# Strategic Macroprudential Policymaking: When Does Cooperation Pay Off?

Camilo Granados
University of Washington

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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?

**Motivation:**

- Global Financial Cycle Literature (Rey (2013); Passari and Rey (2015)) : EMEs are at the mercy of the cycles imposed by Financial Centers.
- Forbes (2019, AER, P&P): Effects of Macro-prudential policies

  *"there is 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 and current Systemic Risks:
  - Basel I, II, III: Centralized policy recommendations for all countries (not legally binding).
  - Basel III: Focus on limiting moral hazard by LCFIs.
  - Financial Stability Board: Priority → promote coordinated program of reforms.

# What I do

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

**Periphery/EMEs:** I consider countries with limited financial development that must rely on lending from a Center.

$\Longrightarrow$ 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 of countries) frameworks.

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

- **Capital Controls:** Korinek (2020, REStud), Jin and Shen (2020, RED), Devereux and Davis (202X, AEJ-Macro)

K2020, DD202X: 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** ⟶ **Reason:** My Center can react to the Cooperative policies of EMEs.

- **Liquidity Requirements:** Bengui (2014) ⟶ Gains arise due to cancellation of national incentives to manipulate TOT
- **Capital Adequacy:** Kara (2016, JIE) → Non-cooperative symmetric countries apply inefficiently low level of regulation

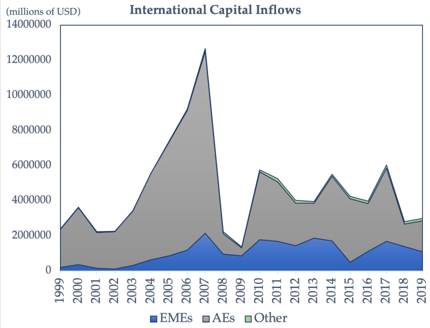
Conversely, **here better regimes feature less volatile regulations**⟶ Cooperation prevents excessive policymaking

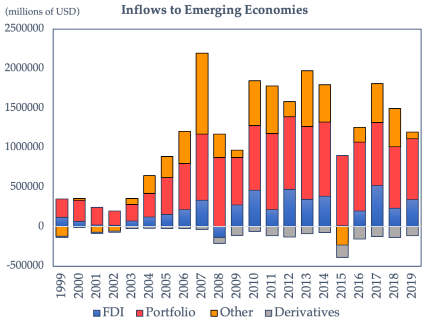
**In adition:** I find another welfare increasing mechanism from cooperative setups.

# Capital flows empirics

Total flows: switch toward emerging economies

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



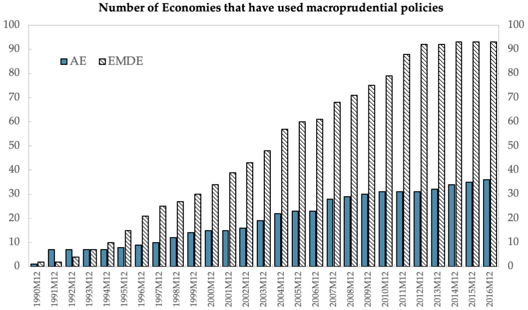



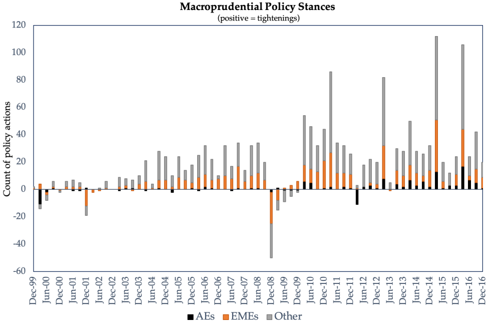

Source: IMF-IFS amd BOP statistics.

# 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

- Cooperation helps? Yes, but not any type: **Center Cooperation Matters**
  - Welfare Ranking: $Coop \succcurlyeq CoopAC \succcurlyeq Nash \succcurlyeq CoopEMEs$
  - Cooperation of peripheries only: redundant or counterproductive.
- Distributional issues may dificult cooperation.
  - Individually countries prefer smaller coalitions.
- Sources of gains:

  (1) national portfolio incentives cancel out (more financial stability).

