Strategic Macroprudential Policymaking: When Does Cooperation Pay Off?

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Introduction

Research Questions:

(i) Can Emerging Economies benefit from Cooperative Macroprudential Policies

(ii) Are cooperative arrangements useful in protecting these economies from External Shocks

Related: How do Centers respond to potential Regional Cooperation by peripheries?

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Motivation:

- Global Financial Cycle Literature (Rey, 2013) : EMEs are at the mercy of the cycles imposed by Financial Centers.

- Forbes (2019, AER, P&P): Effects of Macro-prudential policies
  *"Accumulating evidence that [Macroprudential policies] can be effective on its direct targets, **albeit often with unintended leakages and spillovers**. There has been less progress in terms of understanding the ramifications of these leakages"*

- BIS, G20: Large Complex Financial Institutions (LCFIs) in economic centers are at the core of Financial Crises:
  - Basel I, II: Recommendations for all countries (not legally binding) - Basel III: Focus on moral hazard by LCFIs
  - Financial Stability Board: Priority $\rightarrow$ promote coordinated program of reforms

What I do

Set a Multi-**periphery** Open Economy Model with Banking **Frictions** and Solve for the Optimal **Policies** of several **Regimes** with different types of Cooperation.

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Periphery/EMEs: Countries with limited financial development that must rely on lending from a Center.

$\Rightarrow$ I consider regional (EMEs) interactions while accounting for financial spillovers from Advanced Economies

Frictions: financial agency frictions in lending relationships that imply augmented credit spreads and cycles.

Policies: Macroprudential taxes on banks (or leverage caps) set to fight the distortion by smoothing credit cycles.

Regimes: with multiple (3) economies I can study cooperative and semi-cooperative (sub-coalitions) frameworks.

Contribution: this is the first paper that considers: **(i)** the interactions of EMEs with general equilibrium effects, **(ii)** that face an active Center exerting strong policy spillovers and **(iii)** a larger menu of cooperative regimes.

Studies on the Coordination of Macroprudential Policies

Related Literature

Capital Controls: Korinek (2020, REStud), Jin and Shen (2020, RED), Devereux and Davis (2021, AEJ-Macro)

K2020, DD2021: Gains due to nullified national incentives to distort TOT in presence of non-competitive planners.

one of my mechanisms is analogous but I show it in a scenario with banking frictions

JS2020: Gains generated by pooled SOE national incentives to distort the interest rates.

My mechanism works in the opposite direction $\longrightarrow$ **Reason:** My Center can react to the Cooperative policies of EMEs.

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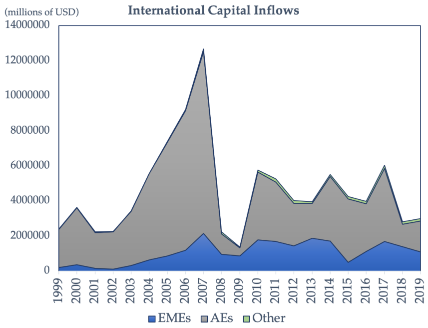
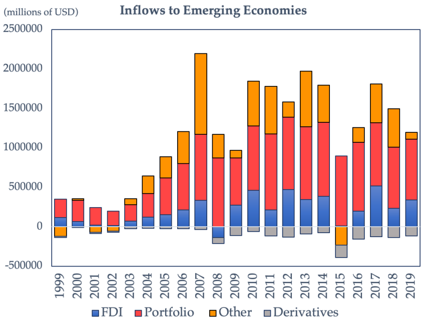
In adition: I find **another** welfare increasing mechanism from cooperation $\longrightarrow$ unique to banking frameworks

Capital flows empirics

Total flows: switch toward emerging economies

Type of flows: Increase is concentrated in short term flows (portfolio + banking) $\longrightarrow$ **highly volatile**



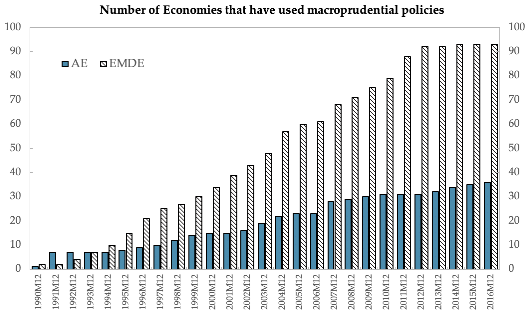


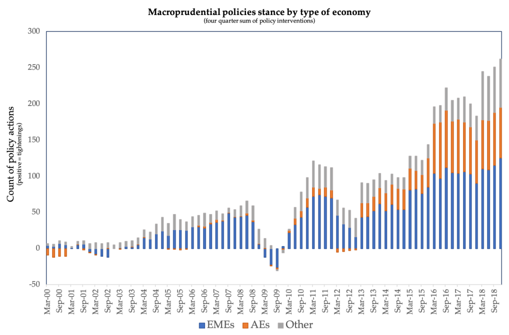
Source: IMF-IFS amd BOP statistics.

Policy Response

In response the macroprudential policies have been used more in EMEs

Most frequent policy: Tightening





Source: Left panel: Alam et al (2019), right: IMF-iMaPP (2019)

Possible cross-border comovement patterns: **The MaP Policies have an international dimension**.

Can governments exploit this dimension to improve MaP policy implementation?

Results Preview

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- Sources of gains:

  (1) Cancellation of Incentives to Manipulate Interest Rates to boost NFA

  (2) Higher Incentives to Steer K Flows to Productive Destinations (EMEs)
- Mechanisms work better with more participating EMEs (social gains boosted).

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- Smoother capital accumulation and mitigated deleveraging processes under Center-Periphery(ies) cooperation.

A small 3-period model

As an initial approximation I set a toy model to analyze the main mechanisms at play.

Three periods ($t = \{1, 2, 3\}$) and Three country model, with two EMEs (a, b) and a Center (c).

LOE setup: Each economy has a size n_i with $i = \{a, b, c\}$ and $\sum_i n_i = 1$ and $n_c \geq \frac{1}{2}$

Production takes place by aggregating capital.

Initial capital is given, after that the banks intermediate it $\rightarrow$ 2 periods of intermediation.

Agent	**Role**
Households	Buy consumption goods, assets (bonds, deposits), own firms, and pay a lump sum tax (-)
Investors	Buy old capital and produce new capital goods to generate investment
Firms	Produce consumption good, sell undepreciated capital. **Funds capital with banking loans**
Government	Balanced budget, levies macroprudential tax on banks, rebates it to households
Banks	Lend to firms and participate in the interbank market (EMEs borrow from Center). Reinvest/retain profits if continuing in business **Subject to a costly enforcement friction** $\Rightarrow$ **charged with a MaP Tax**

▸ Households ▸ Final Good Firms ▸ Capital Firms ▸ Bank-EMEs ▸ Bank-Center ▸ Government

Numerical exercise - Policy effect on Welfare

I solve the model for several combinations of taxes and approximate the marginal effect of a tax on welfare:

Effect		Change in tax 1%	3%	5%	8%
Direct effect of $\mathcal{T}2$	$\tau^a \rightarrow W^a$	0.146	0.144	0.142	0.138
	$\tau^b \rightarrow W^b$	0.146	0.144	0.142	0.138
	$\tau^c \rightarrow W^c$	-0.242	-0.457	-0.179	-0.027
Cross-border effect	$\tau^a \rightarrow W^b$	-0.047	-0.047	-0.047	-0.048
	$\tau^a \rightarrow W^c$	-0.016	-0.017	-0.017	-0.017
	$\tau^b \rightarrow W^a$	-0.047	-0.047	-0.047	-0.048
	$\tau^b \rightarrow W^c$	-0.016	-0.017	-0.017	-0.017
	$\tau^c \rightarrow W^a$	-0.162	-0.226	-0.180	-0.155
	$\tau^c \rightarrow W^b$	-0.162	-0.226	-0.180	-0.155
Direct effect of $\mathcal{T}3$	$\tau^a \rightarrow W^a$	0.057	0.057	0.056	0.056
	$\tau^b \rightarrow W^b$	0.057	0.057	0.056	0.056
	$\tau^c \rightarrow W^c$	-0.087	-0.122	-0.243	-0.134
Cross-border effect	$\tau^a \rightarrow W^b$	-0.018	-0.018	-0.018	-0.018
	$\tau^a \rightarrow W^c$	0.006	0.005	0.004	0.003
	$\tau^b \rightarrow W^a$	-0.018	-0.018	-0.018	-0.018
	$\tau^b \rightarrow W^c$	0.006	0.005	0.004	0.003
	$\tau^c \rightarrow W^a$	-0.051	-0.059	-0.087	-0.074
	$\tau^c \rightarrow W^b$	-0.051	-0.059	-0.087	-0.074

Note: change approximated with respect to the no-policy case as $\frac{\Delta W}{\Delta \tau} \approx \frac{\partial W}{\partial \tau}$.

