Capital Flow Management when Capital Controls Leak

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Motivation

- Central banks in emerging markets have responded to large capital inflows using capital flow management (CFM) policies

- Disagreement about effectiveness of capital controls:

- Wide theoretical support for prudential CFM policies

- ...but empirical literature is more skeptical & suggests existence of important leakages in CFM policies (IMF; Forbes; Klein; etc...)
Motivation

- Central banks in emerging markets have responded to large capital inflows using capital flow management (CFM) policies.

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- Wide theoretical support for prudential CFM policies:

- ...but empirical literature is more skeptical & suggests existence of important leakages in CFM policies (IMF; Forbes; Klein; etc...)

- Crucial disconnect between theory and empirical literatures
Key Questions

1. To what extent do leakages in regulation undermine the effectiveness of macroprudential capital controls?

2. How do leakages affect the optimal design of regulation?

3. Are macroprudential capital controls desirable when they leak?
This Paper

- Theory of optimal CFM with imperfect regul. enforcement
- Rationale for capital controls due to pecuniary externality
- ...but “shadow sector” can evade capital controls
This Paper

- Theory of optimal CFM with imperfect regul. enforcement
- Rationale for capital controls due to pecuniary externality
- ...but “shadow sector” can evade capital controls
- Key trade-off: macroprudential benefits vs. costs of risk-shifting by unregulated agents (allocative inefficiency)
Related Literature

- **Theoretical:**
  - **Capital Controls & Macorpru. Policies:**

- **Empirical:**
  - **Capital Controls & Macorpru Policies:**
    - Aiyar, Calomiris, and Wieladek 2014; Dassatti-Peydro 2013

**Key contribution:** Optimal macroprudential capital controls under imperfect enforcement
Roadmap

1. Illustration of Mechanisms in 3-period Model
2. Quantitative Results from Calibrated Model
Simple 3-period Model

- 3-period small open economy model
- Endowment economy: Tradable/Non-tradable goods
- Shock to tradable endowment only
- Incomplete markets:
  - Debt in units of tradables
  - Credit constraint linked to current income
Simple 3-period Model

- Simple form of heterogeneity
- Two types of agents (exogenously given):
  - Unregulated $U$, with measure $\gamma$
  - Regulated $R$, with measure $1 - \gamma$
- Parsimonious way to capture:
  - Shadow banking sector
  - Differences in access to sources of funding
  - Differences in ability to exploit loopholes
Households

Unregulated Agents’ Full Problem

Agent maximizes

\[ c_T^{U_0} + \mathbb{E}_0 \left[ \beta \ln (c_{U_1}) + \beta^2 \ln (c_{U_2}) \right] \]

with \( c_{Ut} = (c_T^{Ut})^\omega \left( c_N^{Ut} \right)^{1-\omega} \) subject to

(\text{BC0}) \quad c_T^{U_0} \leq b_{U_1}

(\text{BC1}) \quad c_T^{U_1} + p_1^N c_N^{U_1} + b_{U_2} = (1 + r) b_{U_1} + y_T^1 + p_1^N y_1^N

(\text{BC2}) \quad c_T^{U_2} + p_2^N c_N^{U_2} = (1 + r) b_{U_2} + y_T^2 + p_2^N y_2^N

and credit constraint:

\[ b_{U_2} \geq -\kappa (y_T^1 + p_1^N y_1^N) \]
Households

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Agent maximizes

\[ c_{U0}^T + \mathbb{E}_0 \left[ \beta \ln (c_{U1}) + \beta^2 \ln (c_{U2}) \right] \]

with \( c_{Ut} = \left( c_{Ut}^T \right)^\omega \left( c_{Ut}^N \right)^{1-\omega} \) subject to

\[(BC0) \quad c_{U0}^T \leq b_{U1} \]

\[(BC1) \quad c_{U1}^T + p_{1}^N c_{U1}^N + b_{U2} = (1 + r) b_{U1} + y_{1}^T + p_{1}^N y_{1}^N \]

