Banking Limits on Foreign Holdings
Disentangling the Portfolio Balance Channel
(Exchange Rate Effects of Financial Regulation)

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February 19, 2019

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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
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)

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

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

s. t.

\[
\begin{align*}
c_0 + B + e_0 B^* &= A_0 + \tau_0 \\
c_1 &= (1 + r)B + (1 + r^*)e_1 B^* + A_1 + \tau_1
\end{align*}
\]

\[
B \leq \frac{e_0 B^*}{I} \leq B
\]

where

\[
I \equiv A_0 + \tau_0 + \frac{A_1 + \tau_1}{1+r}
\]

**Government**

Budget is balanced through lump-sum transfers

\[
\begin{align*}
\tau_0 &\equiv B_G - e_0 B^* \\
\tau_1 &\equiv -(1 + r)B_G + (1 + r^*)e_1 B_G
\end{align*}
\]

We can only pin down \( \frac{e_1}{e_0} \), so we assume \( e_0 = 1 \)
Maximization Problem

- From Household’s maximization problem:

\[ 1 + r = e_1 (1 + r^*) - \frac{\bar{\lambda} - \lambda}{\beta I} c_1 \]

- \( \bar{\lambda} (\lambda) \): Lagrange multiplier of upper (lower) bound on dollar exposure

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

- \( 1 + r > e_1 (1 + r^*) \iff \bar{\lambda} = 0 \) and \( \lambda > 0 \)
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 $e_1$
  \[
  e_1 = \frac{1 + r}{1 + r^*} \left( 1 - \frac{1}{\tilde{B}} - \frac{(1 + \beta) A_0}{B_G^*} \right) \quad \text{for } \tilde{B} \in \{\overline{B}, \underline{B}\}
  \]

Cardozo, Gamboa, Perez, Villamizar
Banking Limits on Foreign Holdings
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)
Assignment of treatment:

\[ D_t = 1 \{ X_t \geq x_0 \} \]

Average Treatment Effect

\[
\text{ATE} = E(Y_{1t} - Y_{0t} \mid X_t = x_0) \\
= E(Y_{1t} \mid X_t = x_0) - E(Y_{0t} \mid X_t = x_0) \\
= \lim_{\epsilon \downarrow 0} E(Y_t \mid X_t = x_0 + \epsilon) - \lim_{\epsilon \uparrow 0} E(Y_t \mid X_t = x_0 + \epsilon)
\]

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

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

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

- \( \theta = (\theta_1, ..., \theta_J)' \) 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: $\frac{1}{x_0} \frac{\text{Net Short Term Assets (USD)}}{\text{Capital}} < 1,$
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
### Introduction

### Model

### Empirical methodology

### Conclusion

### General Framework

### Data

### Testable Implications

### Results

**IRF’s of Exchange rate ($\Delta e_t$)**

### Table: Correlation of Fundamentals with Treatment

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>BW=0.1</td>
<td>BW=0.06</td>
<td>BW=0.03</td>
</tr>
<tr>
<td>Running Variable ($X_t$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_t - \pi^*$</td>
<td>-0.712**</td>
<td>-1.218**</td>
<td>-1.703**</td>
<td>0.0778</td>
<td>3.407</td>
</tr>
<tr>
<td></td>
<td>(0.311)</td>
<td>(0.514)</td>
<td>(0.701)</td>
<td>(0.658)</td>
<td>(16.84)</td>
</tr>
<tr>
<td>$e_t - \bar{e}$</td>
<td>0.394**</td>
<td>0.257**</td>
<td>0.242**</td>
<td>0.582*</td>
<td>2.432</td>
</tr>
<tr>
<td></td>
<td>(0.169)</td>
<td>(0.110)</td>
<td>(0.107)</td>
<td>(0.347)</td>
<td>(3.080)</td>
</tr>
<tr>
<td>$\Delta y_t$</td>
<td>-0.148**</td>
<td>-0.188**</td>
<td>-0.246**</td>
<td>-0.295**</td>
<td>-0.125</td>
</tr>
<tr>
<td></td>
<td>(0.0636)</td>
<td>(0.0787)</td>
<td>(0.101)</td>
<td>(0.141)</td>
<td>(0.762)</td>
</tr>
<tr>
<td>$FX \text{ Vol}_t$</td>
<td>-0.402**</td>
<td>-0.252**</td>
<td>-0.238*</td>
<td>-0.940*</td>
<td>-3.044</td>
</tr>
<tr>
<td></td>
<td>(0.173)</td>
<td>(0.109)</td>
<td>(0.128)</td>
<td>(0.567)</td>
<td>(5.765)</td>
</tr>
<tr>
<td>$i^*_t$</td>
<td>-0.661**</td>
<td>0.303</td>
<td>0.749*</td>
<td>-3.285*</td>
<td>0.343</td>
</tr>
<tr>
<td></td>
<td>(0.306)</td>
<td>(0.195)</td>
<td>(0.398)</td>
<td>(1.714)</td>
<td>(16.83)</td>
</tr>
<tr>
<td>$Embi$</td>
<td>-0.0172**</td>
<td>-0.0133**</td>
<td>-0.0139**</td>
<td>-0.0427*</td>
<td>0.0884</td>
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<tr>
<td></td>
<td>(0.00750)</td>
<td>(0.00581)</td>
<td>(0.00667)</td>
<td>(0.0242)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,211</td>
<td>1,211</td>
<td>718</td>
<td>238</td>
<td>39</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.053</td>
<td>0.080</td>
<td>0.125</td>
<td>0.291</td>
<td>0.676</td>
</tr>
</tbody>
</table>

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 ($\% \Delta e_t$)

<table>
<thead>
<tr>
<th>Periods</th>
<th>Marginal Effect of $D_t$</th>
<th>Incremental Effect of $INT_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rectangular kernel</td>
<td>Triangular kernel</td>
</tr>
<tr>
<td>1</td>
<td>0.599* (0.307)</td>
<td>0.655* (0.341)</td>
</tr>
<tr>
<td>2</td>
<td>0.713* (0.384)</td>
<td>0.930** (0.418)</td>
</tr>
<tr>
<td>3</td>
<td>1.153** (0.535)</td>
<td>1.410** (0.467)</td>
</tr>
<tr>
<td>4</td>
<td>1.652** (0.569)</td>
<td>1.590** (0.414)</td>
</tr>
<tr>
<td>5</td>
<td>1.846** (0.760)</td>
<td>1.590** (0.561)</td>
</tr>
<tr>
<td>6</td>
<td>2.050** (0.616)</td>
<td>1.849** (0.511)</td>
</tr>
<tr>
<td>7</td>
<td>1.448** (0.585)</td>
<td>1.267** (0.468)</td>
</tr>
<tr>
<td>10</td>
<td>0.474 (0.928)</td>
<td>0.193 (0.801)</td>
</tr>
<tr>
<td>15</td>
<td>0.907 (1.271)</td>
<td>0.609 (1.173)</td>
</tr>
</tbody>
</table>

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

Figure: \( \frac{L^*_t}{L_t} \): Loans (USD) as share of loans (COP)
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.