  (2) increased substitution of capital at Center for inflows to EMEs (more efficient)
- Mechanisms work better with more participating EMEs (social gains boosted).
- Smoother capital accumulation and mitigated deleveraging processes under Center-Periphery(ies) cooperation.
- Best policies are also smoother and countercyclical (in relative terms)

# 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).<br>Reinvest/retain profits if continuing in business<br>**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 $\tau_2$ | $\tau^a \to W^a$ | 0.146 | 0.144 | 0.142 | 0.138 |
| | $\tau^b \to W^b$ | 0.146 | 0.144 | 0.142 | 0.138 |
| | $\tau^c \to W^c$ | -0.242 | -0.457 | -0.179 | -0.027 |
| Cross-border effect | $\tau^a \to W^b$ | -0.047 | -0.047 | -0.047 | -0.048 |
| | $\tau^a \to W^c$ | -0.016 | -0.017 | -0.017 | -0.017 |
| | $\tau^b \to W^a$ | -0.047 | -0.047 | -0.047 | -0.048 |
| | $\tau^b \to W^c$ | -0.016 | -0.017 | -0.017 | -0.017 |
| | $\tau^c \to W^a$ | -0.162 | -0.226 | -0.180 | -0.155 |
| | $\tau^c \to W^b$ | -0.162 | -0.226 | -0.180 | -0.155 |
| Direct effect of $\tau_3$ | $\tau^a \to W^a$ | 0.057 | 0.057 | 0.056 | 0.056 |
| | $\tau^b \to W^b$ | 0.057 | 0.057 | 0.056 | 0.056 |
| | $\tau^c \to W^c$ | -0.087 | -0.122 | -0.243 | -0.134 |
| Cross-border effect | $\tau^a \to W^b$ | -0.018 | -0.018 | -0.018 | -0.018 |
| | $\tau^a \to W^c$ | 0.006 | 0.005 | 0.004 | 0.003 |
| | $\tau^b \to W^a$ | -0.018 | -0.018 | -0.018 | -0.018 |
| | $\tau^b \to W^c$ | 0.006 | 0.005 | 0.004 | 0.003 |
| | $\tau^c \to W^a$ | -0.051 | -0.059 | -0.087 | -0.074 |
| | $\tau^c \to W^b$ | -0.051 | -0.059 | -0.087 | -0.074 |

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

The 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 ($\tau_2$) than from static ($\tau_3$): Why? $\longrightarrow$ retained banking profits

# Analytical exercise: Welfare effects

Following Davis and Devereux (2020) I set a social planner problem and simplify the welfare with the equilibrium conditions. Then we obtain expressions for the policy effects:

For the EMEs:

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

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 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:

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

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.

▸ other taxes

# Optimal Taxes: Cooperative Planner

Analogously, I find the optimal Cooperative tax from the welfare expression of a Centralized planner
(coop welfare = weighted average of national planners welfare)

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

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

As previously: $\frac{\partial \alpha_s(\kappa)}{\partial \kappa} > 0$ 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. (more later)

tax of EME

# Main Model

- To performe a more complete welfare comparison in a stochastic environment I set a larger scale model
- Infinite horizon with discrete time ($t = 1, 2, 3, \dots$)
- Three economies: Center (c) with population size $n_c = 1 - n_a - n_b$, and two Peripheries: $a$ and $b$ with sizes $n_a$ and $n_b$ such that $n_a + n_b \leq \frac{1}{2}$.
- 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

# 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,

$\Pi_t^i$ : 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.

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# 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 $\xi^i$ 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:

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

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

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# 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:

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

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

$\tilde{R}_{k,t}$ 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 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: $$K_t^i = I_t^i + (1 - \delta)\xi_t^i K_{t-1}^i$$

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# 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 $R^e_{b,t}$ and $D^e_{jt}$: deposits from domestic households.

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

Aggregate net worth of the banking system :

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

$N^e_{j,t}$: 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

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

The problem of the $j$ banker is to maximize the value of the bank:

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

subject to: net worth $(N^{e_i}_{j,t})$ dynamics and Incentive Compatibility Constraint:

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

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

The bank's optimal decisions:

The F.O.C. of the banker's problem are:

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

the envelope condition:

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

where $\mu^{e_i}_t$ is the lagrange multiplier associated with the ICC and $\Omega_{t+1|t} = \Lambda^e_{t+1}(1-\theta+\theta J^{e'}_{t+1})$ is the effective pricing kernel of the bank.

