Capital Flow Management when Capital Controls Leak

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IMF ARC Conference, November 14, 2014
Motivation

- How desirable is macroprudential policy when it cannot be enforced on all agents?

- Relevance of policy enforcement problem for macroprudential capital flow management (CFM)?

- Recent research supports use of CFM policies as second-best tools on grounds of financial stability, macro stabilization or ToT management.

- One general criticism of CFM policy opponents is problem of policy enforcement
Motivation

- How desirable is macroprudential policy when it cannot be enforced on all agents?
- Relevance of policy enforcement problem for macroprudential capital flow management (CFM)?
- Recent research supports use of CFM policies as second-best tools on grounds of financial stability, macro stabilization or ToT management.
- One general criticism of CFM policy opponents is problem of policy enforcement
- This paper: evaluate role of policy enforcement for effectiveness, design and desirability of macroprudential CFM policy
Key Questions

1. To what extent do leakages in regulation undermine the **effectiveness** of macropru CFM?

2. How do leakages affect the **optimal design** of macropru CFM?

3. Is macropru CFM still **desirable** when it leaks?
What we do

- Set up a model of macropru CFM with imperfect policy enforcement
  - Emerging market crises model with occasionally binding credit constraint (Mendoza 2002)
  - Credit constraint depends on market price, causing pecuniary externality and overborrowing
- Tax on borrowing can restore constrained efficiency
- ... but “shadow sector” can evade the tax
- Key trade-off of CFM: macroprudential benefits vs. costs of risk-shifting by “shadow sector”
Related Literature

- **Theoretical:**
  - **Capital Controls & Macropru Policies:**

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

- **Key contribution:** Optimal macroprudential capital controls under imperfect enforcement
Preview of results

- Controls encourage more borrowing by unregulated sphere
- Some controls are in general still desirable
- Optimal controls are more pre-emptive when they leak
- Effectiveness of controls seriously compromised when relative size of unregulated sphere reaches 0.4
- Welfare gains from controls accrue disproportionately to unregulated agents
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 date 1 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):
  - Regulated $R$ subject to tax $\tau$ on date 0 borrowing (measure $1 - \gamma$)
  - Unregulated $U$ (measure $\gamma$)

- Parsimonious way to capture:
  - Shadow banking sector
  - Differences in access to sources of funding
  - Differences in ability to exploit loopholes
Households

Type \( i \in \{U, R\} \) Agents’ Problem

Agent maximizes

\[
c_{i0}^T + \mathbb{E}_0 \left[ \beta \ln (c_{i1}) + \beta^2 \ln (c_{i2}) \right]
\]

with \( c_{it} = (c_{it}^T)^\omega (c_{it}^N)^{1-\omega} \) subject to (BC0), (BC1) and (BC2) and date 1 credit constraint:

\[
b_{i2} \geq -\kappa \left( y_1^T + p_1^N y_1^N \right)
\]

\( y_1^T \) is only stochastic variable
Model Mechanics

- Binding credit constraint $b_2 \geq -\kappa (y_1^T + p_1^N y_1^N)$ at $t = 1$ triggers decrease in demand for consumption and $p^N$, which tightens further the constraint, creating pecuniary externality.

- ...but private agents fail to internalize these effects, leading to overborrowing (Bianchi (2011), Korinek (2010)).

- Planner seeks to reduce overborrowing via $\tau > 0$.

- ...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

\[ \phi_{R}(b_{U1}; 0) \]

\[ \phi_{U}(b_{R1}) \]
Responses to Capital Controls

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

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

\[ b_{DE} \quad b_{DE} \quad b^*_U \quad b_{U1} \quad b^*_R \quad b_{R1} \]
Welfare Effects of Capital Controls

Positive controls lead to Pareto improvements
Optimal Capital Controls Without Leakages

Planner's optimal bond choice on behalf of regulated agents

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

credit constraint relaxation

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

- Controls less effective
- But more desirable
Optimal Capital Controls

Planner’s optimal bond choice on behalf of regulated agents

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

credit constraint relaxation

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Optimal Capital Controls

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

credit constraint relaxation

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

Capital controls **less effective** but **more desirable**
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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

