Financial Stability, Growth and Macroprudential Policy

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Introduction

Background

Macroprudential policy is a new policy after Global Financial Crisis.

Two Features: macroprudential policy

1. reduces systemic risk
2. is used during normal periods

One example: capital inflows tax.

Existing literature on the smoothing effect: smooth boom-bust cycle.

Research Question

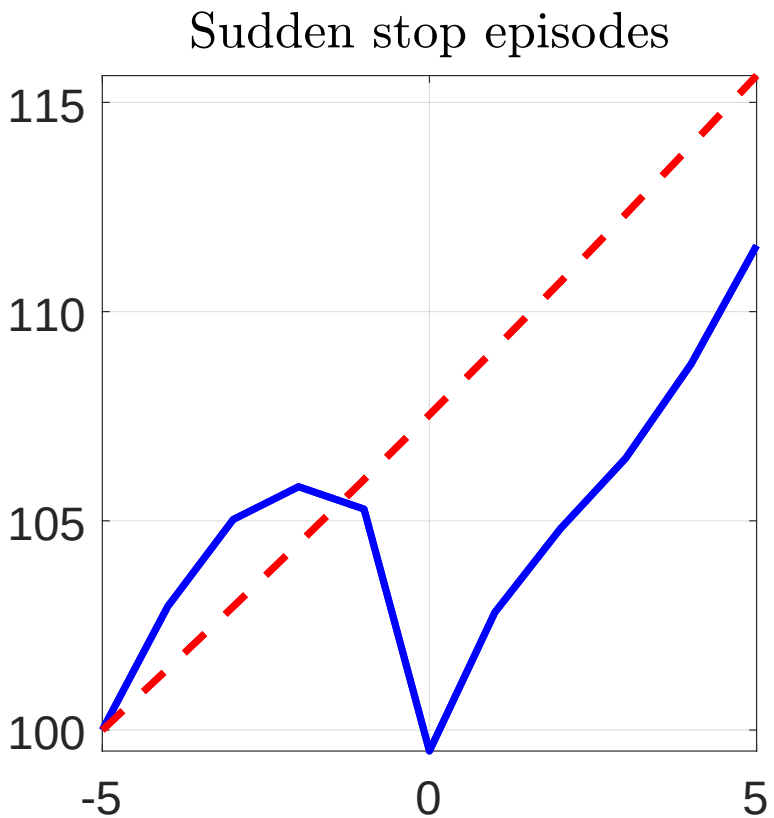
This paper studies the growth effect of macroprudential policy.

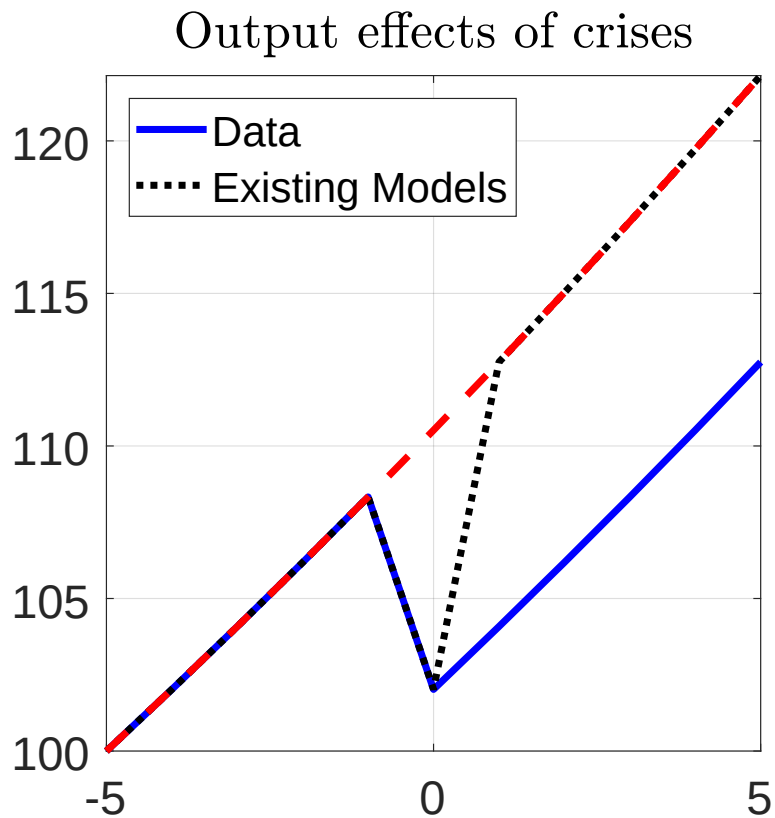
Motivation

Why studying the growth effect?

- Relationship between financial stability (volatility) and growth.
  - Ramey and Ramey (1995), Ranciere et al. (2008), Sanchez and Gori (2016), Boar et al. (2017), etc.
- Financial crises have very persistent effects on output.
  - Cerra and Saxena (2008), Reinhart and Reinhart (2009), Rogoff and Reinhart (2009) and Ball (2014), etc.

Persistent Effects of Financial Crises





Sudden stop episodes are taken from Calvo et al. (2006).
Existing models refer to models in the macroprudential literature.

In Terms of Growth

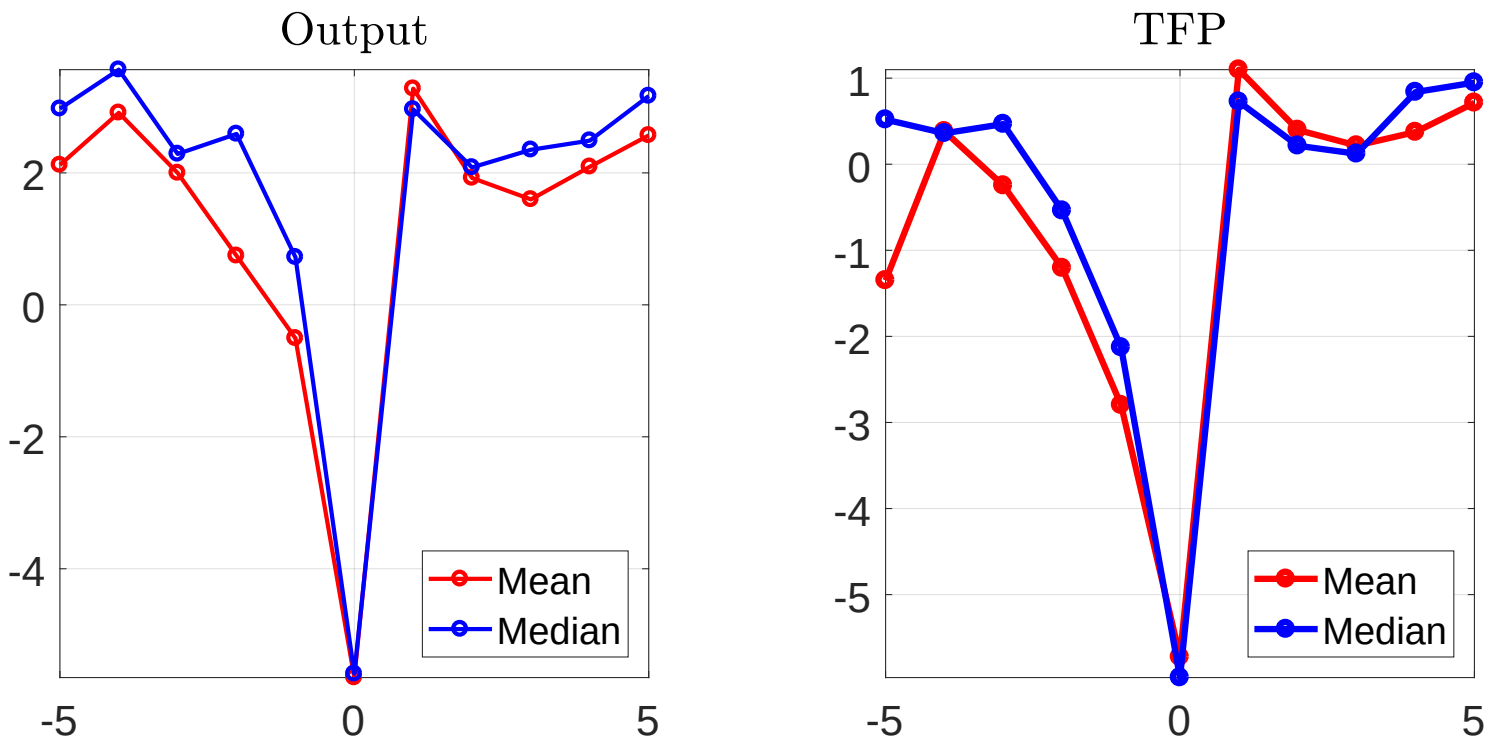


Figure: Growth Rates in Sudden Stop Episodes (%)

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  - macroprudential policy+stimulus policy

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  - larger welfare gains: 0.24% increase in annual consumption

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- Extension: Other policy instruments
  - macroprudential policy+stimulus policy
  - larger welfare gains: 0.24% increase in annual consumption
  - generate a short-run boom in growth and consumption

Relation to Literature

This paper is related to the literature on

1. Empirical works
   - **Persistent output level effects:** Cerra and Saxena (2008), Rogoff and Reinhart (2009), Ball (2014), etc.
   - **Volatility and growth:** Ramey and Ramey (1995), Ranciere, Tornell and Westermann (2008), Aghion et al (2010), Sanchez and Filippo (2016), etc.
2. Theoretical works
   - **Positive analysis:** Comin and Gertler (2006), Guerron-Quintana and Jinnai (2014), Queralto (2015), etc.
   - **Normative analysis:** Lorenzoni(2008), Bianchi (2011), Jeanne and Korinek (2010, 2017), Benigno et al. (2013, 2016), etc.