Center has a stronger cross-country policy effect.

Positive Policy Spillover from Center taxes: EMEs may want to free-ride

Stronger Effects from Forward Looking taxes (τ_2) than from static (τ_3): Why? $\longrightarrow$ **retained banking profits**

$\Rightarrow$ New w/ Banking Regulation: MaP Policy has Long-lasting (strong) effect on the Economy

Optimal Taxes: Cooperative Planner

The cooperative tax equals the non-cooperative one $\cdots$

$$\tau_3^{c,coop} = \tau_3^{c,nash} \quad \cdots \tag{1}$$

Optimal Taxes: Cooperative Planner

The cooperative tax equals the non-cooperative one $\cdots$ plus a wedge:

$$\tau_3^{c,coop} = \tau_3^{c,nash} - \frac{\lambda_2^a}{\lambda_2^c} \overbrace{\frac{Q_2^c}{r_3^c}\frac{B_2^c}{R_2}\frac{dR_2}{dF_2^{ab}}}^{\text{1: interest rate manipulation motive}} + \overbrace{\frac{Q_2^c}{\Lambda_{23} r_3^c}\frac{\lambda_2^a}{\lambda_2^c}\left\{\alpha_5(\kappa)\frac{dK_2^a}{dF_2^{ab}} + \alpha_4(\kappa)\frac{dQ_2^a}{dF_2^{ab}}\right\}}^{\text{2: Reallocation of capital incentive}} \quad (1)$$

$\frac{\partial \alpha_s(\kappa)}{\partial \kappa} > 0$ for $s = \{4, 5\}$. (one of the new mechanisms increase with the friction)

1: Present in any country with (net foreign assets) NFA $\neq 0$

2: Is present only in the Center due to its global creditor role

This wedge allows me to explain differences in performance between policy regimes.

tax of EME

Main Model

- For a comprehensive welfare comparison in a stochastic environment I set a larger scale model
- Infinite horizon with discrete time ($t = 1, 2, 3, \ldots$)
- Three economies: Center with size $n_c = 1 - n_a - n_b$ and two EMEs: a and b with sizes n_a and n_b with $n_a + n_b \leq \frac{1}{2}$
- There is an international financial market where the households trade non-contingent bonds.
- Agents: Households, Production Sector (final consumption good and capital), **Banks** and Government.
- EMEs banks have limited capacity to take in local deposits $\longrightarrow$ **Instead: EMEs banks rely on loans from the financial Center banks.**

▸ Households ▸ Final Good Firms ▸ Capital Firms ▸ Bank-EMEs ▸ Bank-Center ▸ Government Skip

Banking Sector - EMEs

Sector targeted by Macroprudential policies. Set-up based on Gertler and Karadi (2011).

Banks start with a bequest from the households and continue their activities with prob. $\theta \Rightarrow$ **there is exit**

N^e_{jt} : net worth, F^e_{jt} : interbank borrowing j at a rate $R^e_{b,t}$

Balance sheet of the bank j: $$Q^e_t Z^e_{jt} = N^e_{jt} + F^e_{jt} \qquad \text{(e: EME)}$$

Aggregate net worth of sector : $$N^e_t = \underbrace{\theta N^e_{j,t}}_{\text{surviving banks}} + \underbrace{\delta_T Q^e_t K^e_{t-1}}_{\substack{\text{new banks} \\ \text{start-up K}}}$$

$N^e_{j,t}$: net worth of surviving banks: $$N^e_{j,t} = R^e_{k,t} Q^e_{t-1} Z^e_{j,t-1} - R^e_{b,t-1} F^e_{j,t-1}$$

Gross return on capital (after-tax): $$R^e_{k,t} = \xi^e_t \frac{(1-\tau^e_{k,t}) r^e_t + (1-\delta) Q^e_t}{Q^e_{t-1}}$$

$\tau^e_{k,t}$: macroprudential tax/subsidy

Banking Sector - EMEs (cont.)

Agency problem in EMEs

Lending contracts subject to **limited enfoceability**: a bank can default and run away with a portion κ^e of the assets.

The j banker solves:

$$J^e(N^e_{j,t}) = \mathbb{E}_t \max_{N_t, Z^e_t, V^e_{s,t}} (1-\theta) \sum_{s=0}^{\infty} \Lambda^e_{t+1+s} [\theta^s N^e_{j,t+1+s}]$$

s.t.: net worth ($N^{e_i}_{j,t}$) dynamics and ICC:

$$\underbrace{J^e_{j,t}}_{\text{value of bank}} \geq \underbrace{\kappa^e Q^e_t Z^e_{s,t}}_{\text{value of defaulting}}$$

ICC: the continuation value of the bank is larger than the profit from defaulting.

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FOCs:

$$[Z_t]: \qquad \mathbb{E}_t\{\Omega_{t+1|t}(R^{e_i}_{k,t+1} - R^{e_i}_{b,t})\} = \mu^e_t \kappa^e$$

Envelope cond.:

$$[N^e_{j,t}]: \qquad J^{e'}(N^e_{j,t})(1-\mu^{e_i}_t) = \mathbb{E}_t\{\Omega_{t+1|t} R^e_{b,t}\}$$

$\mu^{e_i}_t$: Lagrange mult.(ICC), $\Omega_{t+1|t} = \Lambda^e_{t+1}(1-\theta+\theta J^{e'}_{t+1})$: effective pricing kernel of banks

Back

Banking sector - Center Country

Most of the sectors are analogous to the EMEs. However, the banking sector differs in their degree of development and agency frictions.

Implications:

- Center banks can intermediate local deposits without restrictions.
  - Foreign lending flows from center to peripheries.
- Agency frictions present but can be milder.

The balance sheet of bank j:

$$F^a_{j,t} + F^b_{j,t} + Q^c_t Z^c_{j,t} = N^c_{jt} + D^c_t$$

where $F^e_{j,t}$: claims on the j-th representative peripheral bank and $Q^c_t Z^c_{j,t}$: claims on the core country capital stock.

Return on capital is given as before: $R^c_{k,t} = \xi^c_t \frac{(1-\tau^c_{k,t})r^c_t + (1-\delta)Q^c_t}{Q^c_{t-1}}$

Banking sector - Center Country (cont.)

The bank j value function is:

$$J^c_{j,t}(N^c_{j,t}) = \mathbb{E}_t \max_{N^c_{j,t}, Z^c_t, F^e_{s,t}, D^c_t} \Lambda^c_{t+1} \Big[(1-\theta)(\underbrace{R^c_{k,t+1} Q^c_t Z^c_{j,t} + R^a_{b,t} F^a_{j,t} + R^b_{b,t} F^b_{j,t}}_{\text{gross return on assets}} - \underbrace{R^c_{D,t} D^c_t}_{\substack{\text{deposits} \\ \textit{repayment}}}) + \theta J^c_{j,t+1}(N^c_{j,t+1}) \Big]$$

The bank determines such value while being subject to an incentive compatibility constraint:

$$J^c_{jt} \geq \kappa^c_{F_a} F^a_{jt} + \kappa^c_{F_b} F^b_{jt} + \kappa^c Q_{c,t} Z^c_{j,t} \tag{ICC-C}$$

with $\kappa^c_F, \kappa^c > 0$, i.e., the pledgeable fraction can be asymmetric across assets.

The FOCs will reflect the spread and friction for each type of lending relationship

FOCs
Back

Ramsey Policy Problem

Solution criterion: *open-loop Nash* equilibrium. definition

Given an initial state, the players define their sequence of actions taking the path of tools for other players as given

Cooperation: objective function of the planner is the weighted average of the welfare of coalition participants.

Problem of the planner (under commitment):

$$\hat{W}_{coop,0} = \max_{\mathbf{x}_t, \boldsymbol{\tau}_t} [n_a \hat{W}_0^a + n_b \hat{W}_0^b + (1 - n_a - n_b) \hat{W}_0^c]$$

s.t.,

$$\mathbb{E}_t F(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}, \boldsymbol{\tau}_{t-1}, \boldsymbol{\tau}_t, \boldsymbol{\tau}_{t+1}; \boldsymbol{\varphi}_t) = 0$$

$\mathbf{x}_t$ is the vector of endogenous variables, $\boldsymbol{\tau}_t = (\tau_t^a, \tau_t^b, \tau_t^c)'$ the instruments, and φ_t is a vector of exogenous variables and shocks.

Semi-cooperative cases: subsets of countries form a coalition.