\[(BC2) \quad c_{U2}^T + p_{2}^N c_{U2}^N = (1 + r) b_{U2} + y_{2}^T + p_{2}^N y_{2}^N \]

and credit constraint:

\[ b_{U2} \geq -\kappa \left( y_{1}^T + p_{1}^N y_{1}^N \right) \]
Households

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Agent maximizes

\[ c^T_{U0} + \mathbb{E}_0 \left[ \beta \ln(c_{U1}) + \beta^2 \ln(c_{U2}) \right] \]

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\[(BC0)\quad c^T_{U0} \leq b_{U1}\]

\[(BC1)\quad c^T_{U1} + p^N_1 c^N_{U1} + b_{U2} = (1 + r) b_{U1} + y^T_1 + p^N_1 y^N_1\]

\[(BC2)\quad c^T_{U2} + p^N_2 c^N_{U2} = (1 + r) b_{U2} + y^T_2 + p^N_2 y^N_2\]

and credit constraint:

\[ b_{U2} \geq -\kappa \left( y^T_1 + p^N_1 y^N_1 \right) \]
Households

Unregulated Agents’ Full Problem

Agent maximizes

$$c_{U0}^T + \mathbb{E}_0 \left[ \beta \ln (c_{U1}) + \beta^2 \ln (c_{U2}) \right]$$

with $c_{Ut} = \left( c_{Ut}^T \right)^\omega \left( c_{Ut}^N \right)^{1-\omega}$ subject to

$$(BC0) \quad c_{U0}^T \leq b_{U1}$$

$$(BC1) \quad c_{U1}^T + p_1^N c_{U1}^N + b_{U2} = (1 + r) b_{U1} + y_1^T + p_1^N y_1^N$$

$$(BC2) \quad c_{U2}^T + p_2^N c_{U2}^N = (1 + r) b_{U2} + y_2^T + p_2^N y_2^N$$

and credit constraint:

$$b_{U2} \geq -\kappa \left( y_1^T + p_1^N y_1^N \right)$$
Households

Regulated Agents’ Full Problem

Agent maximizes

\[ c_{R0}^T + \mathbb{E}_0 \left[ \beta \ln (c_{R1}) + \beta^2 \ln (c_{R2}) \right] \]

with \( c_{Rt} = (c_{Rt}^T)^\omega (c_{Rt}^N)^{1-\omega} \) subject to

\[(BC0) \quad c_{R0}^T \leq b_{R1}\]

\[(BC1) \quad c_{R1}^T + p_1^N c_{R1}^N + b_{R2} = (1 + r)(1 + \tau)b_{R1} + y_1^T + p_1^N y_1^N + T\]

\[(BC2) \quad c_{R2}^T + p_2^N c_{R2}^N = (1 + r)b_{R2} + y_2^T + p_2^N y_2^N\]

and credit constraint:

\[ b_{R2} \geq -\kappa (y_1^T + p_1^N y_1^N) \]
Regulated Equilibrium

Indexed by $\tau$

- Households choose $b', c^T, c^N$ optimally:
- Market for NT goods clear and gov. budget constraint is satisfied
Binding credit constraint $b_2 \geq -\kappa \left( y_1^T + p_1^N y_1^N \right)$ at $t = 1$ triggers decrease in demand for consumption and $p^N$, which tightens further the constraint.

...but private agents fail to internalize these effects.

Planner seeks to reduce overborrowing via $\tau > 0$ (Bianchi, 2011).