Road map

Model

Environment: A Small Open Economy

1. **Agents:** Identical atomistic consumers and Int'l investors
2. **Preference:** CRRA + Stone/Geary form

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t - \mathcal{H}_t\right) \equiv E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(c_t - \mathcal{H}_t\right)^{1-\gamma}}{1-\gamma}$$

3. **Production:**

$$y_t = A_t n_t^{\alpha}$$

4. **Productivity:**

$$A_t = \theta_t z_t$$

5. **Notations**
   - Subsistence level of consumption: $\mathcal{H}_t = hz_t$
   - Fixed supply of productive assets: n_t
   - Endogenous productivity: z_t
   - Exogenous productivity: θ_t

Environment (Cont.)

- Budget constraint (BC)

$$c_t + \Psi(z_{t+1}, z_t) + q_t n_{t+1} + b_{t+1} = y_t + q_t n_t + (1 + r)\, b_t$$

- Growth-enhancing expenditure $\Psi(z_{t+1}, z_t)$ includes
  - Physical capital investment
  - Human capital investment
  - R & D expenditure
- Assumption

$$\Psi(z_{t+1}, z_t) = z_{t+1} - \psi z_t + \kappa \left(\frac{z_{t+1}}{z_t} - \psi \right)^2 z_t$$

  where $\kappa > 0$, $\psi > 0$.
- b_t : bond holdings and negative value means debt
- Collateral constraint (CC)

$$-b_{t+1} \leq \phi q_t$$

  e.g. Jeanne and Korinek (2010), Bianchi and Mendoza (forthcoming)

Competitive Equilibrium (CE)

- Denote $c_t^h = c_t - \mathcal{H}_t$.
- Choose $\{c_t^h, z_{t+1}, n_{t+1}, b_{t+1}\}$ to maximize U_0 subject to BC & CC.
- Optimality conditions
  - Asset pricing equation

$$q_t u'(c_t^h) = \beta E_t \left[u'(c_{t+1}^h) \left(\alpha \theta_{t+1} z_{t+1} + q_{t+1} \right) \right]$$

  - Bond holding equation

$$u'(c_t^h) = \mu_t^{CE} + \beta(1+r) E_t \left[u'(c_{t+1}^h) \right]$$

  - Growth equation

$$u'(c_t^h) \Psi_{1,t} = \beta E_t \left[u'(c_{t+1}^h) \left(\theta_{t+1} - h - \Psi_{2,t+1} \right) \right]$$

Vicious Cycle

- There is a vicious cycle in the economy as in the literature
- CC binds, crises; CC slack, normal periods
- $\theta_t \downarrow \Rightarrow \{c_t, z_{t+1}, q_t\} \downarrow \Rightarrow \phi q_t \downarrow \Rightarrow \{c_t, z_{t+1}, q_t\} \downarrow$ **Amplification**
- Private agent does NOT internalize his contribution to the cycle
- $\Rightarrow$ Pecuniary Exteranlities
- $\Rightarrow$ Room for policy intervention

Remarks

1. Pecuniary externalities are due to financial friction
2. NO growth externalities in choosing z_{t+1}

Macroprudential Policy

Macroprudential Social Planner (MP)

A social planner chooses allocation $\{c_t^h, z_{t+1}, b_{t+1}, q_t\}$ but respects private agents' choice of

- Asset price q_t
- Productivity z_{t+1}

$$
\begin{aligned}
V_t^{MP}(z_t, b_t, \theta_t) \quad &= \max_{c_t^h, z_{t+1}, b_{t+1}, q_t} u\left(c_t^h\right) + \beta E\left[V_{t+1}^{MP}(z_{t+1}, b_{t+1}, \theta_{t+1})\right] \\
\text{s.t.} \quad & c_t^h + hz_t + \Psi(z_{t+1}, z_t) + b_{t+1} = \theta_t z_t + (1+r)b_t, \left(\lambda_t^{MP}\right) \\
& -b_{t+1} \leq \phi q_t, \left(\mu_t^{MP}\right) \\
& u'(c_t^h) q_t = \underbrace{\beta E_t\left[u'(c_{t+1}^h)\left(\alpha\theta_{t+1} z_{t+1} + q_{t+1}\right)\right]}_{G(z_{t+1}, b_{t+1})}, \left(\xi_t^{MP}\right) \\
& u'(c_t^h)\Psi_{1,t} = \underbrace{\beta E_t\left[u'(c_{t+1}^h)\left(\theta_{t+1} - h - \Psi_{2,t+1}\right)\right]}_{I(z_{t+1}, b_{t+1})}. \left(\nu_t^{MP}\right)
\end{aligned}
$$

Equilibrium Conditions (MP)

- $FOC(c_t)$:

$$\lambda_t^{MP} = u'(c_t^h) \underbrace{-\xi_t^{MP} u''(c_t^h) q_t \underbrace{-\nu_t^{MP} u''(c_t^h) \Psi_{1,t}}_{\text{Quantitatively small}}}_{>0},$$

- $FOC(q_t)$:

$$\phi \mu_t^{MP} = \xi_t^{MP} u'(c_t^h)$$

- $FOC(z_{t+1})$:

$$\begin{aligned} &\lambda_t^{MP} \Psi_{1,t} - \xi_t^{MP} G_{1,t} - \nu_t^{MP} \left(I_{1,t} - u'(c_t^h) \Psi_{11,t} \right) \\ &= \beta E_t \left[\lambda_{t+1}^{MP} \left(\theta_{t+1} - h - \Psi_{2,t+1} \right) - \nu_{t+1}^{MP} u'(c_{t+1}^h) \Psi_{12,t+1} \right] \end{aligned}$$

- $FOC(b_{t+1})$:

$$\lambda_t^{MP} = \xi_t^{MP} G_{2,t} + \nu_t^{MP} I_{2,t} + \mu_t^{MP} + \beta (1+r) E_t \lambda_{t+1}^{MP}$$

Difference between CE and MP

- **Over-borrowing** in CE, consistent with literature;
- During normal periods, social planner borrows *less*;
- During crises, allocation coincides with CE;
- MP intervenes ex-ante.

Macroprudential Policy

- Implementation: a capital flow tax τ_t^b with lump-sum transfer T_t
- Private budget constraint changes into

$$\begin{aligned} & c_t^h + hz_t + \Psi(z_{t+1}, z_t) + q_t n_{t+1} + \left(1 - \tau_t^b\right) b_{t+1} \\ & = y_t + q_t n_t + (1 + r) b_t + T_t \end{aligned}$$

where $T_t = -\tau_t^b b_{t+1}$.