Problem of Cooperation between Center and **One** EME:

$$\hat{W}_{coopAC,0} = \max_{\mathbf{x}_t, \tau_t^a, \tau_t^c} [n_a \hat{W}_0^a + n_c \hat{W}_0^c]$$

$$\text{s.t.,} \qquad \mathbb{E}_t F(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}, \boldsymbol{\tau}_{t-1}, \boldsymbol{\tau}_t, \boldsymbol{\tau}_{t+1}; \boldsymbol{\varphi}_t) = 0$$

Regional (EMEs) cooperation case:

$$\hat{W}_{coopEME,0} = \max_{\mathbf{x}_t, \tau_t^a, \tau_t^b} [n_a \hat{W}_0^a + n_b \hat{W}_0^b]$$

$$\text{s.t.,} \qquad \mathbb{E}_t F(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}, \boldsymbol{\tau}_{t-1}, \boldsymbol{\tau}_t, \boldsymbol{\tau}_{t+1}; \boldsymbol{\varphi}_t) = 0$$

Nash: A **non-cooperative** planner at country $j = \{a, b, c\}$ maximizes the national welfare:

$$\hat{W}^j_{nash,0} = \max_{\mathbf{x}_t, \tau_t^j} \hat{W}_0^j$$

$$\text{s.t.,} \qquad \mathbb{E}_t F(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}, \boldsymbol{\tau}_{t-1}, \boldsymbol{\tau}_t, \boldsymbol{\tau}_{t+1}; \boldsymbol{\varphi}_t) = 0$$

I compute optimal policies and **conditional welfare** for all regimes and compare it to the First Best (frictionless eq.)

Welfare Gains method Solution method

[detour] Ramsey Models' Solution Algorithm

1. Obtain conditions characterizing the equilibrium of each regime:
   - Obtain Private Equilibrium FOCs (1)
   - Use (1) as constraint of Planner(s) Problem(s) $\longrightarrow$ get policy FOCs (2)

2. Find Steady State of Ramsey Problem
   - Infinite solutions
   - Then focus on **Instrument Conditional Steady State** as in Christiano, Motto, Rostagno (2007)

Steady State Details

3. Solve system $[(1);(2)]$ via perturbation.

Issues:

- With multiple planners have to find intersection of best policy responses (Open Loop Nash Eq.)

definition

- Cannot just use Dynare or Toolkits because of multiplicity of planners (up to 3)
  (Toolkits: Lopez-Salido and Levin (2004), Lombardo's OPDSGE, Bodenstein et al (2020))
- Steady State may not be unique (comes from a numerical search)
- Potential Indeterminacy Problems $\longrightarrow$ workaround: Commitment (impose time consistency)

RESULTS

Welfare Comparison

Consumption Equivalent Compensation by Policy Regimes:

	Nash	Cooperation (Center+EME-A)	Cooperation (EMEs)	Cooperation (All)
C	-11.7	2.9	-13.2	-3.9
A	-19.5	0.4	-27.4	-2.4
B	-19.5	-28.3	-27.4	-2.4
World	**-15.6**	**-5.5**	**-20.4**	**-3.2**
EMEs	-19.5	-13.9	-27.4	-2.4

Notes: Compensation using the First Best as benchmark.

In Cooperation symmetry between instruments rules is assumed for EMEs

- Welfare Ranking:

$Coop \succcurlyeq CoopAC \succcurlyeq Nash \succcurlyeq CoopEME$

Interpretation: An agent transitioning from the First Best to Cooperation experiences a welfare loss equivalent to a 3% consumption loss.

alternative method | steady state of taxes

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- EMEs: better with Nash than with regional cooperation.

Peripheries improve with coop. only if Center joins.

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B	-19.5	-28.3	-27.4	-2.4
World	**-15.6**	**-5.5**	**-20.4**	**-3.2**
EMEs	-19.5	-13.9	-27.4	-2.4

Notes: Compensation using the First Best as benchmark.

In Cooperation symmetry between instruments rules is assumed for EMEs

Interpretation: An agent transitioning from the First Best to Cooperation experiences a welfare loss equivalent to a 3% consumption loss.

alternative method | steady state of taxes

- Welfare Ranking:

$Coop \succcurlyeq CoopAC \succcurlyeq Nash \succcurlyeq CoopEME$

- Cooperation **by the Center** matters.

Not every type of cooperation improves on Nash

- EMEs: better with Nash than with regional cooperation.

Peripheries improve with coop. only if Center joins.

- Distribution of gains:

Enforcing the best social outcome (Coop) can be **challenging**: A and C are both better if they form a coalition (Coop(A+C))

Sources of the Gains

We can understand the mechanisms driving the gains by analyzing the wedge between optimal policies:

$$\tau_3^{c,coop} = \tau_3^{c,nash} - \overbrace{\varphi_3^{c,NFA}}^{\substack{\text{portfolio} \\ \text{cancellation effect}}} + \overbrace{\psi_3^{eme}(\kappa)}^{\text{Relocation of K incentive}}$$

Mechanism 1: *Higher Smoothness of Cooperative Taxes* ($\varphi^{c,NFA}$)

National incentives to manipulate the interest rates to improve the NFA portfolio are cancelled out.

Motive present in every country $\rightarrow$ But **Cancellation works only** if Creditors' (C) & Debtors' incentives are pooled

Explaining why $Coop(EMEs)$ is counterproductive.

Mechanism 2: *Substitution of local (c) for global (a,b) intermediation* (ψ^{eme})

Cooperative planner prioritizes global (not national) economic performance $\rightarrow$ boosted steering K inflows to EMEs

Policy incentive present only at the Center (given role as Global Creditor)

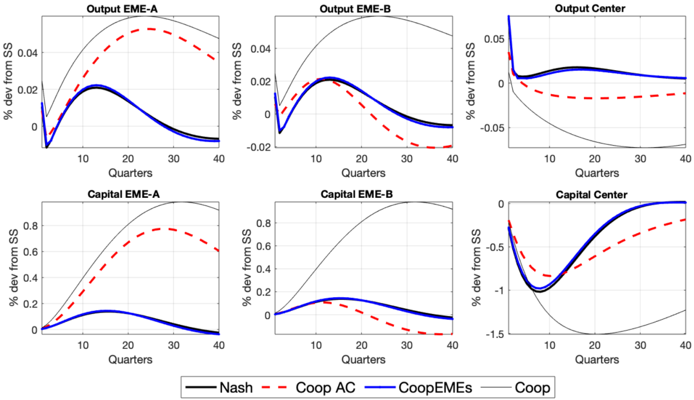
1 and 2 increase financial stability; **2** improves efficiency of capital flows.

other welfare features

IRFs: Dynamic of variables and policies

Cases of interest: Shocks that originate in the Center

IRFs: Negative Financial Shock at the Center

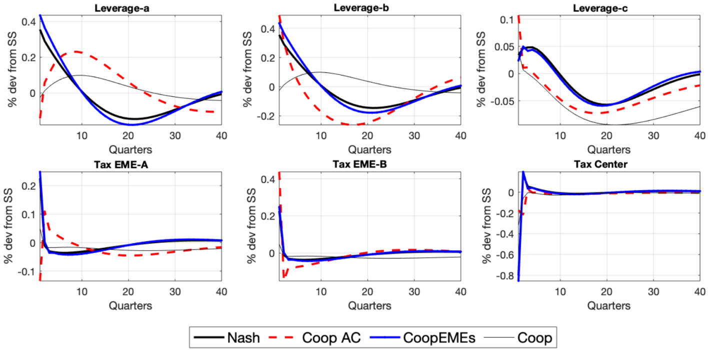


World Cooperative Model is the Best regime at protecting the Output of EMEs

Divergent Crisis Management Strategies:

	Cooperative Planner	**National Planner**
Objective:	Global Economic Recovery	National Recovery
Strategy:	Increase Inflows to EMEs	Increase Capital Stock of Center (shock epicenter)

IRFs: (-) Financial shock on country C - Financial Variables and Policies



EMEs: Increase in Leverage is smoothed under cooperation $\longrightarrow$ mitigating deleveraging process.

Center: non-cooperative planner encourages the local recovery pushing up leverage

Other financial vars.

Taxes: countercyclical response (tax at EMEs, subsidize at Center)

W/ cooperation taxes are smoother and move on narrower range $\rightarrow$ prevents unnecessary policy fluctuations (comp.adv.)