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

credit constraint relaxation

\[ + \gamma \sum_{t=1}^{2} \beta^t E_0 \left[ \left( \frac{\omega}{c_{U_t}^T} - \frac{\omega}{c_{R_t}} \right) \left( c_{R_t}^N - c_{U_t}^N \right) \left( \frac{\partial p_t^N}{\partial b_{R1}} + \frac{\partial p_t^N}{\partial b_{U1}} \frac{\partial b_{U1}}{\partial b_{R1}} \right) \right] \]

wealth redistribution

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

Capital controls less effective but more desirable
Insights from 3-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 $X = (b_U, b_R, y^T)$

- Global (non-linear) solution

- Preliminary calibration

- Today will show $\gamma \in [0, 1]$
Planner’s problem with leakages

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

subject to

\[ c_i^T + \mu^N c_i^N + b_i' = b_i(1 + r) + y^T + \mu^N y^N \quad \text{for} \quad i \in \{U, R\} \]
\[ b_i' \geq - \left( \kappa^N \mu^N y^N + \kappa^T y^T \right) \quad \text{for} \quad i \in \{U, R\} \]
\[ y^N = \gamma c_U^N + (1 - \gamma) c_R^N \]
\[ \mu^N = \left( \frac{1 - \omega}{\omega} \right) \left( \frac{c_R^T}{c_R^N} \right)^{\eta+1} \quad \text{for} \quad i \in \{U, R\} \]
\[ u_T \left( c_U^T, c_U^N \right) \geq \beta (1 + r) \mathbb{E} u_T \left( C_U^T(X'), C_U^N(X') \right) \]
\[ \left[ b_U' + \left( \kappa^N \mu^N y^N + \kappa^T y^T \right) \right] \times \left[ \beta (1 + r) \mathbb{E} u_T \left( C_U^T(X'), C_U^N(X') \right) - u_T \left( c_U^T, c_U^N \right) \right] = 0 \]

Markov Perf. Eq.: \[ B_i(X) = b'_i(X), C_i^T(X) = c_i^T(X), C_i^N(X) = c_i^N(X) \]
Quantitative Results

- Comparative statics w.r.t. size of shadow sector $\gamma$
  - Severity of crises (i.e. sudden stops defined as $CA > \text{std}(CA)$)
  - Frequency of crises
  - Welfare effects of macroprudential controls

- $U$ agents' borrowing
- $R$ agents' borrowing
- Optimal taxes
Severity of Crises

Credit dynamics

Credit of Regulated Agents

Credit of Unregulated Agents

Without Controls
Severity of Crises
Credit dynamics

Credit of Regulated Agents

Without Controls
With Controls $\gamma = 0$

Credit of Unregulated Agents

Without Controls
With Controls $\gamma = 0$
Severity of Crises

Credit dynamics

Credit of Regulated Agents

Without Controls

With Controls $\gamma = 0\%$

With Controls $\gamma = 30\%$

Credit of Unregulated Agents

Without Controls

With Controls $\gamma = 0\%$

With Controls $\gamma = 30\%$
Severity of Crises

Credit dynamics

Credit of Regulated Agents

Without Controls
With Controls $\gamma = 0\%$
With Controls $\gamma = 30\%$
With Controls $\gamma = 40\%$

Credit of Unregulated Agents

Without Controls
With Controls $\gamma = 0\%$
With Controls $\gamma = 30\%$
With Controls $\gamma = 40\%$
Severity of Crises

Exchange rate depreciation and Current account reversal

Real exchange rate

Current Account-to-GDP(%)
Severity of Crises

Exchange rate depreciation and Current account reversal

Real exchange rate

Current Account-to-GDP(%)
Severity of Crises

Exchange rate depreciation and Current account reversal

Real exchange rate

Current Account-to-GDP(%)
Severity of Crises

Exchange rate depreciation and Current account reversal

Real exchange rate

Current Account-to-GDP(\%)
Severity of crises

Probability of crisis and optimal tax

Conditional probability of a crisis (%)

Aggregate credit
Severity of crises

Probability of crisis and optimal tax

Conditional probability of a crisis (%)

Optimal tax (%)

Aggregate credit
Severity of crises

Probability of crisis and optimal tax

Conditional probability of a crisis (%)

Optimal tax (%)

Aggregate credit

Without Controls

With Controls $\gamma = 0\%$

With Controls $\gamma = 30\%$
Severity of crises

Probability of crisis and optimal tax

Conditional probability of a crisis (%)