Calibration

Targeted Event Window

- Persistent output loss of financial crises
- Sudden stop episodes from Calvo et al. (2006)

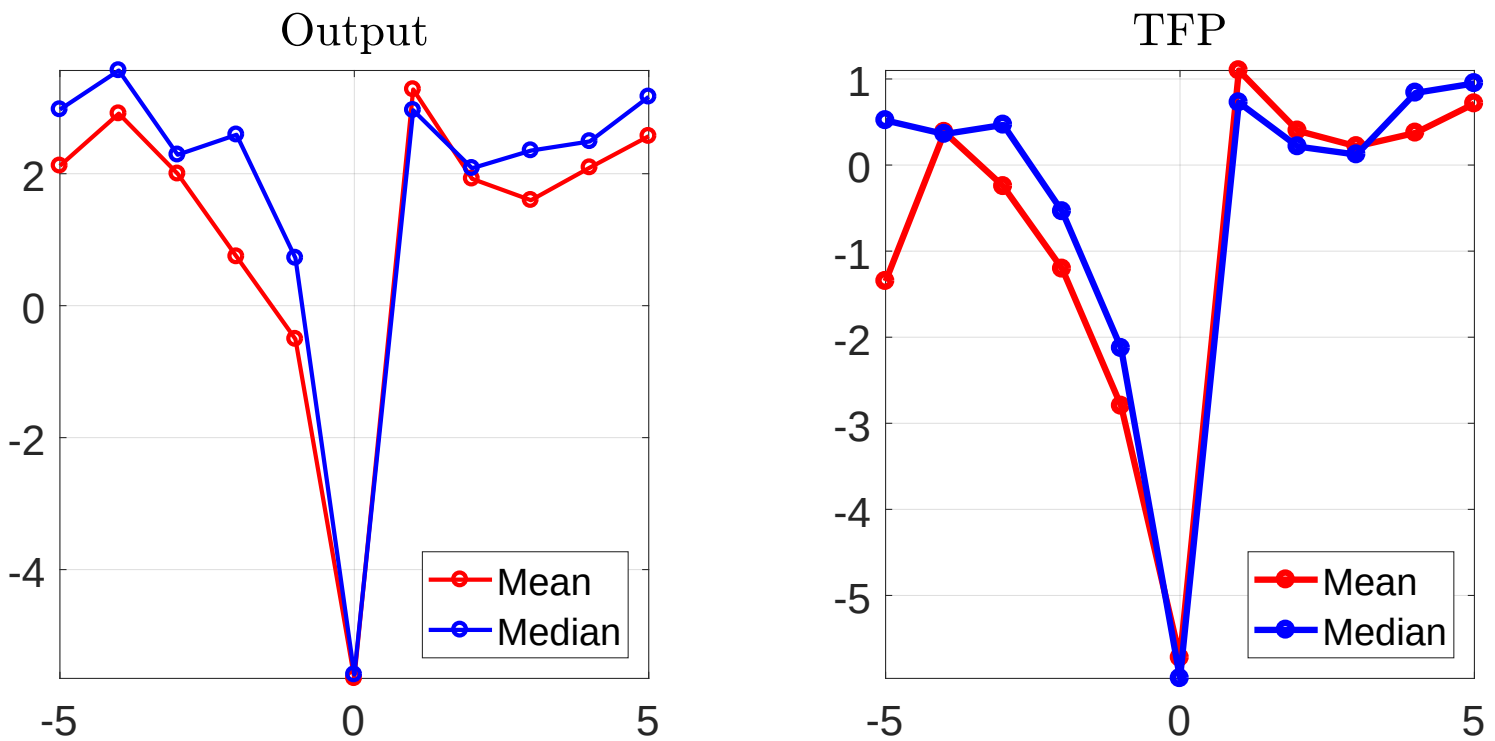


Figure: Growth Rates in Sudden Stop Episodes (%)

Calibration

- One period stands for one year.
- Only one shock: θ_t

$$\log \theta_t = \rho \log \theta_{t-1} + \varepsilon_t, \text{ where } \varepsilon_t \sim N(0, \sigma^2)$$

- Normalize by z_t. Denote $\hat{x}_t = \frac{x_t}{z_t}$ and $g_{t+1} = \frac{z_{t+1}}{z_t}$
- Endogenous gridpoint method as in Carroll (2006).

Parameter Values

	Value	Source/target
Parameter in production function	$\alpha = 0.2$	Jeanne and Korinek (2010)
Risk-free interest rate	$r = 6\%$	Benigno et al. (2013)
Risk aversion	$\gamma = 2$	Standard in the literature
Volatility of technology shock	$\sigma = 0.04$	Output growth rate at time of crises $= -5.65$ %
Parameter in Ψ functions	$\psi = 0.95$	Output growth rate one year after crises $= 3.28\%$
Parameter in Ψ functions	$\kappa = 26.29$	Consumption-GDP ratio $= 77.6\%$
Subsistence level parameter	$h = 0.51$	Average GDP growth $= 2.3\%$
Discount rate	$\beta = 0.968$	Probability of crisis $= 5.5\%$
Persistence of technology shock	$\rho = 0.83$	Correlation between current account and output $= -0.25$
Collateral constraint parameter	$\phi = 0.0852$	NFA-GDP ratio $= -30\%$

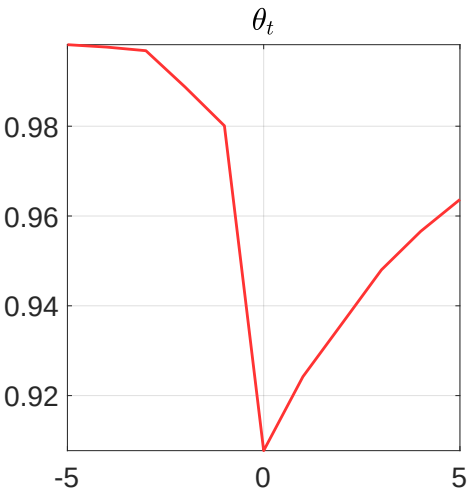
Moments calculated using 55 countries' data between 1961 and 2015.
Source: WDI, Lane and Milesi-Ferretti (2007).

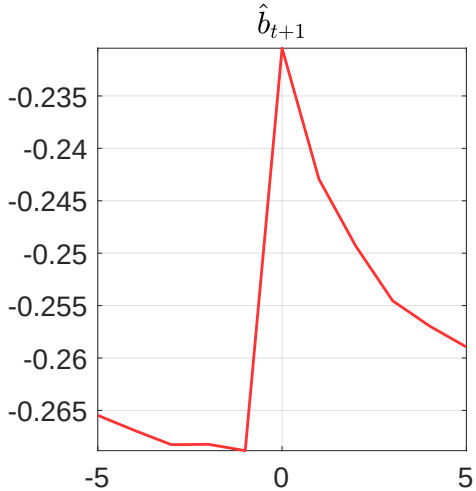
Model Performance

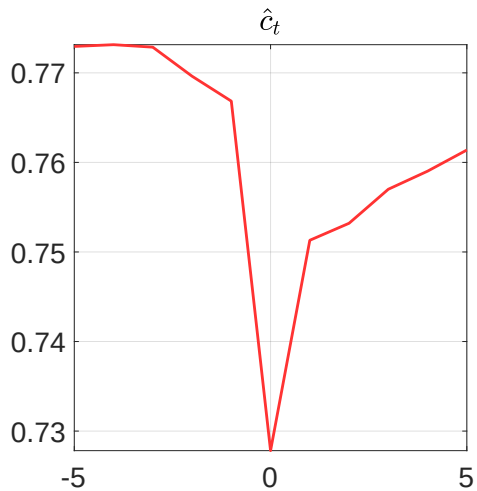
Table: Moments: Data and Model

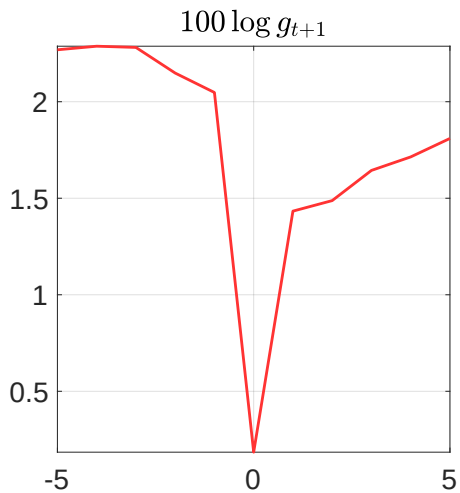
Targeted Moments	Data	Model
Average GDP growth (%)	2.30	2.31
Probability of crisis (%)	5.50	6.23
NFA-GDP ratio (%)	−30.00	−27.18
Consumption-GDP ratio (%)	77.6	77.53
Correlation between current account and output	−0.25	−0.22