Non-cooperative Center planners subsidize the banking sector locally (Nash and Coop(EMEs))

Conclusions Prod. Shock

Conclusions

- I set a multicountry open economy model with financially integrated banks in a dynamic setup
  Dynamic $\Rightarrow$ banking and policy have persistent effects $\Rightarrow$ Substantial Welfare difference across regimes

- Welfare Accounting Ranking: **Coop $\succcurlyeq$ CoopAC $\succcurlyeq$ Nash $\succcurlyeq$ CoopEME**

- There are gains from coordination. However, **only when coordinating with the Center**.

- **Regional Coordination can be detrimental**. EMEs may be worse off by forming a coalition.

- Sources of Gains: Elimination of National Incentives to Manipulate the Interest Rates $\longrightarrow$ (stable taxes)
  Higher incentives to steer K inflows to EMEs

- Gains are higher if more EMEs participate $\longrightarrow$ good cooperation: 12% of Consumption + 1 EME: 15% (wrt not coop.)

- The EMEs have high incentives to be part of a coalition with a Center.
  - But prefer other peripheries not to participate
  - (Problematic) Center is better off in smaller coalitions

- **Recommendation:** Given a participating Center, promote EMEs cooperation, even regionally (the more the better)

Thank You!

Analytical exercise: Welfare effects

Following Davis and Devereux (2021) I set a social planner problem and simplify the welfare with the eq. conditions.

Then we can obtain expressions for the welfare policy effects:

For the EMEs:

$$\frac{dW_0^a}{d\tau_2^a} = \beta\lambda_2^a \left\{ \overbrace{\alpha_1(\kappa)\frac{\mathbf{dK_1^a}}{\mathbf{d\tau_2^a}} + \alpha_2(\kappa)\frac{\mathbf{dQ_1^a}}{\mathbf{d\tau_2^a}} + \frac{B_1^a}{R_1}\frac{\mathbf{dR_1}}{\mathbf{d\tau_2^a}} + \alpha Y_2^a}^{\text{static effects}} + \overbrace{\alpha_3(\kappa)\frac{\mathbf{dK_2^a}}{\mathbf{d\tau_2^a}} + \alpha_4(\kappa)\frac{\mathbf{dQ_2^a}}{\mathbf{d\tau_2^a}} + \frac{B_2^a}{(R_2)^2}\frac{\mathbf{dR_2}}{\mathbf{d\tau_2^a}}}^{\text{dynamic effects}} \right\}$$

Terminal taxes only have *static effects*

Other expressions

The Center also depicts effects from changes in global intermediation.

Expression for Center

The effects grow with the financial distortion: $\frac{\partial \alpha_s(\kappa)}{\partial \kappa} > 0$ for $s = \{1, 2, 3, 4\}$.

Drivers of Welfare effects: **(i)** Hindering K accumulation **(-)**

(ii) Changes in global rates ($\propto$ NFA)

(iii) Changes in prices of capital

(iv) Changes in cross-border rates and quantities **(for Center)**

Optimal Tax (non-cooperative)

Households

The household lifetime utility is given by $U = u(c_1) + \beta u(c_2) + \beta^2 u(c_3)$ with $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$.

The budget constraints:

Emerging markets:

$$C_1^s + \frac{B_1^s}{R_1^s} = r_1^s K_0^s + \pi_{f,1}^s + \pi_{inv,1}^s - \delta_B Q_1^s K_0^s$$

$$C_2^s + \frac{B_2^s}{R_2^s} = \pi_{f,2}^s + \pi_{inv} + \pi_{bank,2}^s - \delta_B Q_2^s K_1^s + B_2^s - T_2^s, \quad for\ s = \{a, b\}$$

$$C_3^s = \pi_{f,3}^s + \pi_{bank,3}^s + B_2^s - T_3^s, \quad for\ s = \{a, b\}$$

Advanced Economy:

$$C_1^c + \frac{B_1^c}{R_1^c} + \boldsymbol{D_1} = r_1^c K_0^c + \pi_{f,1}^c + \pi_{inv,1}^c - \delta_B Q_1^c K_0^c$$

$$C_2^c + \frac{B_2^c}{R_2^c} + \boldsymbol{D_2} = \pi_{f,2}^c + \pi_{inv,2}^c + \boldsymbol{\pi_{bank,2}^c} - \delta_B Q_2^c K_1^c + R_{D,1} D_1 + B_1^c - T_2^c$$

$$C_3^c = \pi_{f,3}^c + \boldsymbol{\pi_{bank,3}^c} + B_2^c + R_{D,2} D_2 - T_3^c$$

back to summary

Investors

The investment decision is now intertemporal.

This is reflected in adjustment costs that penalize the growth in investment.

The investor solves:

$$\max_{I_1} \mathbb{E}_t \sum_{i=0}^{2} \Lambda_{t,t+i} \left\{ Q_{t+i} I_{t+i} - I_{t+i} \left(1 + \frac{\zeta}{2} \left(\frac{I_{t+i}}{I_{t+i-1}} - 1 \right)^2 \right) \right\}$$

the F.O.C is,

$$[I_t] : \qquad Q_t = 1 + \frac{\zeta}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 + \zeta \left(\frac{I_t}{I_{t-1}} - 1 \right) \frac{I_t}{I_{t-1}} - \mathbb{E}_t \Lambda_{t,t+1} \zeta \left(\frac{I_{t+1}}{I_t} - 1 \right) \left(\frac{I_{t+1}}{I_t} \right)^2$$

For the first period, we take as I_0 the Steady state value. We will abstract from the last term for $t = 3$.

back to summary

Firms

Technology: The firm operates with a Cobb-Douglas technology that aggregates capital: $Y_t = A_t(\xi_t K_{t-1})^\alpha$

Capital:

- The capital dynamics for an accumulation period: $K_t = I_t + (1-\delta)\xi_t K_{t-1}$
- First period: given (K_0), rented directly to firms by households => Standard Competitive Firm PMP in $t = 1$
- Other periods: **the EME relies on lending for funding capital accumulation** $\rightarrow$ firms fund K_1 with banks loans.

The problem of the firm for $t = 2, 3$ is:

$$\max_{K_t} \pi_{f,t} = Y_t + \underbrace{Q_t(1-\delta)\xi_t K_1}_{\text{sales of leftover capital}} - \underbrace{R_{k,t} Q_{t-1} K_{t-1}}_{\text{repayment to banks}} \qquad s.t. \quad Y_t = A_t(\xi_t K_{t-1})^\alpha$$

back to summary

Intermediation Returns & The Government

From the F.O.C. we get $R_{k,t}$, the gross **return from intermediation for the bank**. This is the variable targeted by the policy tool:

$$R_{k,t} = \frac{(1 - \tau_t) r_t + (1 - \delta) \xi_t Q_t}{Q_{t-1}}$$ After tax rate

for $t = \{2, 3\}$ and with $r_t = \alpha \frac{Y_t}{K_{t-1}}$

τ_t is the macro-prudential policy tool: a tax/subsidy on the bankers revenue rate.

Notice:

τ_2 has contemporaneous and future effects via retained banking profits $\longrightarrow$ it is a **forward-looking tool**

τ_3 only affects the contemporaneous profits of the terminal period $\longrightarrow$ it is a **static tool**

Government:

Setting and enforcing the rate is the only role of the government which will have a balanced budget constraint:

$$T_t + r_t K_{t-1} = 0$$

back to summary

The EME bank's problem in $t = 1$: maximize the expected franchise present value

$$J_1 = \max_{F_1, L_1} \mathbb{E}_1 \Big\{ \overbrace{(1-\theta)\Lambda_{1,2}(R_{k,2}L_1 - R_{B,1}F_1)}^{\text{Pr(Exit)*profits}_{t=2}} + \overbrace{\Lambda_{1,3}\theta(R_{k,3}L_2 - R_{B,2}F_2)}^{\text{Pr(Survive)*profits}_{t=3}} \Big\}$$

$$\begin{aligned} s.t \quad & L_1 = F_1 + \delta_B Q_1 K_0 && \text{[Balance sheet } t = 1\text{]} \\ & L_2 = F_2 + \delta_B Q_2 K_1 + \theta[R_{k,2}L_1 - R_{B,1}F_1] && \text{[Balance sheet } t = 2\text{]} \\ & J_1 \geq \kappa \cdot Q_1 K_1 && \text{[ICC } t = 1\text{]} \end{aligned}$$

where the $L_1 = Q_1 K_1$ is the total lending intermediated. F_1 is the foreign lending, θ is the survival rate of the banks. $\Lambda_{t,t+j}$ is a Stochastic Discount Factor j periods apart.

the F.O.C. implies a positive credit spread when the ICC binds:

$$[F_1]: \qquad \Omega_1(1-\mu_1)(R_{k,2} - R_{B,1}) = \mu \cdot \kappa$$

μ: lagrange multiplier of the ICC.