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# 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 can be 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.

Optimality Conditions:

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,

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

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# 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.

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

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# Ramsey Policy Problem

**Non-cooperative equilibrium**: *open-loop Nash* equilibrium. definition

We assume players know the initial state vector and define the whole sequence of actions taking the future path of tools for other planners as given.

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

Problem of the planner: Under commitment, choose the vector of endogenous variables and the policy instruments to solve:

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

s.t.,

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

where $\mathbf{x}_t$ is the vector of endogenous variables, $\boldsymbol{\tau}_t = (\tau_t^a, \tau_t^b, \tau_t^c)'$ is the vector of instruments and $\varphi_t$ 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:

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

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

Regional (EMEs) cooperation case:

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

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

**Nash:** On the other hand, a non-cooperative policy-maker of the country $j = \{a, b, c\}$ solves:

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

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

## Gains from cooperation

The gains from cooperative schemes will be given as the difference with respect to the strategic solution from cooperation will be computed as,

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

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

- The welfare obtained is the **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** details ⟶ consumption increase compensation to be indifferent between models.

# RESULTS

# Steady State of Policy Instruments

| | Nash | Cooperation (Center+EME-A) | Cooperation (EMEs) | Cooperation (All) |
|---|---|---|---|---|
| $\tau^c$ | -0.850 | -0.530 | -0.806 | -0.864 |
| $\tau^a$ | 0.319 | -0.164 | 0.348 | -0.697 |
| $\tau^b$ | 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.

# 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

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

alternative method

- 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.

Policy motive is present in every country → But the **Cancellation works only** if Creditors' (Center) and Debtors' (EMEs) incentives are pooled.

Explaining why $Coop(EMEs)$ is counterproductive.

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

Coop. planner prioritizes global (not national) economic performance which is boosted steering K inflows to EMEs.

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

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

# 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 ($n^{eme} \to 0$) the gains tend to zero.

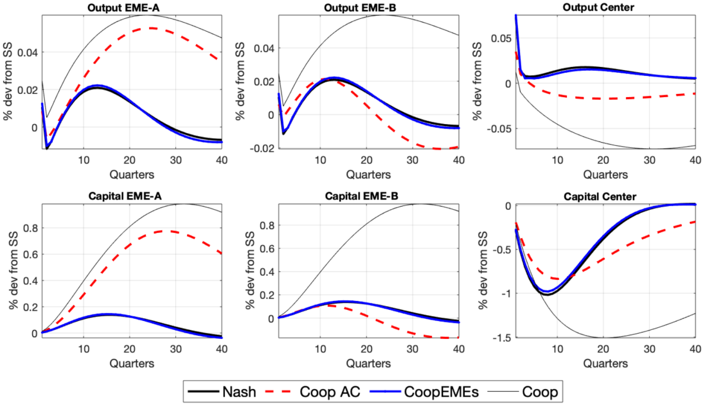
This explains why *Coop* outperforms $Coop(A + C)$ (in $Coop(A + C)$ the weights are biased in favor of $c$).

**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

## IRFs: Dynamic of variables and policies

Cases of interest: Shocks that originate in the Center

## IRFs: Negative Financial Shock at the Center

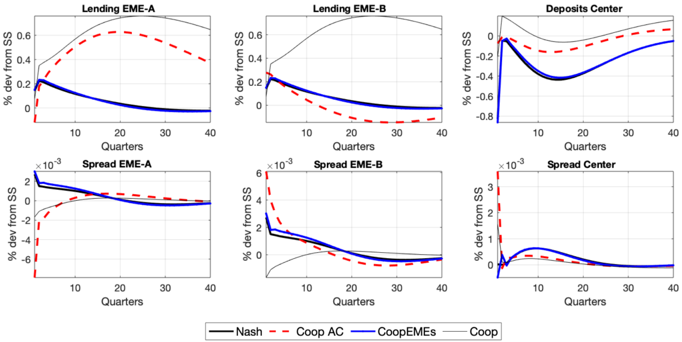



The World Cooperative Model is the Best regime at protecting the Output of the EMEs.