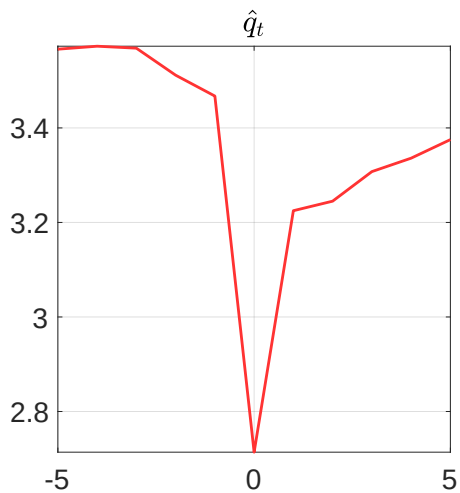
Event windows

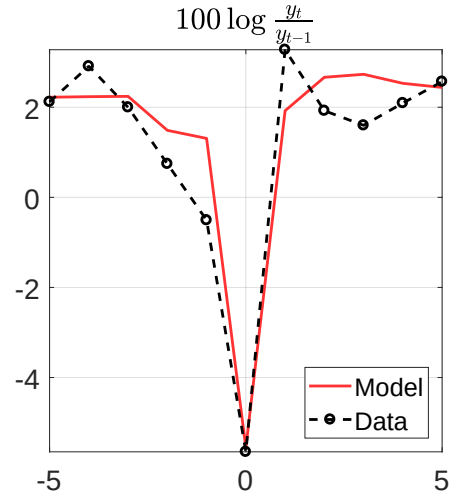






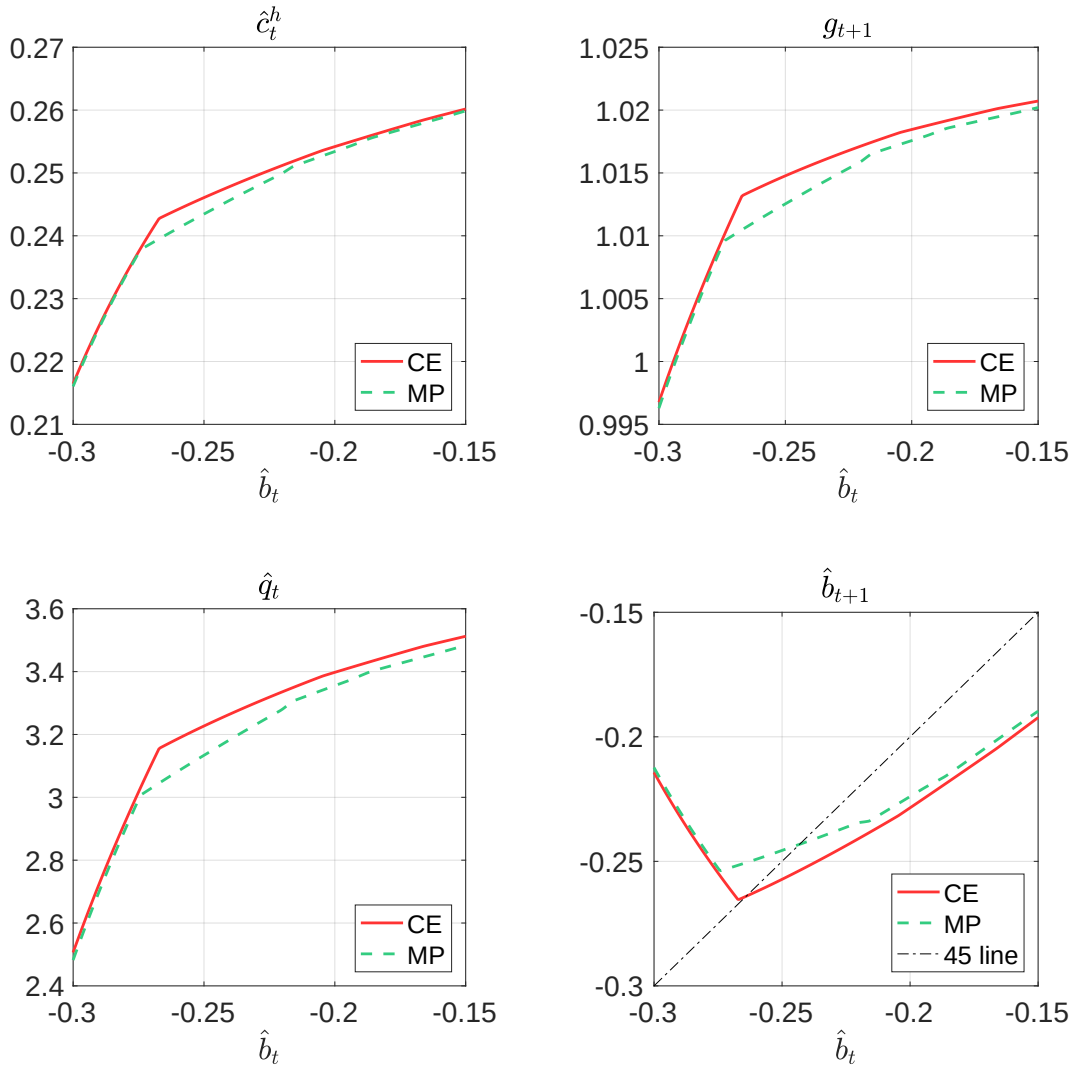






Quantitative Results

Comparing CE and MP Allocations

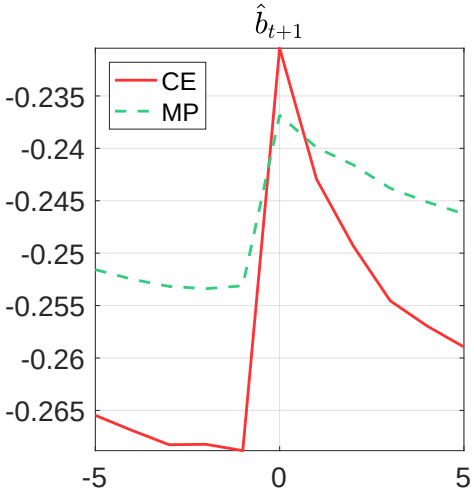


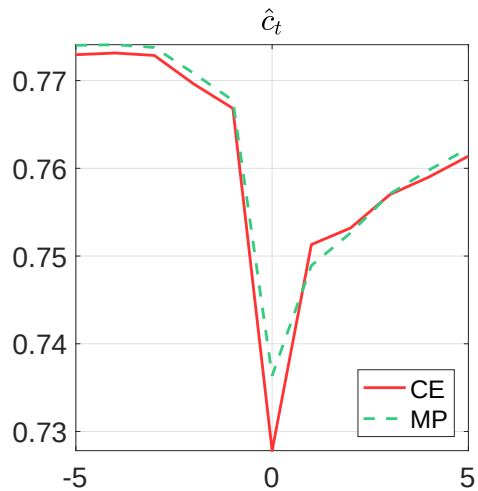
Moments

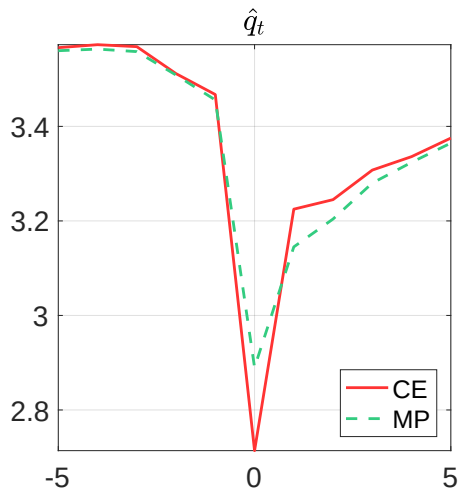
Moments	CE	MP
Average GDP growth (%)	2.315	2.307
Probability of crisis (%)	6.23	1.89
NFA-GDP ratio (%)	−27.18	−25.78
Consumption-GDP ratio (%)	77.53	77.65
Correlation between current account and output	−0.22	−0.37