$\Omega_1 = (1-\theta)\Lambda_{1,2} + \theta^2 R_{k,3}\Lambda_{1,3}$

Bank's problem for $t = 2$: Max. value of the bank but with NO continuation value.

$$J_2 = \max_{F_2, L_2} \mathbb{E}_2 \left\{ \Lambda_{2,3} (R_{k,3} L_2 - R_{B,2} F_2) \right\}$$

$$s.t.$$

$$L_2 = F_2 + \delta_B Q_2 K_1 + \theta [R_{k,2} L_1 - R_{B,1} F_1] \qquad \text{[Balance sheet } t = 2\text{]}$$

$$J_2 \geq \kappa Q_2 \cdot K_2 \qquad \text{[ICC } t = 2\text{]}$$

where the $L_1 = Q_1 K_1$ is the total lending intermediated.

the F.O.C. implies a positive credit spread when the ICC binds:

$$[F_2]: \qquad \mathbb{E}_2 (R_{k,3} - R_{B,2}) = \mu_2 \cdot [\kappa - \mathbb{E}_2 (R_{k,3} - R_{B,2})]$$

back to summary

In $t = 1$ the center economy bank solves:

$$J_1 = \max_{F_1^a, F_1^b, L_1^c, D_1} \mathbb{E}_1 \left\{ (1-\theta)\Lambda_{1,2}(R_{k,2}L_1 + R_{B,1}^a F_1^a + R_{B,1}^b F_1^b - R_{D,1}D_1) + \Lambda_{1,3}\theta(R_{k,3}L_2 + R_{B,2}^a F_2^a + R_{B,2}^b F_2^b - R_{D,2}D_2) \right\}$$

$$s.t \quad L_1 + F_1^a + F_1^b = D_1 + \delta_B Q_1 K_0 \qquad \text{[Balance sheet } t = 1\text{]}$$

$$L_2 + F_2^a + F_2^b = D_2 + \delta_B Q_2 K_1 + \theta[R_{k,2}L_1 + R_{B,1}^a F_1^a + R_{B,1}^b F_1^b - R_{D,1}D_1] \qquad \text{[Balance sheet } t = 2\text{]}$$

the associated F.O.C. are:

$$[F_1^a] : \qquad \mathbb{E}_1 \Omega_1 (R_{B,1}^a - R_{D,1}) = 0$$

$$[F_1^b] : \qquad \mathbb{E}_1 \Omega_1 (R_{B,1}^b - R_{D,1}) = 0$$

$$[L_1^c] : \qquad \mathbb{E}_1 \Omega_1 (R_{k,2}^c - R_{D,1}) = 0$$

With no agency problem in the Center FOC just reflect an zero credit spread in expectation.

In $t = 2$ the center economy bank solves:

$$J_2 = \max_{F_2^a, F_2^b, L_2^c, D_2} \mathbb{E}_2 \left\{ \Lambda_{2,3} (R_{k,3} L_2 + R_{B,2}^a F_2^a + R_{B,2}^b F_2^b - R_{D,2} D_2) \right\}$$

$s.t$

$$L_2 + F_2^a + F_2^b = D_2 + \delta_B Q_2 K_1 + \theta [R_{k,2} L_1 + R_{B,1}^a F_1^a + R_{B,1}^b F_1^b - R_{D,1} D_1] \qquad \text{[Balance sheet } t = 2\text{]}$$

the associated F.O.C. are:

$$\begin{aligned} [F_2^a] : \quad & \mathbb{E}_2 (R_{B,2}^a - R_{D,2}) = 0 \\ [F_2^b] : \quad & \mathbb{E}_2 (R_{B,2}^b - R_{D,2}) = 0 \\ [L_2^c] : \quad & \mathbb{E}_2 (R_{k,3}^c - R_{D,2}) = 0 \end{aligned}$$

back to summary

Other effects from taxes

For the EMEs:

$$\frac{dW_0^a}{d\tau_3^a} = \beta\lambda_2^a \left\{ \alpha_5(\kappa)\frac{dK_2^a}{d\tau_3^a} + \alpha_4(\kappa)\frac{dQ_2^a}{d\tau_3^a} + \frac{B_2^a}{(R_2)^2}\frac{dR_2}{d\tau_3^a} + \alpha\frac{Y_3^a}{R_2} \right\}$$

with $\alpha_4(\kappa) = I_2^a + \kappa\left(1-\theta\Lambda_{23}\right)K_2^a, \alpha_5(\kappa) = \kappa\left(1-\theta\Lambda_{23}\right)Q_2^a + \varphi\left(\tau_3^a\right)\Lambda_{23}r_3^a$

and for the Center:

$$\frac{dW_0^c}{d\tau_2^c} = \overbrace{\beta\lambda_2^c \left\{ \gamma_1\frac{dK_1^c}{d\tau_2^c} + \left(\frac{B_1^c}{R_1} - \theta D_1\right)\frac{dR_1}{d\tau_2^c} + \frac{K_1^c}{R_1}\frac{dQ_1^c}{d\tau_2^c} + \alpha\theta Y_2^c + (1-\theta)\left(F_1^{ab}\frac{dR_{b,1}^{eme}}{d\tau_2^c} + R_{b,1}^{eme}\frac{dF_1^{ab}}{d\tau_2^c}\right)\right\}}^{\text{static effects}}$$

$$\underbrace{+\beta^2\lambda_3^c\left\{\gamma_2\frac{dK_2^c}{d\tau_2^c} + \frac{B_2^c}{R_2}\frac{dR_2}{d\tau_2^c} + \gamma_3\frac{dQ_2^c}{d\tau_2^c} + F_2^{ab}\frac{dR_{b,2}^{eme}}{d\tau_2^c} + R_{b,2}^{eme}\frac{dF_2^{ab}}{d\tau_2^c}\right\}}_{\text{dynamic effects}}$$

$$\frac{dW_0^c}{d\tau_3^c} = \beta^2\lambda_3^c\left\{\gamma_2\frac{dK_2^c}{d\tau_3^c} + \frac{B_2^c}{R_2}\frac{dR_2}{d\tau_3^c} + \gamma_3\frac{dQ_2^c}{d\tau_3^c} + F_2^{ab}\frac{dR_{b,2}^{eme}}{d\tau_3^c} + R_{b,2}^{eme}\frac{dF_2^{ab}}{d\tau_3^c}\right\}$$

With $\gamma_1 = \left(1-\alpha\theta\left(1-\tau_2^c\right)\right)r_2^c + (1-\theta)(1-\delta)Q_2^c$, $\gamma_2 = \left(r_3^c + (1-\delta)Q_3\right)$, $\gamma_3 = R_2\left(I_2^c + (1-\theta)(1-\delta)K_1^c\right)$, and $F_t^{ab} = F_t^a + F_t^b$.

back

Optimal Taxes: National Planner

From the welfare effects expressions we can back out the optimal taxes.

The optimal tax for a nationally oriented planner at the Center is:

$$\tau_3^{c,nash} = \frac{Q_2^c}{r_3^c}\left\{\gamma_2 \frac{dK_2^c}{dF_2^{ab}} + \Lambda_{23} B_2^c \frac{dR_2}{dF_2^{ab}} + \gamma_3 \frac{dQ_2^c}{dF_2^{ab}} + F_2^{ab} \frac{dR_{b2}^{\text{eme}}}{dF_2^{ab}}\right\} + \frac{(1-\delta)Q_3}{r_3^c} + 1 \tag{9}$$

with $\gamma_2 = \left(r_3^c + (1-\delta)Q_3\right)$, $\gamma_3 = R_2\left(I_2^c + (1-\theta)(1-\delta)K_1^c\right)$, and $F_2^{ab} = F_2^a + F_2^b$

The drivers are similar to those of the policy effects on welfare (i) to (iv).