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




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

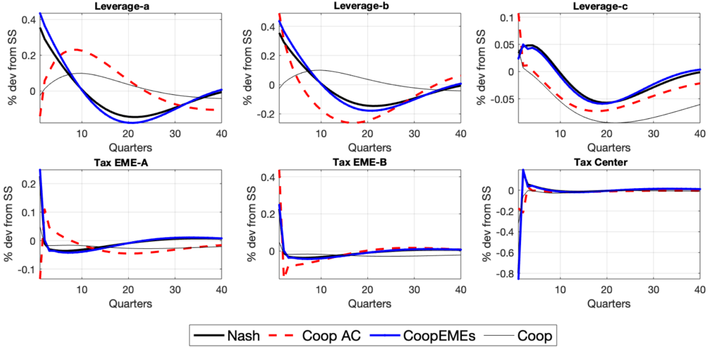
Rather than K for local firms, at Center it reflects more lending demand by banks to increase intermediation to EMEs

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 $\Delta NFA$ **can focus better in improving the financial stability**.

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




EMEs: Increase in Leverage is smoothed under cooperation ⟶ mitigating deleveraging process.

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

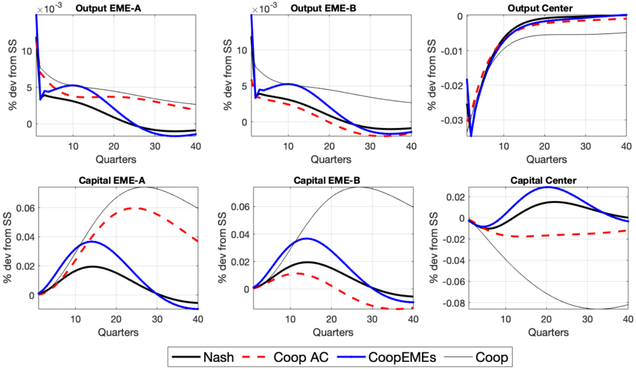
**Taxes:** countercyclical response (tax at EMEs, subsidize at Center)

With cooperation taxes are smoother and move on a narrower range → Comparative advantage of coop. planner: prevent unnecessary tools fluctuations.

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

Conclusions Prod. Shock

## IRFs: **(-)** Productivity shock on C

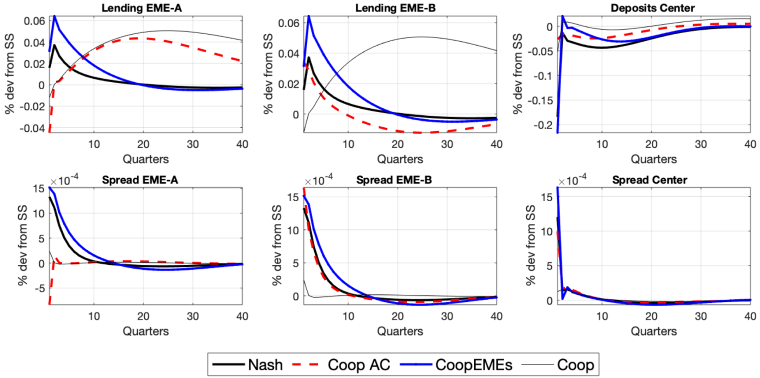



Similar dynamics: noticeably higher capital accumulation at EMEs with Cooperation.

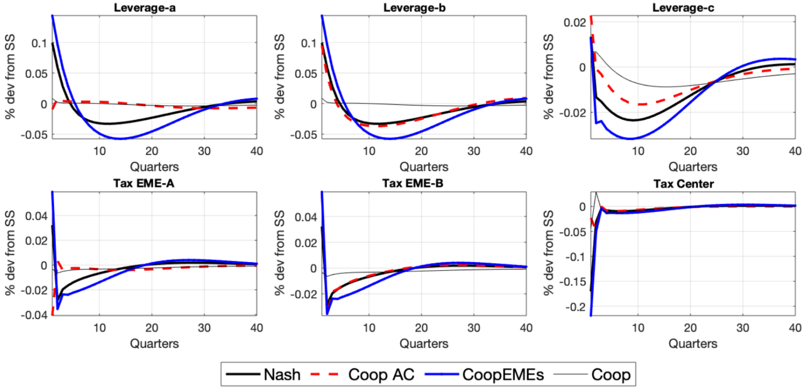
Difference: accumulation is delayed.