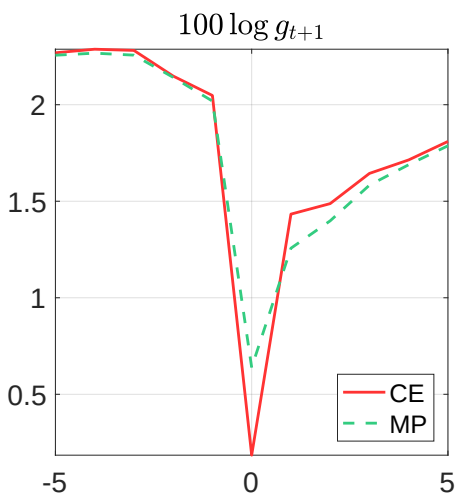
Table: Moments: CE and MP

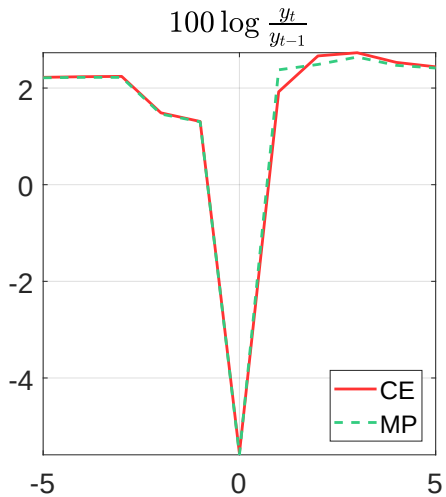
Event Window: CE and MP

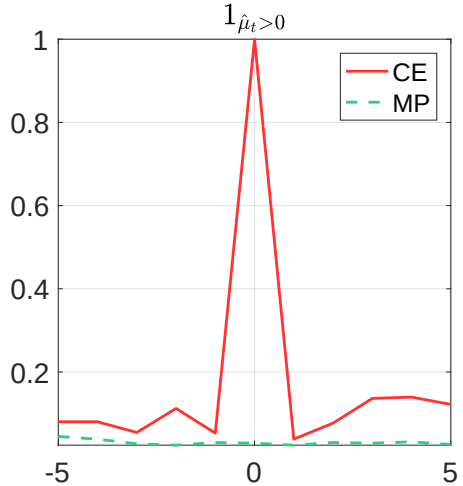












Policy Impacts on Average Growth

- Theoretically Ambiguous.
- Simplify model such that: $\theta_t = 1$ for $\forall t$ but $\theta_2 = 0.9$ with prob p.
- Collateral constraint slack in the long run: adjust β.

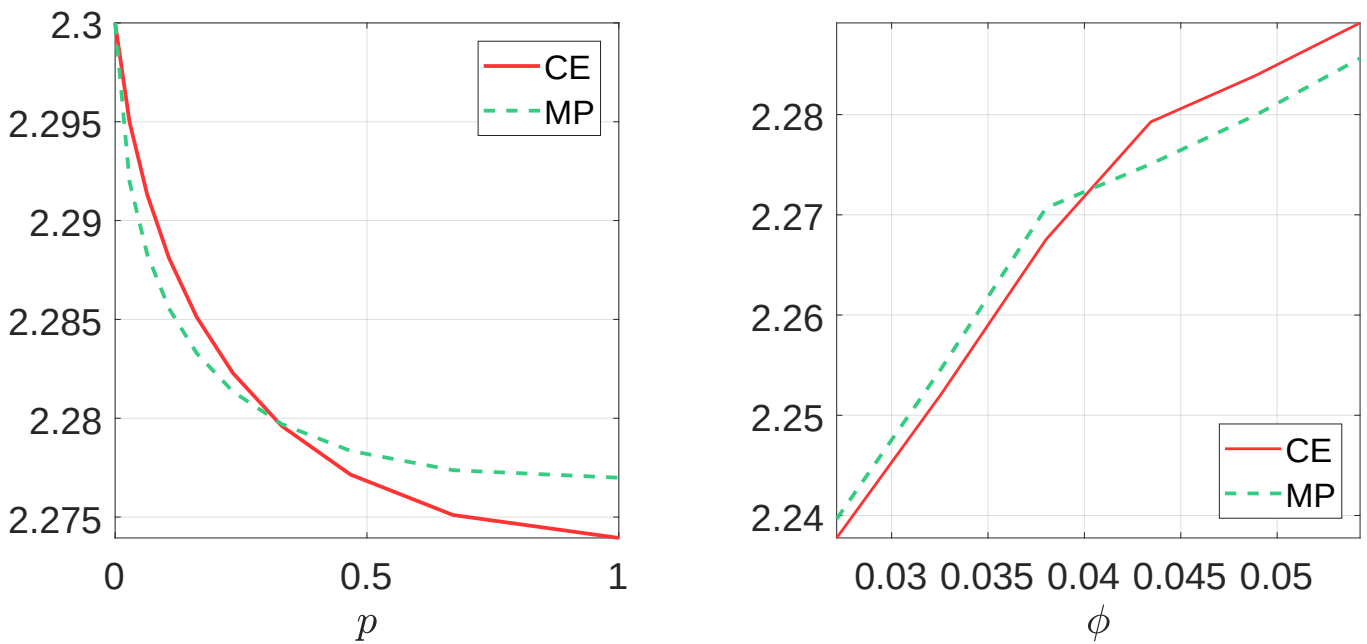


Figure: Policy Impacts on Average Growth: CE and MP

Welfare gains

Following the literature,

$$\Delta V^{MP}(\hat{b}_t, \theta_t) = \left(\frac{V^{MP}(\hat{b}_t, \theta_t)}{V^{CE}(\hat{b}_t, \theta_t)} \right)^{\frac{1}{1-\gamma}} - 1$$

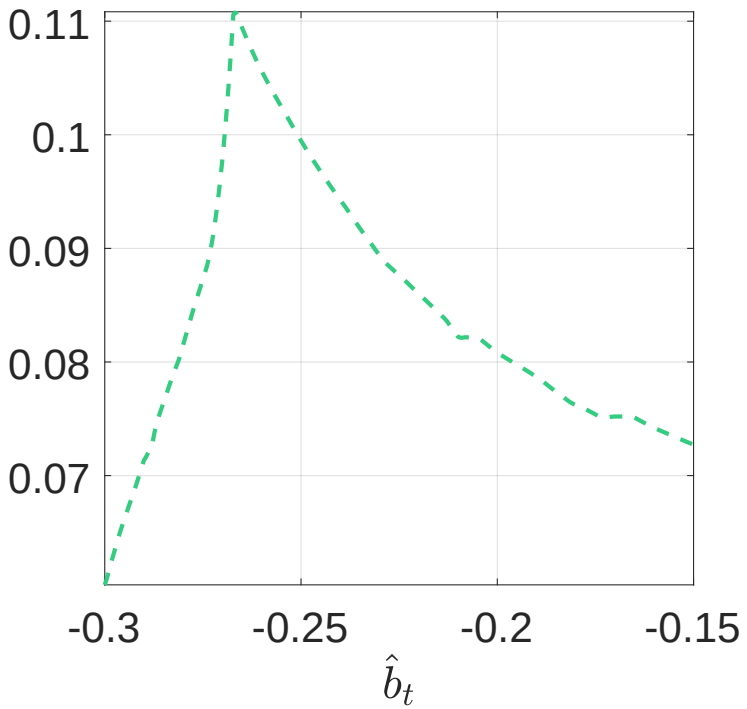


Figure: Welfare gains (%): MP

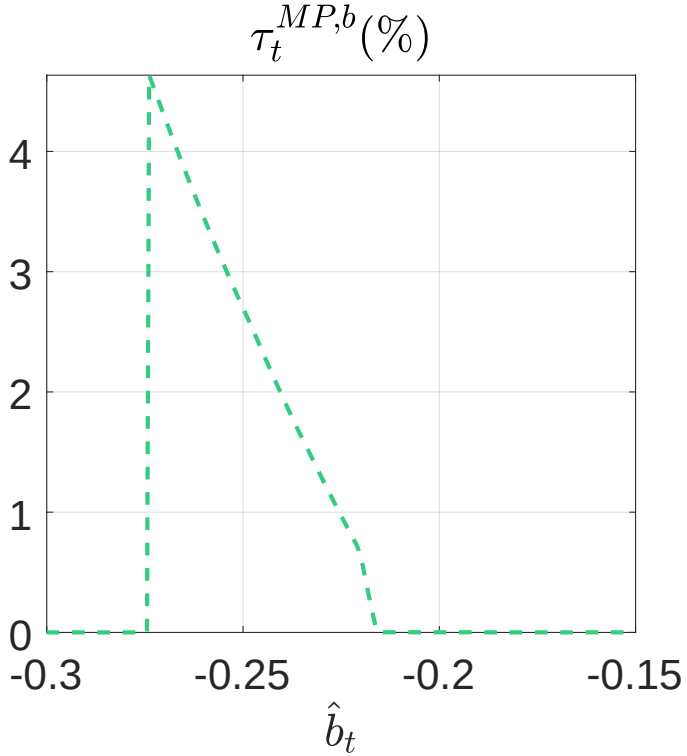
Source of gains

Table: Source of welfare gains (%)

	Overall	Trend Consumption	Cyclical Consumption
MP	0.06	-0.34	0.40

- Decompose overall gains into two channels, $c_t = \hat{c}_t * z_t$
  - Trend consumption: control for $\hat{c}_t$
  - Cyclical consumption: control for z_t
- Gains are through cyclical rather than trend consumption.

