0139** | -0.0427* | 0.0884 |
| | (0.00750) | (0.00581) | (0.00667) | (0.0242) | (0.119) |
| Observations | 1,211 | 1,211 | 718 | 238 | 39 |
| R-squared | 0.053 | 0.080 | 0.125 | 0.291 | 0.676 |

Authors' calculations. heteroskedastic-robust standard errors in parentheses. Each column shows a linear regression with treatment dummy $D_t$ as dependent variable (constant term not reported). ***, **, and * denotes statistical significance at the 1, 5, and 10 percent level respectively.

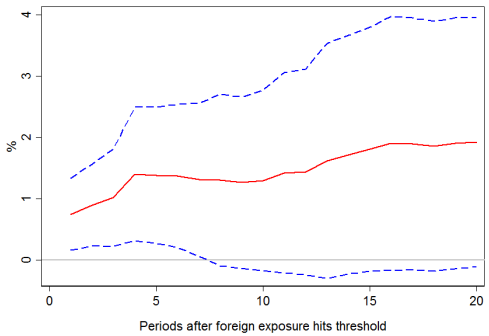
# IRF's of Exchange rate ($\%\Delta e_t$)

| | Marginal Effect of $D_t$ | | Incremental Effect of $INT_t$ | |
|---|---|---|---|---|
| Periods | Rectangular kernel | Triangular kernel | Rectangular kernel | Triangular kernel |
| 1 | 0.599* | 0.655* | 0.016 | 0.006 |
| | (0.307) | (0.341) | (0.016) | (0.008) |
| 2 | 0.713* | 0.930** | 0.053** | 0.021 |
| | (0.384) | (0.418) | (0.021) | (0.014) |
| 3 | 1.153** | 1.410** | 0.087** | 0.036 |
| | (0.535) | (0.467) | (0.036) | (0.022) |
| 4 | 1.652** | 1.590** | 0.052 | 0.027* |
| | (0.569) | (0.414) | (0.034) | (0.015) |
| 5 | 1.846** | 1.590** | 0.015 | 0.012 |
| | (0.760) | (0.561) | (0.050) | (0.019) |
| 6 | 2.050** | 1.849** | 0.061** | 0.031* |
| | (0.616) | (0.511) | (0.027) | (0.017) |
| 7 | 1.448** | 1.267** | 0.054** | 0.028** |
| | (0.585) | (0.468) | (0.011) | (0.012) |
| 10 | 0.474 | 0.193 | 0.055 | 0.018 |
| | (0.928) | (0.801) | (0.051) | (0.026) |
| 15 | 0.907 | 0.609 | 0.078 | 0.033 |
| | (1.271) | (1.173) | (0.063) | (0.032) |

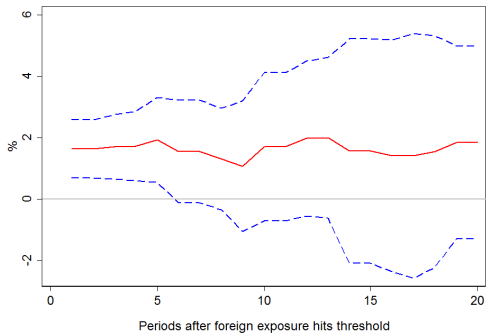
Authors' calculations. Each coefficient results from a separate regression discontinuity model with optimal bandwidth from Calonico et al. (2014). Heteroskedastic-robust standard errors in parentheses. ***, **, and * denotes statistical significance at the 1, 5, and 10 percent level respectively.

# IRF's of Exchange rate ($\Delta e_t$)

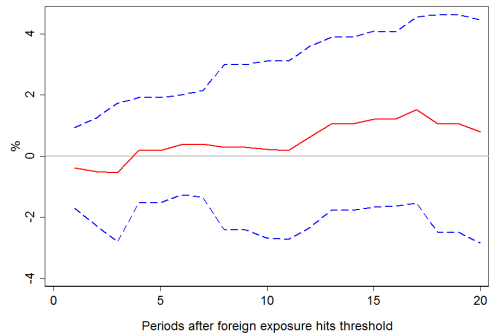
Figure: IRFs -Exchange rate changes




(a) Whole Sample




(b) Episodes of FXI

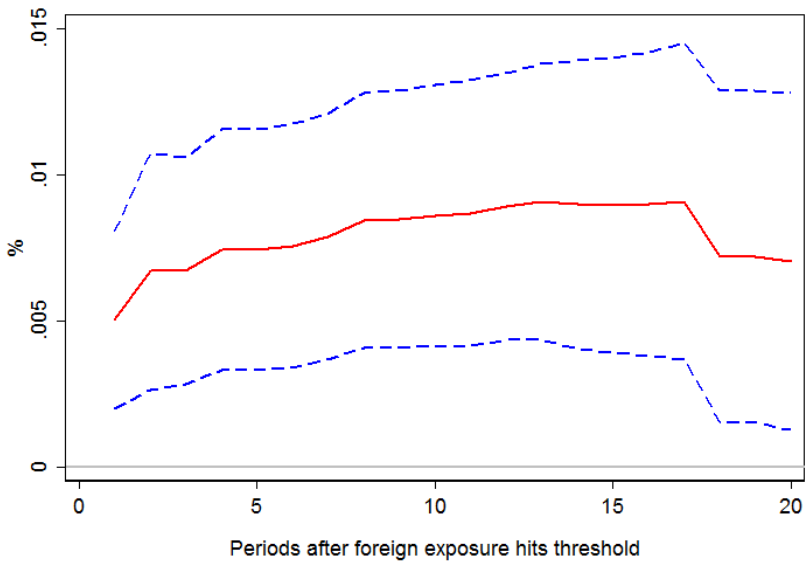



(c) Episodes of no FXI

# Portfolio shifts

We consider effects of banking limits on Loans for the five largest banks

Figure: $\frac{L_t^* e_t}{L_t}$: Loans (USD) as share of loans (COP)



# Conclusion

Concluding remarks:

- 2-period tractable model: intervention has an effect on exchange rate when limits bind. Empirical exercise support this. Effects are relatively small and short lived.
- Same for the incremental effect of regulation based on the level of FXI.
- We find shifts in portfolio balances (loans) as a response to limits on foreign holdings.