Optimal tax (%)

Aggregate credit
Conclusion

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

Unregulated Agents’ Full Problem

Agent maximizes

\[ c_{U0}^T + \mathbb{E}_0 \left[ \beta \ln (c_{U1}) + \beta^2 \ln (c_{i2}) \right] \]

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

\[
\begin{align*}
    c_{U0}^T &= -b_{U1} \\
    c_{U1}^T + p_1^N c_{U1}^N + b_{U2} &= (1 + r) b_{U1} + y_1^T + p_1^N y_1^N \\
    c_{U2}^T + p_2^N c_{U2}^N &= (1 + r) b_{U2} + y_2^T + p_2^N y_2^N \\
    b_{U2} &\geq -\kappa \left( y_1^T + p_1^N y_1^N \right)
\end{align*}
\]
Agent maximizes

\[ c_{R0}^T + E_0 \left[ \beta \ln (c_{R1}) + \beta^2 \ln (c_{R2}) \right] \]

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

\[ c_{R0}^T = -b_{R1} \]

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

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

\[ b_{R2} \geq -\kappa \left( y_1^T + p_1^N y_1^N \right) \]
### Calibration

<table>
<thead>
<tr>
<th>Value Source</th>
<th>Value</th>
<th>Target</th>
</tr>
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<tbody>
<tr>
<td>Interest rate</td>
<td>$r = 0.04$</td>
<td>Standard value DSGE-SOE</td>
</tr>
<tr>
<td>Risk aversion</td>
<td>$\sigma = 2$</td>
<td>Standard value DSGE-SOE</td>
</tr>
<tr>
<td>Elasticity of substitution</td>
<td>1</td>
<td>Otherwise MPE doesn’t converge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calibration Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight on tradables in CES</td>
<td>$\omega = 0.31$</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta = 0.91$</td>
</tr>
<tr>
<td>Credit coefficient</td>
<td>$\kappa^H = 0.5$</td>
</tr>
<tr>
<td></td>
<td>$\kappa^L = 0.25$</td>
</tr>
<tr>
<td>$P = \begin{bmatrix} 0.1 &amp; 0.9 \ 0.1 &amp; 0.9 \end{bmatrix}$</td>
<td>mean duration $\kappa^H = 10$ years</td>
</tr>
<tr>
<td></td>
<td>LR prob. of $\kappa^L = 10%$</td>
</tr>
</tbody>
</table>
Borrowing decisions

Unregulated agents

The (U) borrowing

Current Bond Holdings with \( b_U = b_R \)

Bond holdings

\( DE \)

Current Bond Holdings with \( b_U = b_R \)
Borrowing decisions

Unregulated agents

The (U) borrowing

Current Bond Holdings with $b_U=b_R$

Bond holdings

$DE$

$SP$

$\gamma = 00\%$
Borrowing decisions

Regulated agents

The (R) borrowing

Current Bond Holdings with \( bU=bR \)

Bond holdings

\( DE \)
Borrowing decisions

Regulated agents

The (R) borrowing

Current Bond Holdings with $bU=bR$

Bond holdings

$DE$

$SP$

Current Bond Holdings with $bU=bR$
The (R) borrowing

Current Bond Holdings with $b_U = b_R$

Bond holdings

$D_E$

$S_P$

$\gamma = 00\%$
The (R) borrowing

Current Bond Holdings with $b_U = b_R$

<table>
<thead>
<tr>
<th>Bond holdings</th>
<th>DE</th>
<th>$SP$</th>
<th>$\gamma = 00%$</th>
<th>$\gamma = 20%$</th>
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<tbody>
<tr>
<td>$-0.85$</td>
<td></td>
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<tr>
<td>$-0.8$</td>
<td></td>
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<tr>
<td>$-0.75$</td>
<td></td>
<td></td>
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<tr>
<td>$-0.7$</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$-0.65$</td>
<td></td>
<td></td>
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<tr>
<td>$-0.6$</td>
<td></td>
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</tbody>
</table>
The average prudential tax

The fraction $\gamma$ of (U) agents(%)

average tax(%)

The fraction $\gamma$ of (U) agents(%)
Optimal tax on borrowing

Example of non-monotonicity w.r.t. $\gamma$