Size of Macroprudential Policy



- On average, τ_t^b is 1.28%.

Extension

Multi-instrument Social Planner (MI)

A social planner chooses allocation $\{c_t^h, z_{t+1}, b_{t+1}, q_t\}$ but respects private agents' choice of

- Asset price q_t

$$
\begin{aligned}
V_t^{MI}(z_t, b_t, \theta_t) \quad &= \max_{c_t^h, z_{t+1}, b_{t+1}, q_t} u\left(c_t^h\right) + \beta E\left[V_{t+1}^{MI}(z_{t+1}, b_{t+1}, \theta_{t+1})\right] \\
\text{s.t.} \quad & c_t^h + h z_t + \Psi(z_{t+1}, z_t) + b_{t+1} = \theta_t z_t + (1+r) b_t, \ \left(\lambda_t^{MI}\right) \\
& -b_{t+1} \leq \phi q_t, \ \left(\mu_t^{MI}\right) \\
& u'(c_t^h) q_t = \underbrace{\beta E_t\left[u'(c_{t+1}^h)\left(\alpha \theta_{t+1} z_{t+1} + q_{t+1}\right)\right]}_{G(z_{t+1}, b_{t+1})}. \ \left(\xi_t^{MI}\right)
\end{aligned}
$$

Equilibrium Conditions (MI)

- $FOC(c_t)$:

$$\lambda_t^{MI} = u'(c_t^h) \underbrace{-\xi_t^{MI} u''(c_t^h) q_t}_{>0},$$

- $FOC(q_t)$:

$$\phi \mu_t^{MI} = \xi_t^{MI} u'(c_t^h)$$

- $FOC(z_{t+1})$:

$$\lambda_t^{MI} \Psi_{1,t} = \xi_t^{MI} G_{1,t} + \beta E_t \left[\lambda_{t+1}^{MI} \left(\theta_{t+1} - h - \Psi_{2,t+1} \right) \right]$$

- $FOC(b_{t+1})$:

$$\lambda_t^{MI} = \xi_t^{MI} G_{2,t} + \mu_t^{MI} + \beta \left(1 + r\right) E_t \lambda_{t+1}^{MI}$$

Difference between CE and MI

- MI intervenes both *ex-ante* and *ex-post*;
- During crises, MI relaxes CC by consuming *more* and investing *less*;
- During normal periods, MI borrows *less* and invests *more*.

Macroprudential and Stimulus Policy

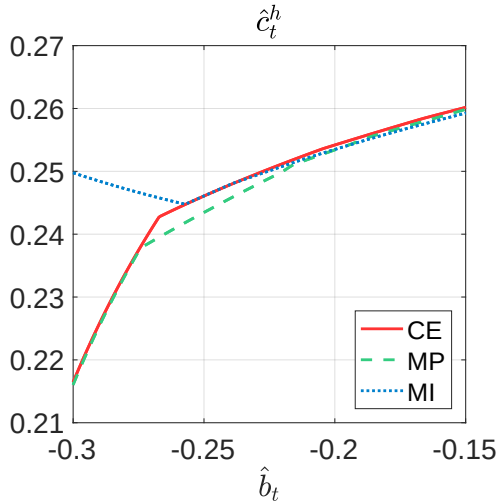
- Implementation: a capital flow tax τ_t^b and a growth subsidy τ_t^z with lump-sum transfer T_t
- Private budget constraint changes into

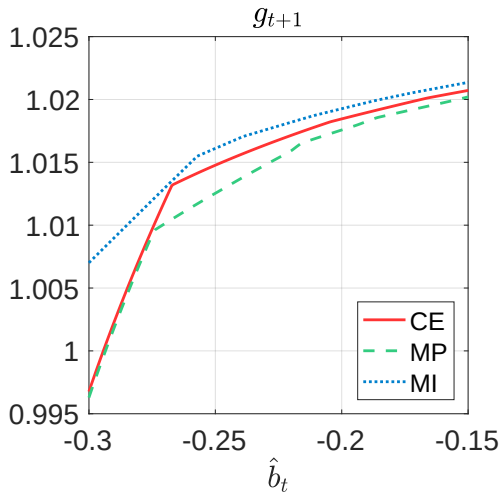
$$\begin{aligned} & c_t^h + hz_t + (1-\tau_t^z)\Psi(z_{t+1}, z_t) + q_t n_{t+1} + \left(1-\tau_t^b\right) b_{t+1} \\ & = y_t + q_t n_t + (1+r)\, b_t + T_t \end{aligned}$$

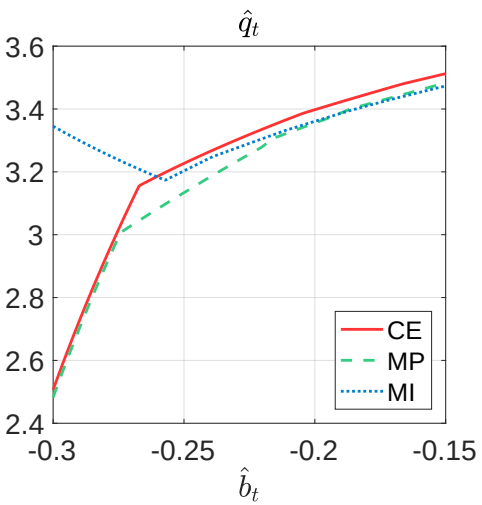
  where $T_t = -\tau_t^z \Psi(z_{t+1}, z_t) - \tau_t^b b_{t+1}$.
- Ex-ante and Ex-post Intervention

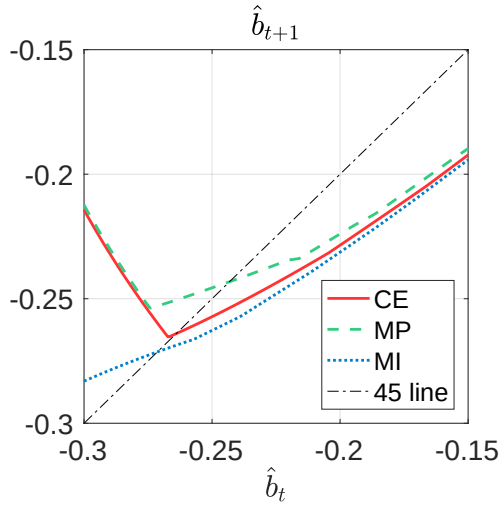
	Ex-ante	Ex-post
τ_t^b	Macroprudential Policy	Stimulus Policy
τ_t^z	Stimulus Policy	Stimulus Policy

Comparing CE, MP and MI Allocations







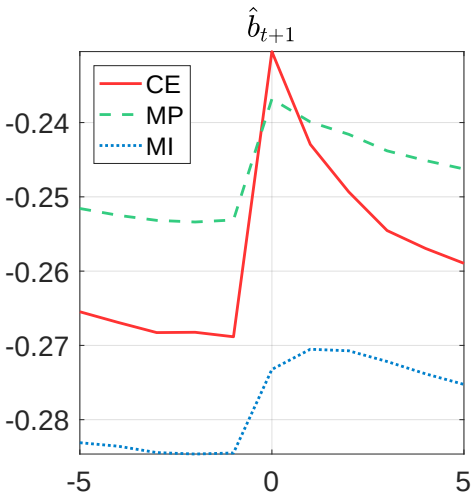


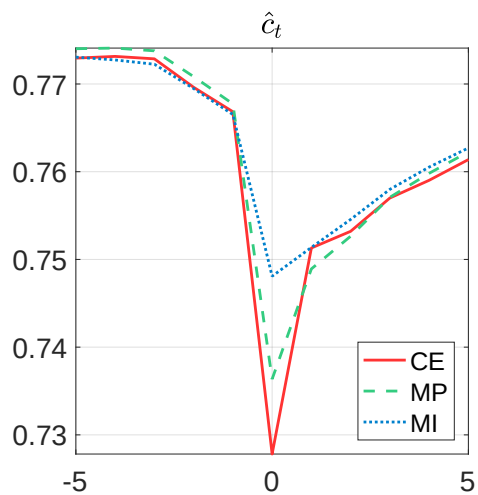
Moments: CE, MP and MI

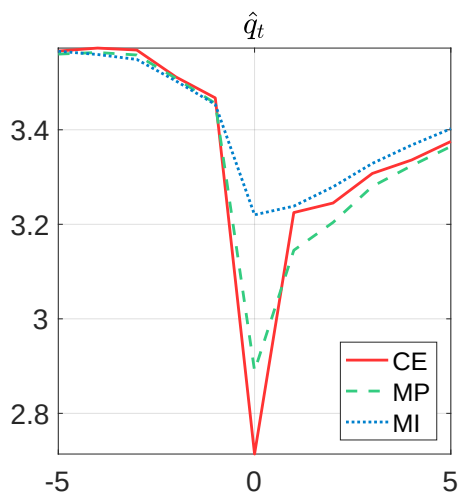
Moments	CE	MP	MI
Average GDP growth (%)	2.315	2.307	2.289
Probability of crisis (%)	6.23	1.89	14.23
NFA-GDP ratio (%)	−27.18	−25.78	−28.98
Consumption-GDP ratio (%)	77.53	77.65	77.58
Correlation between current account and output	−0.22	−0.37	−0.54