...but here $\tau$ creates risk-shifting to the unregulated sphere.
Equilibrium Responses: $b_1$ Strategic Substitutes

\[ \phi_U(b_{R1}) \]
Equilibrium Responses: $b_1$ Strategic Substitutes

$$
\begin{align*}
\phi_R(b_{U1}; 0) & \quad \phi_U(b_{R1}) \\
& \quad \phi_R(b_{U1}; 0) 
\end{align*}
\begin{align*}
\phi_U(b_{R1}) & \quad \phi_U(b_{R1}) \\
& \quad \phi_U(b_{R1}) 
\end{align*}
$$
Responses to Capital Controls

\[ \phi_R(b_{U1}; 0) \quad \phi_R(b_{U1}; \tau > 0) \]

\[ \phi_U(b_{R1}) \]
Welfare Effects of Capital Controls

Regulated agents’ iso-utility curves
Welfare Effects of Capital Controls

Unregulated agents’ iso-utility curves

\[ \phi_U(b_{R1}) \]
Welfare Effects of Capital Controls

Pareto improvements

\[ \phi_U(b_{R1}) \]

\[ b_{U1} \]

\[ b_{SP} \]

\[ b_{DE} \]
Optimal Capital Controls Without Leakages

Planner’s optimal bond choice on behalf of regulated agents

\[ 1 = \beta (1 + r) E_0 \left[ \frac{\omega}{c_{R1}} \right] + \beta E_0 \left[ \left( \mu_{R1}^+ \right) \kappa \left( \frac{\partial p_t^N}{\partial b_{R1}} \right) \right] \]

credit constraint relaxation

Two opposite forces of shadow sector (\( \gamma > 0 \)):
Optimal Capital Controls

Planner’s optimal bond choice on behalf of regulated agents

\[ 1 = \beta (1 + r) E_0 \left[ \frac{\omega}{c_{R1}} \right] + \beta E_0 \left[ \left( \mu_{R1} + \frac{\gamma}{1 - \gamma} \mu_{U1} \right) \kappa \left( \frac{+}{\partial p_t^N} \frac{-}{\partial b_{R1}} + \frac{+}{\partial p_t^N} \frac{-}{\partial b_{U1} \partial b_{R1}} \right) \right] \]

---

credit constraint relaxation

Two opposite forces of shadow sector (\( \gamma > 0 \)): Controls less effective but more desirable
Optimal Capital Controls

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\[
1 = \beta (1 + r) \mathbb{E}_0 \left[ \frac{\omega}{c_{R1}} \right] + \beta \mathbb{E}_0 \left[ \left( \mu_{R1} + \frac{\gamma}{1 - \gamma} \mu_{U1} \right) \kappa \left( \frac{\partial p_t^N}{\partial b_{R1}} + \frac{\partial p_t^N}{\partial b_{U1}} \frac{\partial b_{U1}}{\partial b_{R1}} \right) \right]
\]

credit constraint relaxation

Two opposite forces of shadow sector ($\gamma > 0$):

Capital controls less effective but more desirable
Optimal Capital Controls

Planner’s optimal bond choice on behalf of regulated agents

\[ 1 = \beta (1 + r) \mathbb{E}_0 \left[ \frac{\omega}{c_{R1}} \right] + \beta \mathbb{E}_0 \left[ \left( \mu^+_{R1} + \frac{\gamma}{1-\gamma} \mu^+_U \right) \kappa \left( \frac{\partial p_N^t}{\partial b_{R1}} + \frac{\partial p_N^t}{\partial b_{U1}} \frac{\partial b_{U1}}{\partial b_{R1}} \right) \right] \]

credit constraint relaxation

Two opposite forces of shadow sector (\( \gamma > 0 \)):

Capital controls \textbf{less effective} but \textbf{more desirable}
Optimal Capital Controls