Noticeably, there is also a substitution effect betwen local and global intermediation at the Center.

back other taxes

Other Optimal Non-Cooperative taxes

$$\tau_2^a = \overbrace{\frac{\alpha-1}{\alpha} - \frac{1}{\alpha r_2^a}\Bigg\{(I_1+\kappa K_1)\frac{dQ_1^a}{dK_1^a} + \frac{B_1^a}{R_1}\frac{dR_1}{dK_1^a} + \kappa R_1 Q_1^a}^{\text{contemporaneous component}}$$

$$\underbrace{+\left(1-\frac{\Lambda_{1,2}}{\Lambda_{2,3}}\right)\alpha_4(\kappa)\frac{dQ_2^a}{dK_1^a} + (1-\Lambda_{1,2})\frac{B_2^a}{R_2}\frac{dR_2}{dK_1^a} + \kappa\left(1+\theta\left(\Lambda_{1,2}-\Lambda_{2,3}\right) - \frac{\Lambda_{1,2}}{\Lambda_{2,3}}\right)Q_2^a\frac{dK_2^a}{dK_1^a}\Bigg\}}_{\text{forward-looking component}}$$

$$\tau_3^a = -\frac{1}{\Lambda_{2,3}\alpha r_3^a}\left\{\alpha_4(\kappa)\frac{dQ_2^a}{dK_2^a} + \Lambda_{2,3}\frac{B_2^a}{R_2}\frac{dR_2}{dK_2^a} + \kappa\left(1-\theta\Lambda_{2,3}\right)Q_2^a\right\} + 1 - \frac{1}{\alpha}$$

$$\tau_2^c = \overbrace{-\frac{1}{\theta\alpha r_2^c}\Bigg\{(1-\theta)(1-\delta)Q_2^c + \left(\frac{B_1^c}{R_1}-\theta D_1\right)\frac{dR_1}{dK_1^c} + R_1K_1^c\frac{dQ_1^c}{dK_1^c} + (1-\theta)\left(\frac{dR^{eme}_{b,1}}{dK_1^c}F_1^{ab} + R^{eme}_{b1}\frac{dF_1^{ab}}{dK_1^c}\right)}^{\text{contemporaneous component}}$$

$$\underbrace{+\frac{1}{R_2}\left[\gamma_2\frac{dK_2^c}{dK_1^c} + \frac{B_2^c}{R_2}\frac{dR_2}{dK_1^c} + \gamma_3\frac{dQ_2^c}{dK_1^c} + \left(\frac{dR^{eme}_{b2}}{dK_1^2}F_2^{ab} + R^{eme}_{b2}\frac{dF_2^{ab}}{dK_1^c}\right)\right]\Bigg\}}_{\text{forward looking component}} + \frac{\alpha\theta-1}{\alpha\theta}$$

With $\alpha_4(\kappa) = I_2^a + \kappa\left(1-\theta\Lambda_{2,3}\right)K_2^a$, $\gamma_2 = r_3^c + (1-\delta)Q_3$, $\gamma_3 = R_2\left(I_2^c + (1-\theta)(1-\delta)K_1^c\right)$, $F_t^{ab} = F_t^a + F_t^b$, and $\frac{\partial\alpha_4(\kappa)}{\partial\kappa} > 0$.

back to Welfare Effects

Other Optimal Cooperative taxes

$$\tau_3^{a,coop} = \overbrace{\frac{\alpha-1}{\alpha} - \frac{1}{\alpha\Lambda_{2,3}r_3^a}\left\{\left(\alpha_4(\kappa)\frac{dQ_2^a}{dK_2^a} + \kappa\left(1-\theta\Lambda_{2,3}\right)Q_2^a\right) + \left(\frac{B_2^a}{(R_2)^2}\right.}^{\tau_3^{a,nash}} - \left.\frac{\lambda_2^c}{\lambda_2^a}\frac{B_2^a}{(R_2)^2}\right)\frac{dR_2}{dK_2^a}$$
$$\left(\gamma_2\Lambda_{2,3}\frac{dK_2^c}{dK_2^a} + \gamma_3\frac{dQ_2^c}{dK_2^a} + \Lambda_{2,3}F_2^{ab}\frac{dR_{b,2}^{\mathrm{eme}}}{dK_2^a} + R_{b,2}^{\mathrm{eme}}\frac{dF_2^{ab}}{dK_2^a}\right)\Bigg\}$$

with $\alpha_4 = I_2^a + \kappa(1-\theta\Lambda_{2,3})K_2^a$, $\gamma_2 = r_3^c + (1-\delta)Q_3$, and $\gamma_3 = I_2^c + (1-\theta)(1-\delta)K_1^c$

We can express the tax in terms of a wedge with respect to the non-cooperative one as:

$$\tau_3^{a,coop} = \tau_3^{a,nash} - \varphi_3^{a,NFA} - \omega_3$$

Although not refered to explicitely in the main sections, it can be noticed ω_3 is consistent the fact a cooperative planner sets higher subsidies with the EMEs instruments. back

Households

$$\max_{\{C_t, B_t, D_t\}_{t=0}^{\infty}} W_0^i = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{i(1-\sigma)}}{1-\sigma} - \frac{H_t^{i(1+\psi)}}{1+\psi} \right)$$

s.t.,

$$C_t^i + B_t^i + D_t^i + \frac{\eta}{2}(B_t^i)^2 + \frac{\eta_D}{2}(D_t^i - \bar{D}^i)^2 = R_{t-1}^i B_{t-1}^i + R_{D,t-1}^i D_{t-1}^i + W_t^i H_t^i + \Pi_t^i, \quad i = \{a, b, c\}$$

B_t^i: Non-contingent international bonds (units of consumption bundle),

D_t^i: domestic deposits - dropped for the peripheries that rely on foreign lending,

$W_t^i H_t^i$: labor income,

Π_t^i : profits from banks and capital firms net of lump-sum taxes $\rightarrow$ quite different between Center and EMEs.

One good is produced worldwide and C^i is the corresponding consumption by the household in the country i.

Incomplete Mkts: Adjustment costs of assets allow the model to be stationary.

Back

Final goods firms

There is one single good produced in the world that is obtained from a CD technology:

$$Y_t^i = A_t^i \left(\xi_t^i K_{t-1}^i\right)^{\alpha} H_t^{i(1-\alpha)} \qquad \text{(technology)}$$

H^i, K^i are labor and capital. A_t^i is a productivity shock and ξ^i is a capital-quality shock (AR(1) processes).

Profits are derived from production and the resale of undepreciated capital to investors.

The firms choose the inputs optimally to solve:

$$\max_{K_{t-1}, H_t} \Pi_t^{i,prod} = Y_t^i + (1-\delta)\xi_t^i Q_t^i K_{t-1}^i - W_t^i H_t^i - \underbrace{\tilde{R}_{k,t}^i Q_{t-1}^i}_{\text{Repayment to bank}}$$

$$s.t. \quad \text{(technology)}$$

Back

Final goods firms and returns on Banking

Let $r_t^i \equiv \alpha A_t^i H_t^{i(1-\alpha)} (\xi^i K_{t-1}^i)^{(\alpha-1)} \propto MPK_t \longrightarrow$ we can obtain the optimal payments to each input (workers and bankers) as:

$$W_t^i = (1-\alpha) A_t^i H_t^{i(-\alpha)} \xi_t^{i\ \alpha} K_{t-1}^{i(\alpha)}$$

$$\tilde{R}_{k,t} = \xi_t^i \frac{r_t^i + (1-\delta) Q_t^i}{Q_{t-1}^i}$$

$\tilde{R}_{k,t}$ is the gross rate of return of bankers **before** paying the macroprudential taxes.

This structure reflects that Capital is funded by selling securities to domestic banks $Z_t^i = K_t^i$.

Capital Goods Firms: Competitive producers that manufacture physical capital subject to adjustment costs. Go

Capital Goods production

Physical capital is produced in a competitive market by using old capital and investment.

The depreciation rate of capital is $1-(1-\delta)\xi_t^i$.

The investment will be subject to convex adjustment costs:

Total cost of Investing: $$C(I_t^i) = I_t^i \left(1 + \frac{\zeta}{2}\left(\frac{I_t^i}{I_{t-1}^i} - 1\right)^2\right)$$

The firms buy back the old capital stock at price Q_t^i and produce new capital units for future production.

Capital stock dynamics: $$K_t^i = I_t^i + (1-\delta)\xi_t^i K_{t-1}^i$$

Back

Optimality Conditions for Center's Banks:

The F.O.C. are:

$$
\begin{aligned}
[Z_{j,t}]: &\quad \mathbb{E}_t \Omega^c_{t+1|t}(R^c_{k,t+1} - R^c_{D,t}) = \kappa^c \mu^c_t \\
[F^a_{j,t}]: &\quad \mathbb{E}_t \Omega^c_{t+1|t}\left(R^a_{b,t} - R^c_{D,t}\right) = \kappa^c_{F_a} \mu^c_t \\
[F^b_{j,t}]: &\quad \mathbb{E}_t \Omega^c_{t+1|t}\left(R^b_{b,t} - R^c_{D,t}\right) = \kappa^c_{F_b} \mu^c_t
\end{aligned}
$$

and the envelope condition,

$$
[N^c_{j,t}]: \quad J^{c'}(N^c_{j,t})(1 - \mu^c_t) - \mathbb{E}_t \Omega^c_{t+1|t} R^c_{D,t} = 0
$$

Back

Macroprudential Policy

Several potential choices (capital controls, taxes, leverate ratios, etc.).