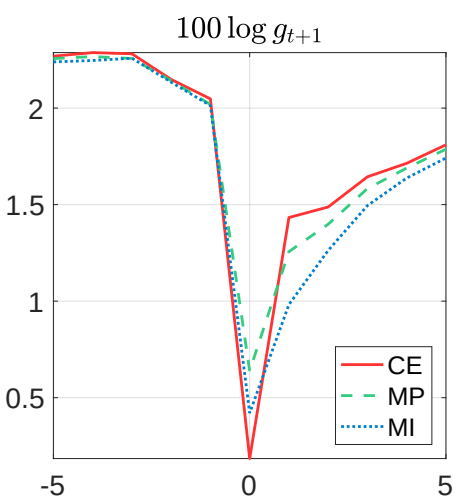
Table: Moments: CE, MP and MI

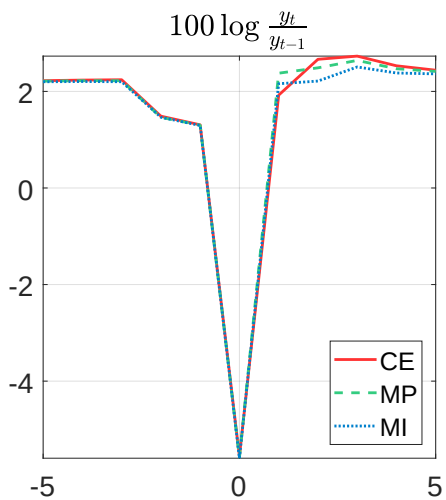
Event Window: CE, MP and MI

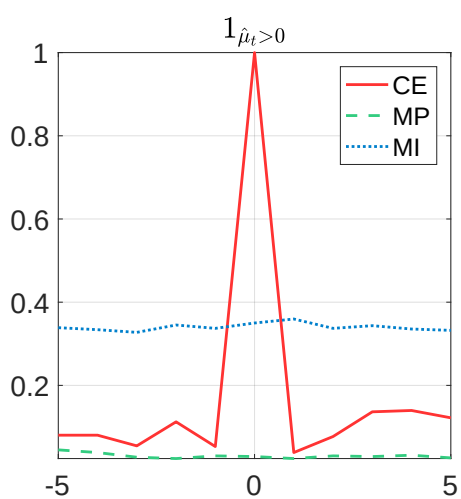












Policy Impacts on Average Growth: MI

- Theoretically Ambiguous.
- Simplify model such that: $\theta_t = 1$ for $\forall t$ but $\theta_2 = 0.9$ with prob p.
- Collateral constraint slack in the long run: adjust β.

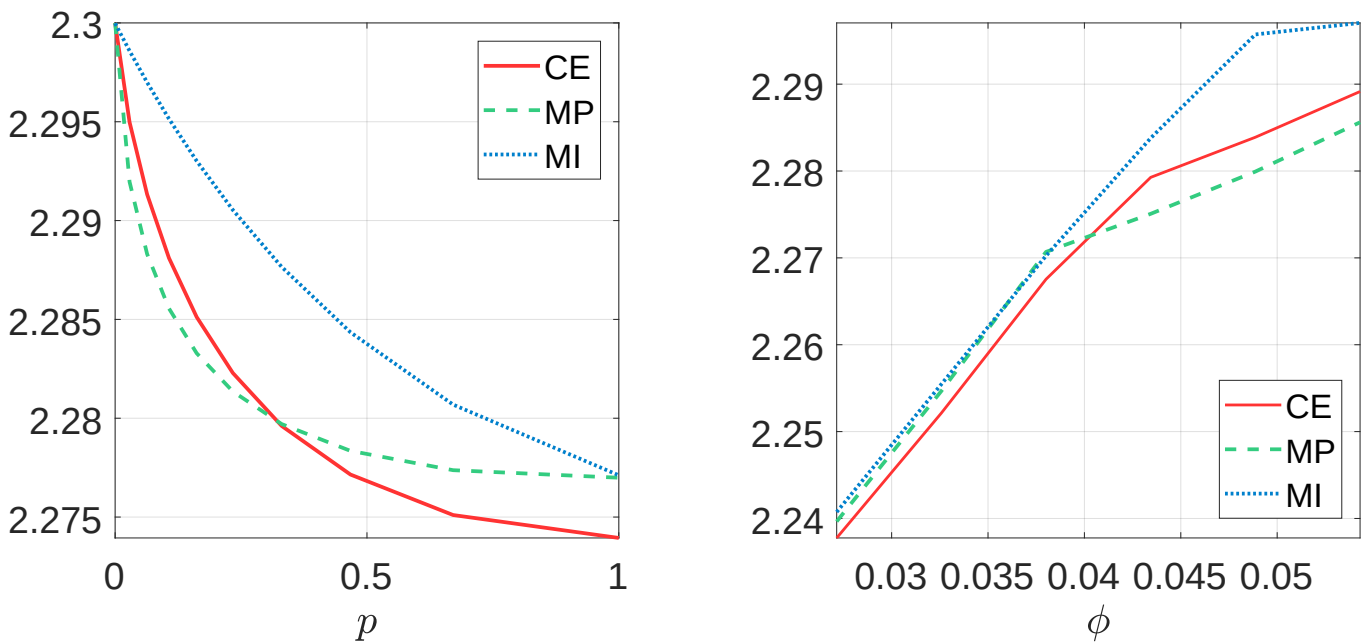


Figure: Policy Impacts on Average Growth: CE, MP and MI

Welfare gains: MI

Following the literature,

$$\Delta V^{MI}(\hat{b}_t, \theta_t) = \left(\frac{V^{MI}(\hat{b}_t, \theta_t)}{V^{CE}(\hat{b}_t, \theta_t)} \right)^{\frac{1}{1-\gamma}} - 1$$

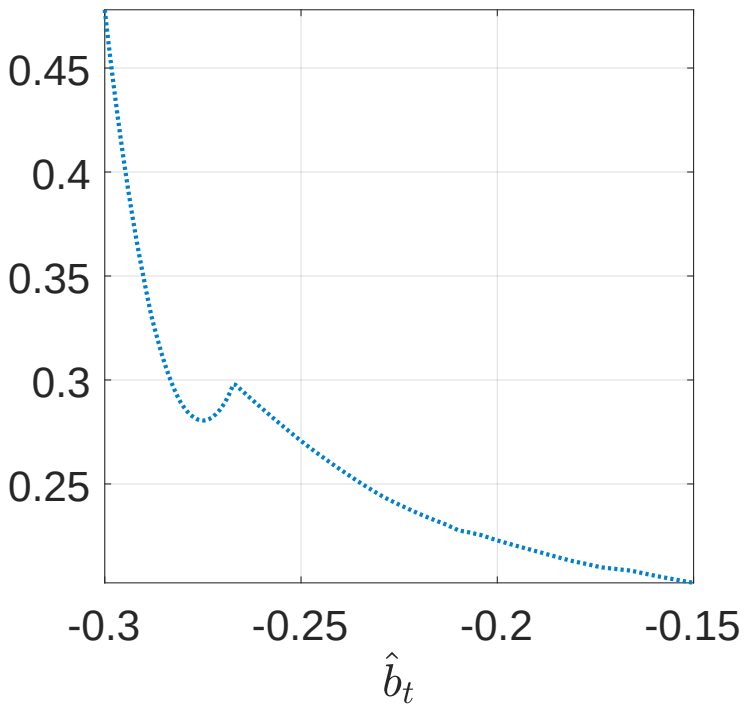


Figure: Welfare gains (%): MI

Source of gains: MP and MI

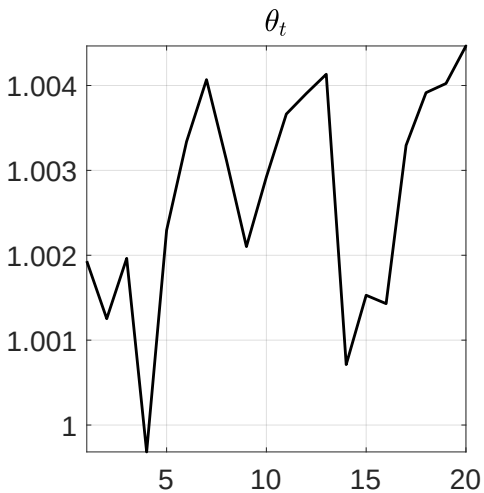
Table: Source of welfare gains (%)