Planner’s optimal bond choice on behalf of regulated agents

\[ 1 = \beta (1 + r) \mathbb{E}_0 \left[ \frac{\omega}{c_{R1}} \right] + \beta \mathbb{E}_0 \left[ \left( \mu_{R1} + \frac{\gamma}{1 - \gamma} \mu_{U1} \right) \kappa \left( \frac{\partial p_t^N}{\partial b_{R1}} + \frac{\partial p_t^N}{\partial b_{U1}} \frac{\partial b_{U1}}{\partial b_{R1}} \right) \right] \]

\[ + \gamma \sum_{t=1}^{2} \beta^t \mathbb{E}_0 \left[ \left( \frac{\omega}{c_{Ut}} - \frac{\omega}{c_{Rt}} \right) \left( c_{Rt}^N - c_{Ut}^N \right) \left( \frac{\partial p_t^N}{\partial b_{R1}} + \frac{\partial p_t^N}{\partial b_{U1}} \frac{\partial b_{U1}}{\partial b_{R1}} \right) \right] \]

Two opposite forces of shadow sector (\( \gamma > 0 \)):

Capital controls less effective but more desirable
Insights from Three-Period Model

- Controls increase borrowing by unregulated sphere
- Controls are still desirable (Pareto improvements)
- Size of optimal controls depends on two forces
  1. leakages make controls less effective ↓
  2. leakages make controls more desirable ↑
Insights from Three-Period Model

- Controls increase borrowing by unregulated sphere
- Controls are still desirable (Pareto improvements)
- Size of optimal controls depends on two forces
  1. leakages make controls less effective ↓
  2. leakages make controls more desirable ↑
- Next, a quantitative model to explore these magnitudes
Quantitative Model of Emerging Markets Crises

- Infinite horizon extension of 3 period model with CRRA utility function and CES aggregator of T-NT goods, (Bianchi, 2011)
- Focus on optimal time consistent policy
  - Policies are a function of $X = (b_U, b_R, y^T)$
- Full non-linear solution
- Baseline Calibration for Brazil (preliminary)
- Today will show $\gamma \in [0, 1]$
Planner’s problem without leakages

\[ \mathcal{V}(X) = \max_{\{c_i^T, c_i^N, b'_i\}_{i \in \{U,R\}}, p^N} \gamma u \left( c \left( c_U^T, c_U^N \right) \right) + (1 - \gamma) u \left( c \left( c_R^T, c_R^N \right) \right) + \beta \mathbb{E} \mathcal{V}(X') \]

subject to

\[ c_i^T + p^N c_i^N + b'_i = b_i (1 + r) + y^T + p^N y^N \quad \text{for} \quad i \in \{U, R\} \]
\[ b'_i \geq -\left( \kappa^N p^N y^N + \kappa^T y^T \right) \quad \text{for} \quad i \in \{U, R\} \]
\[ y^N = \gamma c_U^N + (1 - \gamma) c_R^T \]
\[ p^N = \left( \frac{1 - \omega}{\omega} \right) \left( \frac{c_R^T}{c_R^N} \right)^{\eta + 1} \quad \text{for} \quad i \in \{U, R\} \]
Planner’s problem without leakages

\[ \mathcal{V}(X) = \max_{\{c_i^T, c_i^N, b_i'\} \in \{U, R\}, p^N} \gamma u \left( c \left( c_i^T, c_i^N \right) \right) + (1 - \gamma) u \left( c \left( c^T_R, c^N_R \right) \right) + \beta \mathbb{E} \mathcal{V}(X') \]

subject to

\[
\begin{align*}
  c_i^T + p^N c_i^N + b_i' & = b_i(1 + r) + y^T + p^N y^N & \text{for } i \in \{U, R\} \\
  b_i' & \geq - \left( \kappa^N p^N y^N + \kappa^T y^T \right) & \text{for } i \in \{U, R\} \\
  y^N & = \gamma c^N_U + (1 - \gamma) c^T_R \\
  p^N & = \left( \frac{1 - \omega}{\omega} \right) \left( \frac{c^T_R}{c^N_R} \right)^{\eta+1} & \text{for } i \in \{U, R\}
\end{align*}
\]
Planner’s problem with leakages