Policy used here: **tax on return to capital**.

Advantage: targets the source of the friction (credit spread).

Government budget (balanced):

$$\tau^j_{k,t} r^j_{k,t} K^j_{t-1} + T^j_t = 0 \qquad j = \{a, b, c\}$$

Welfare objective of each policy maker is given by PV of agents utility.

However, there could be policy implementation costs.

$$\hat{W}^j_0 = W^j_0 \quad - \quad \psi_{\tau,k} E_0 \sum_{t=0}^{\infty} \beta^t \tau^{j\,2}_{k,t}$$

Back

Open Loop Nash Equilibrium (def.):

Sequence of tools $\{\tau_t^{i\ *}\}_{t=0}^{\infty}$ such that for all t^*:

$\tau_{t^*}^{i\ *}$ maximizes the player i's objective function subject ot the structural equations of the economy that characterize the private equilibrium for given sequences $\{\tau_{-t^*}^{i\ *}\}_{t=0}^{\infty}$ and $\{\tau_t^{-i\ *}\}_{t=0}^{\infty}\ldots$

where: $\{\tau_{-t^*}^{i\ *}\}_{t=0}^{\infty}$ denotes the policy instruments of player i in other periods than t^* and $\{\tau_t^{-i\ *}\}_{t=0}^{\infty}$ is the sequence of policy moves by all other players.

Then: Each player's action is the best response to the other players' best responses.

Given that the policymakers specify a contingent plan at time 0 for the complete path of their instruments $\{\tau_t^i\}_{t=0}^{\infty}$ for $i = \{a, b, c\}$, **the problem they solve can be interpreted as a static game.**

This allows me to recast their maximization problems as an optimal control problem where the instruments of the other planners are taken as given.

Back

Steady State of Policy Instruments

	Nash	Cooperation (Center+EME-A)	Cooperation (EMEs)	Cooperation (All)
τ^c	-0.850	-0.530	-0.806	-0.864
τ^a	0.319	-0.164	0.348	-0.697
τ^b	0.319	0.328	0.348	-0.697

- We obtain the **Instrument conditional Steady States** ▸ Details
- In all cases the Center subsidizes the financial sector
- Peripheries use their tools to mitigate the friction, unless they cooperate with the Center.

▸ Back

Steady State of Ramsey model

In the Ramsey model we work with a **instrument conditional steady state**, i.e., we set a value for the policy tools $\bar{\boldsymbol{\tau}}$ and obtain an associated steady state for the rest of the variables. **How to pick $\bar{\boldsymbol{\tau}}$**?

We follow an algorithm outlined in Christiano, Motto and Rostagno (2007):

1. set any value for $\bar{\boldsymbol{\tau}}$ and solve, using the static private FOCs, for the steady state of private variables: $\mathbf{x_t}$

2. replace $\mathbf{x_t}$ in remaining $N + k$ equations, the policy FOC w.r.t. the N endogenous variables and k tools: get a linear system of $N + k$ equations for N unknowns (policy multipliers)

3. More equations than unknowns. Then solution is subject to an approximation error $\mathbf{u}$:

   - set $N + k$ static equations in vector form as: $U_1 + \bar{\lambda}[1/\beta F_3 + F_2 + \beta F_1] = 0$
   - let $Y = U_1', X = [1/\beta F_3 + F_2 + \beta F_1]$ and $\beta = \bar{\lambda}'$
   - get the tools as: $\beta = (X'X)^{-1}X'Y$ with error $\mathbf{u} = Y - X\beta$
   - repeat for several $\bar{\boldsymbol{\tau}}$ and pick it as: $\bar{\boldsymbol{\tau}} = \arg\min_{\tau} \mathbf{u}$

Back

Gains from cooperation

The gains from cooperation are given by the welfare difference relative to the strategic (non-cooperative) solution:

$$Gain \equiv \hat{W}_{coop,0} - (n_a \hat{W}^a_{nash,0} + n_b \hat{W}^b_{nash,0} + (1 - n_a - n_b)\hat{W}^c_{nash,0})$$

The gains are approximated at the second order around the non-stochastic steady state (Taylor exp. around $\varphi = 0$)

- Measure used: **conditional welfare**: the same initial state values are used in the simulation of each model
- The Gain above is given in utility units. Hence, we normalize them by the change in utility from a 1% increase in Steady State consumption and get the **consumption equivalent variation** $\longrightarrow$ consumption increase compensation to be indifferent between models.

details back

Consumption Equivalent Variation

λ: proportional increase in the steady-state consumption of the world cooperation model (**model 1**) that would deliver the same welfare as the Nash case (**benchmark**):

$$W_0^{i,coop}(\lambda) = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{\left((1+\lambda)C_t^{i,coop}\right)^{1-\sigma}}{1-\sigma} - \frac{(H_t^{i,coop})^{(1+\psi)}}{1+\psi} \right) = W_0^{i,nash}$$

For each economy $i = \{a, b, c\}$.

Similarly, the global consumption equivalent gain (cost) will be the weighted average of the national ones.

Example: with gains of cooperation $\lambda < 0$

i.e., consumption would have to decrease in the **Coop** model to match the Welfare of **Nash**. back

Alternative Method for Consumption Equivalent Variation

Logaritmic approximation

Table: Welfare in consumption equivalent compensation units (alternative method)

	Consumption Equivalent % Compensation				
	Nash	Cooperation (Center+EME-A)	Cooperation (EMEs)	Cooperation (All)	Cooperation (Time Variant)
C	-10.8	2.9	-12.1	-3.8	-93.9
A	-17.5	-0.4	-23.7	-2.3	-97.6
B	-17.5	-24.3	-23.7	-2.3	-97.6
World	**-14.2**	**-5.3**	**-18.1**	**-3.0**	**-96.1**
EMEs	-17.5	-12.8	-23.7	-2.3	-97.6

Notes: Compensation using the First Best as benchmark.

In Cooperation symmetry between instruments rules is assumed for EMEs

Back

Other relevant features

A number of features add to the effects of these mechanisms:

Cyclicality of Optimal Taxes: The best performing policies will adopt countercyclical patterns details

Appropriate Welfare Weights: Mechanisms 1 and 2 work better if the welfare weights of EME block is comparable to the Center's $\Rightarrow$ in a SOE ($n^{eme} \rightarrow 0$) the gains tend to zero.

This explains why *Coop* outperforms $Coop(A + C)$ (in $Coop(A + C)$ the weights are biased in favor of c).

Time Consistency: As an exercise we solved time variant models. These display multiple solutions. However, some cooperative regimes allow to override the indeterminacy issues (usually welfare improving). results In the model

back

Correlations with Output

$Corr(\tau^j, Y^j)$	Nash	Cooperation (EMEs)	Cooperation (Center+EME-A)	Cooperation (All)
EME-A	-0.164	-0.265	-0.611	-0.861
EME-B	-0.164	-0.265	-0.221	-0.861
Center	-0.419	-0.425	**0.085**	**0.138**

A policy τ is **Countercyclical** if $Corr(\tau^j, Y^j) > 0$ (higher taxes in booms)

- Cooperation for Center implies more countercyclical policies

- Cooperation for EMEs implies more procyclical policies

Back to results Back to Conclusions

Ciclycality of MaP Policies

① **Countercyclicality as a Target:** Broad objective of MaP Policy is to limit the external and systemic negative effects that financial intermediation puts in the economy (and on itself).

Specific goals to do it:

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(i) limit excesive systemic risk (e.g. overseeing interconnectedness of banks)

(ii) Curb procyclicality imposed by financial markets $\equiv$ mitigate Financial Accelerator mechanism

$\approx$ set countercyclical taxes to discourage (encourage) borrowing in booms (busts)

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① and ② are at odds and it's not clear what ends up describing empirical and optimal MaP

Cyclicality of MaP Policies (cont.)

- Actual MaP do behave procyclically: Rebucci, Fernandez, and Uribe (2015)
- Optimal MaP is procyclical: SG-U2017
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Explanation of differences: 1) value of intra-temporal elasticities between NT and T goods, 2) types of shock that matters more for precautionary savings (SGU17: Interest Rate shocks; Bianchi11: Technology). 3) different time units, important for parameters related to collateral effect on debt (more sensitive in SGU17).

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- Tools do lack counter-cyclicality *within* policy most frameworks.

- However, *between* policy schemes, the best performing ones become counter-cyclical (for center).

That is, both aspects co-exist and vary meaningfully with better policies.

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Possible explanation:

- With less cooperation: Stonger trade-off between subsidizing bankign and curbing the cycle.

- With cooperation: Country internalizes subsidizing comes at the cost of decreased intermediation by the neighbor.