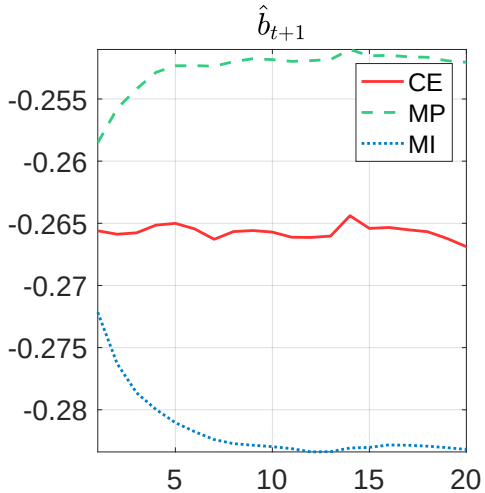
	Overall	Trend Consumption	Cyclical Consumption
MP	0.06	-0.34	0.40
MI	0.24	−0.13	0.38

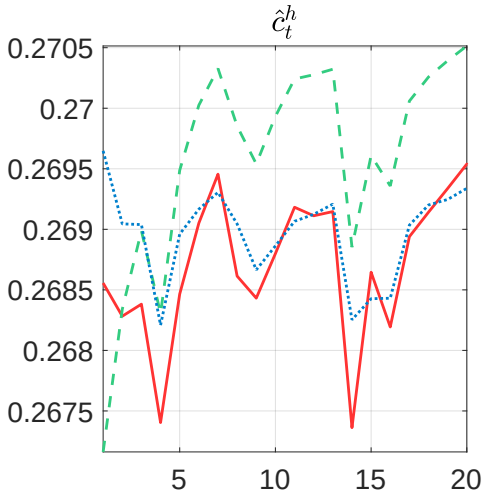
- Decompose overall gains into two channels, $c_t = \hat{c}_t * z_t$
  - Trend consumption: control for $\hat{c}_t$
  - Cyclical consumption: control for z_t
- Gains are through cyclical rather than trend consumption.

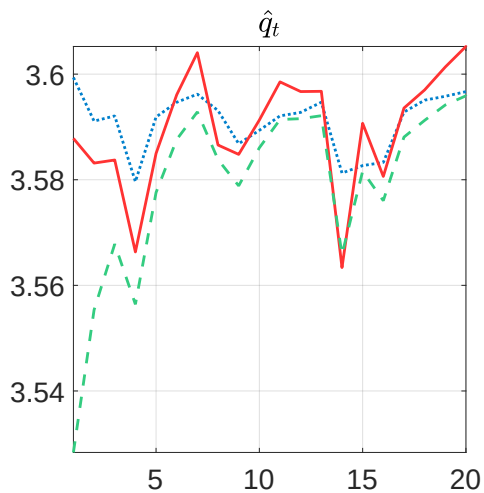
Difference between MP and MI

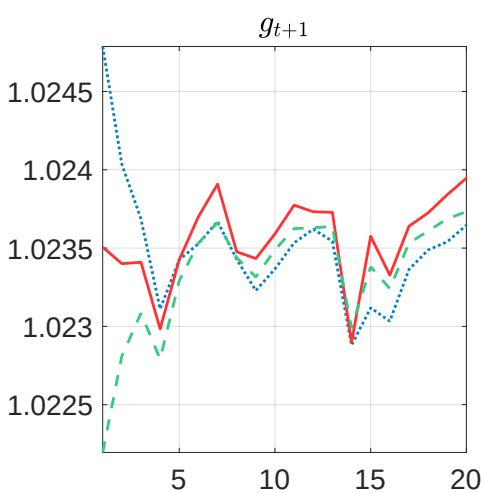
Transition Dynamics

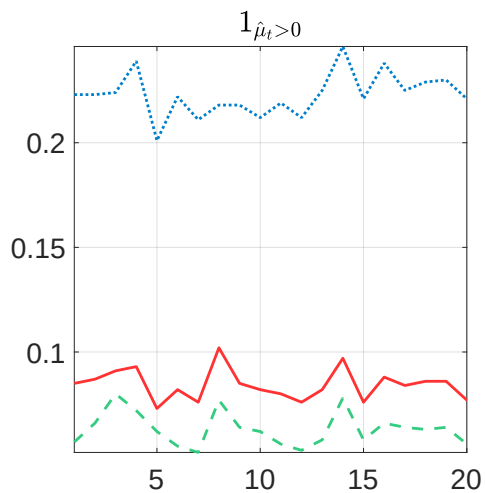




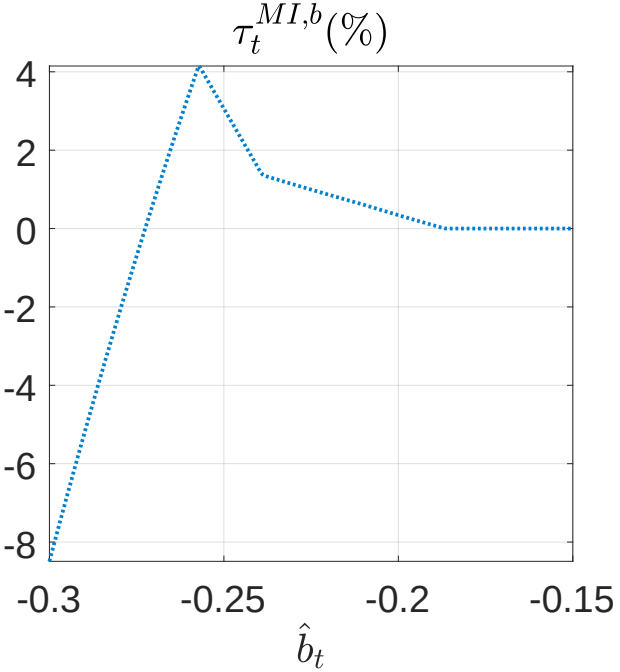


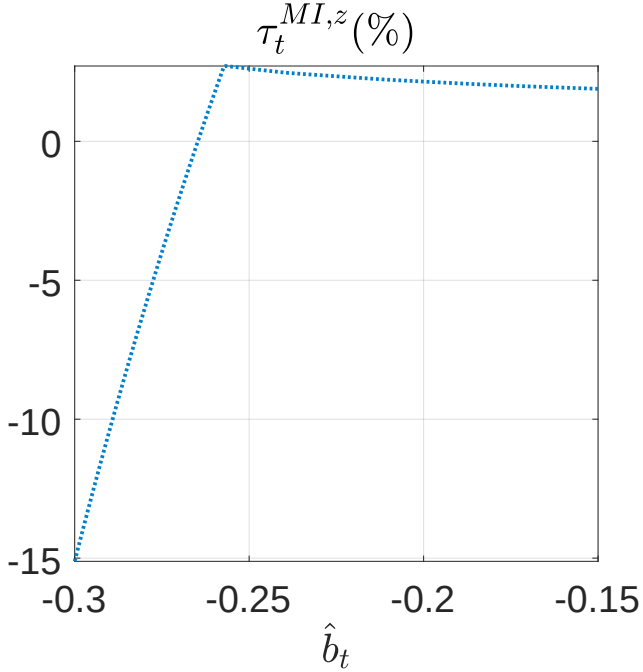






Size of Policies





	Capital Flows Tax	Growth Subsidy
MP	1.28	N.A.
MI	1.12	1.00
MI (Ex-ante)	1.10	1.87
MI (Ex-post)	1.19	−1.78

Conclusion

Conclusion and Future Work

- Main findings
  - Policy's impact on average growth is ambiguous
  - Quantitative results
    - macroprudential policy significantly reduces financial instability
    - but only lowers average growth by a small amount
  - Macroprudential policy is desirable
    - gains equivalent to 0.06% of permanent increase in consumption
  - Gains are larger with stimulus policy
- Future work: study other policies such as reserve, bailout, etc.