\[
\mathcal{V}(X) = \max_{\{c_i^T, c_i^N, b_i\}_{i \in \{U, R\}}, p^N} \gamma u \left( c \left( c_U^T, c_U^N \right) \right) + (1 - \gamma) u \left( c \left( c_R^T, c_R^N \right) \right) + \beta \mathbb{E} \mathcal{V}(X')
\]

subject to

\[
c_i^T + p^N c_i^N + b' \quad = \quad b_i(1 + r) + y^T + p^N y^N \quad \text{for} \quad i \in \{U, R\}
\]

\[
b' \quad \geq \quad - \left( \kappa^N p^N y^N + \kappa^T y^T \right) \quad \text{for} \quad i \in \{U, R\}
\]

\[
y^N \quad = \quad \gamma c_U^N + (1 - \gamma) c_R^N
\]

\[
p^N \quad = \quad \left( \frac{1 - \omega}{\omega} \right) \left( \frac{c_R^T}{c_R^N} \right)^{\eta+1} \quad \text{for} \quad i \in \{U, R\}
\]

\[
u_T \left( c_U^T, c_U^N \right) \quad \geq \quad \beta(1 + r)\mathbb{E}u_T \left( C_U^T(X'), C_U^N(X') \right)
\]

\[
\left[ b'_U + \left( \kappa^N p^N y^N + \kappa^T y^T \right) \right] \times \left[ \beta(1 + r)\mathbb{E}u_T \left( C_U^T(X'), C_U^N(X') \right) - u_T \left( c_U^T, c_U^N \right) \right] = 0
\]

Markov Perf. Eq.: \( \mathcal{B}_i(X) = b'_i(X), C_i^T(X) = c'_i(X), C_i^N(X) = c_i^N(X) \)
Quantitative Results

Comparative statics w.r.t. size of shadow sector $\gamma$

- Severity of sudden stops (sudden stops defined as $CA > std(CA)$)
- Frequency of sudden stops
- Welfare effects of macroprudential controls
Severity of Sudden Stops

Real exchange rate

Current Account-to-GDP(%)
Severity of Sudden Stops

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Current Account-to-GDP(%)
Severity of Sudden Stops

Credit of Regulated Agents

Credit of Unregulated Agents
Severity of Sudden Stops

Credit of Regulated Agents

Credit of Unregulated Agents
Severity of Sudden Stops

Credit of Regulated Agents

Credit of Unregulated Agents
Severity of Sudden Stops

Credit of Regulated Agents

Credit of Unregulated Agents
Severity of crises

Capital controls can be more pre-emptive when they leak

The conditional probability of a sudden stop (%)

Aggregate credit
Severity of crises

Capital controls can be more pre-emptive when they leak

The conditional probability of a sudden stop (\%)

The optimal tax (\%)

Aggregate credit
Severity of crises

Capital controls can be more pre-emptive when they leak
Severity of crises

Capital controls can be more pre-emptive when they leak
Current Account-to-GDP Ratio of Sudden Stops

The diagram shows the relationship between the current account-to-GDP ratio and the fraction of unregulated agents. The x-axis represents the fraction of unregulated agents (%), while the y-axis shows the current account-to-GDP (%). Two lines are plotted: one for SP (solid line) and one for DE (dotted line). The graph illustrates how the current account-to-GDP ratio increases as the fraction of unregulated agents increases.
Welfare Effects

The Fraction of Unregulated Agents (%)
Percentage Points

Unregulated Agents
Regulated Agents

The Fraction of Unregulated Agents (%)
Percentage Points

0 10 20 30 40 50 60
−0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0 10 20 30 40 50 60
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14

Unregulated Agents
Regulated Agents
Conclusion

- Theory of macropru CFM under imperfect enforcement
- Unregulated agents respond to capital controls by taking more risk, undermining their effectiveness
- Capital controls should be even more preemptive
- Capital controls appear to be effective despite large leakages
- Potentially relevant for other areas of macropru policies