Time consistency

Policy problem in Lagrangian form (Nash):

$$\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big\{ U(\mathbf{x}_t, \mathbf{s}_t) + \boldsymbol{\lambda}_t' \overbrace{\mathbb{E}_t F(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}; \mathbf{s}_t, \mathbf{s}_{t+1})}^{\text{Private C. Eq. FOCs}} \Big\}$$

F.O.C.
for $t > 0$

$$U_1(\mathbf{x}_t, \mathbf{s}_t) + \frac{1}{\beta}\boldsymbol{\lambda}_{t-1}' F_3(\mathbf{x}_{t-2}, \mathbf{x}_{t-1}, \mathbf{x}_t; \mathbf{s}_{t-1}, \mathbf{s}_t) + \boldsymbol{\lambda}_t' \mathbb{E}_t F_2(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}; \mathbf{s}_t, \mathbf{s}_{t+1}) + \beta \boldsymbol{\lambda}_{t+1}' \mathbb{E}_t F_1(\mathbf{x}_t, \mathbf{x}_{t+1}, \mathbf{x}_{t+2}; \mathbf{s}_{t+1}, \mathbf{s}_{t+2}) = 0$$

for $t = 0$, with $\boldsymbol{\lambda}_{t-1} = 0$

$$U_1(\mathbf{x}_t, \mathbf{s}_t) + \boldsymbol{\lambda}_t' \mathbb{E}_t F_2(\mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t+1}; \mathbf{s}_t, \mathbf{s}_{t+1}) + \beta \boldsymbol{\lambda}_{t+1}' \mathbb{E}_t F_1(\mathbf{x}_t, \mathbf{x}_{t+1}, \mathbf{x}_{t+2}; \mathbf{s}_{t+1}, \mathbf{s}_{t+2}) = 0$$

Implications:

- Policies of $t = 0$ are **not consistent** with those of $t > 0$.

- Policymakers reoptimize at 0 and reset their policy weights, i.e., disregard the past (Juillard and Pelgrin, 2007)

- Multiple solutions (sunspot eq.) issues may arise, Evans and Honkapohja (2003 ReStud, 2006 ScandJofEcon).

Solution: Adopt *timeless perspective* (Woodford (2003), Woodford and Benigno (2003)) $\Longrightarrow$ set $\boldsymbol{\lambda}_{t-1} \neq 0$.

With this, we assume policy makers were making optimal decisions in the past in a time consistent manner (King and Wolman, 1999).

Back

Time consistency of policy can be important

- **Indeterminacy:** Non-cooperative policies and some semi-cooperative are not well defined if time inconsistent.
- **Benefits of Cooperation:** implementing cooperation overrides sunspot equilibria and allows to obtain a solution (i.e., Coop and CoopAC) $\longrightarrow$ Models with multiple solutions: when C plays individually (Nash and CoopEMEs).

	Nash	Cooperation (Center+EME-A)	Cooperation (EMEs)	Cooperation (All)	Cooperation (Time Variant)
W^c	-4980.2	-4964.8	-4979.5	-4963.4	**-5189.3**
W^a	-5030.1	-5016.4	-5037.2	-5025.4	**-5343.6**
W^b	-5030.3	-5037.6	-5037.0	-5025.4	**-5343.3**
W	-5005.2	-4995.9	-5008.3	-4994.4	**-5266.3**
W^{ab}	-5030.2	-5027.0	-5037.1	-5025.4	**-5343.4**
Consumption Equivalent Compensation					
C	-10.9	4.8	-10.2	6.3	**-224.9**
A	-17.0	-3.1	-24.2	-12.2	**-335.7**
B	-16.6	-24.0	-23.4	-11.6	**-334.5**
World	**-13.9**	**-4.4**	**-17.0**	**-2.9**	**-280.2**
EMEs	-16.8	-13.5	-23.8	-11.9	**-335.1**

Notes: Compensation using the First Best as benchmark.
In Cooperation symmetry between instruments rules is assumed for EMEs

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- Still, the best of these models is much worse than any timeless-perspective model:

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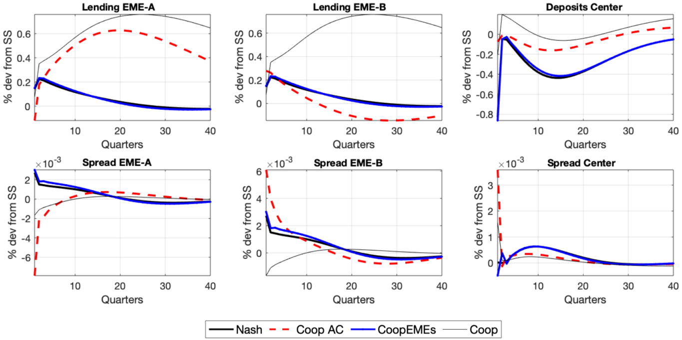


Consistently, the lending is boosted more strongly under cooperation. This happens in every country.

Rather than K for local firms, at Center it reflects more lending demand by banks to increase intermediation to EMEs

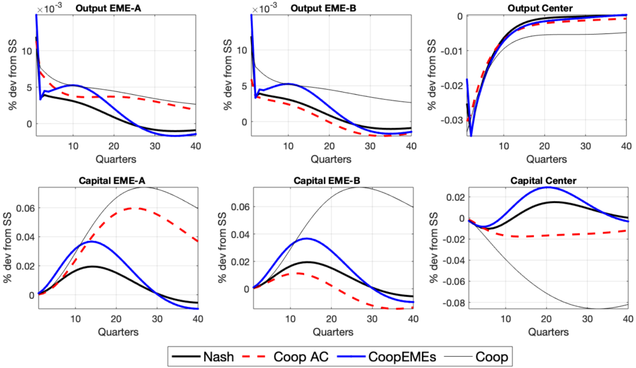
Spread reflects a higher effort in Cooperation to compensate the shock: ↑ rates at the Center (↓ at EMEs).

In contrast, non-cooperative planners are less effective at managing the downturn → **lower incentives to fight a shock that improves the NFA position.**

⇒ A planner that does not bother about ΔNFA **can focus better in improving the financial stability**.

back

IRFs: (-) Productivity shock on C

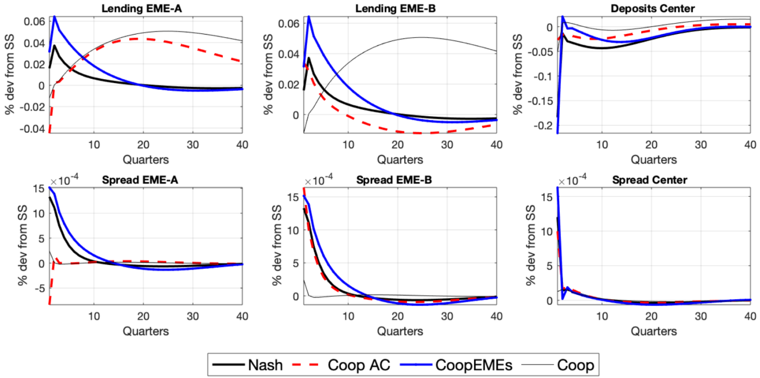


Similar dynamics: noticeably higher capital accumulation at EMEs with Cooperation.

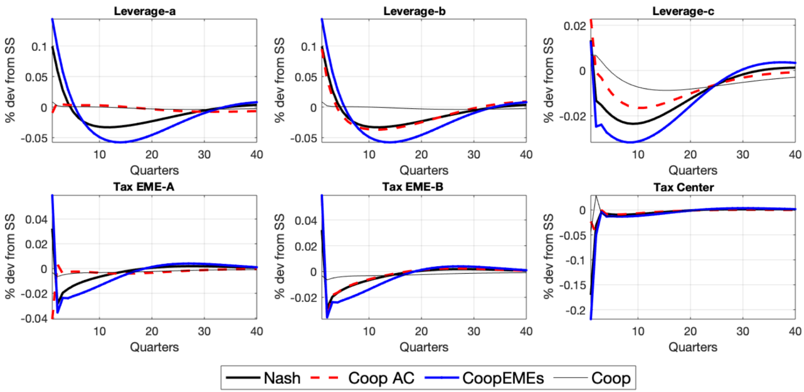
Difference: accumulation is delayed.

Why?: financial shock facilitated to increase K flows to EMEs.

IRFs: **(-)** Productivity shock on C - Financial Variables



IRFs: (-) Productivity shock on C - Financial Variables and Policies



Mitigated deleveraging dynamics in all countries under cooperation.

Center leverage falls more with non-cooperative policies due to combination of strong local subsidies (increase net worth) and increased stock of domestic capital.

Conclusions