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

- I set a multicountry open economy model with financially integrated banks in a dynamic setup
  (banking and policy have persistent effects)
- 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 Move the Interest Rates for portfolio motives (stable taxes, higher financial stability).
  - Higher incentives to reallocate more K inflows in EMEs.
- Gains are higher if more EMEs participate
- The EMEs have high incentives to be part of a coalition with a Center.
  - But also prefer other peripheries not to participate.
  - Potentially problematic: The Center is better off by collaborating with fewer EMEs.
- Best performing policy schemes are Countercyclical (for center) relative to other models.

Corr($\tau$,$Y$)

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

Thank You!

# 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:

$$
\begin{aligned}
C_1^s + \frac{B_1^s}{R_1^s} &= r_1^s K_0^s + \pi_{f,1}^s + \pi_{inv,1}^s - \delta_B Q_1^s K_0^s \\
C_2^s + \frac{B_2^s}{R_2^s} &= \pi_{f,2}^s + \pi_{inv} + \pi_{bank,2}^s - \delta_B Q_2^s K_1^s + B_2^s - T_2^s, \quad for\ s = \{a, b\} \\
C_3^s &= \pi_{f,3}^s + \pi_{bank,3}^s + B_2^s - T_3^s, \quad for\ s = \{a, b\}
\end{aligned}
$$

Advanced Economy:

$$
\begin{aligned}
C_1^c + \frac{B_1^c}{R_1^c} + \boldsymbol{D_1} &= r_1^c K_0^c + \pi_{f,1}^c + \pi_{inv,1}^c - \delta_B Q_1^c K_0^c \\
C_2^c + \frac{B_2^c}{R_2^c} + \boldsymbol{D_2} &= \pi_{f,2}^c + \pi_{inv,2}^c + \boldsymbol{\pi_{bank,2}^c} - \delta_B Q_2^c K_1^c + R_{D,1} D_1 + B_1^c - T_2^c \\
C_3^c &= \pi_{f,3}^c + \boldsymbol{\pi_{bank,3}^c} + B_2^c + R_{D,2} D_2 - T_3^c
\end{aligned}
$$

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 $r_t = \alpha \frac{Y_t}{K_{t-1}}$

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

Notice:

$\tau_2$ has contemporaneous and future effects via retained banking profits $\longrightarrow$ it is a **forward-looking tool**

$\tau_3$ 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

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

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

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

$$J_1 \geq \kappa \cdot Q_1 K_1 \qquad \text{[ICC } t = 1\text{]}$$

where the $L_1 = Q_1K_1$ is the total lending intermediated. $F_1$ is the foreign lending, $\theta$ 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:

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

$\mu$: 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:

$$[F_2^a]: \qquad \mathbb{E}_2 (R_{B,2}^a - R_{D,2}) = 0$$

$$[F_2^b]: \qquad \mathbb{E}_2 (R_{B,2}^b - R_{D,2}) = 0$$

$$[L_2^c]: \qquad \mathbb{E}_2 (R_{k,3}^c - R_{D,2}) = 0$$

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

# Other Optimal Non-Cooperative taxes

$$\tau_2^a = \overbrace{\frac{\alpha-1}{\alpha} - \frac{1}{\alpha r_2^a}\left\{(I_1+\kappa K_1)\frac{dQ_1^a}{dK_1^a} + \frac{B_1^a}{R_1}\frac{dR_1}{dK_1^a} + \kappa R_1 Q_1^a\right.}^{\text{contemporaneous component}}$$
$$\underbrace{\left. + \left(1-\frac{\Lambda_{1,2}}{\Lambda_{2,3}}\right)\alpha_4(\kappa)\frac{dQ_2^a}{dK_1^a} + (1-\Lambda_{1,2})\frac{B_2^a}{R_2}\frac{dR_2}{dK_1^a} + \kappa\left(1+\theta\left(\Lambda_{1,2}-\Lambda_{2,3}\right) - \frac{\Lambda_{1,2}}{\Lambda_{2,3}}\right)Q_2^a\frac{dK_2^a}{dK_1^a}\right\}}_{\text{forward-looking component}}$$

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

$$\tau_2^c = \overbrace{-\frac{1}{\theta\alpha r_2^c}\left\{(1-\theta)(1-\delta)Q_2^c + \left(\frac{B_1^c}{R_1} - \theta D_1\right)\frac{dR_1}{dK_1^c} + R_1K_1^c\frac{dQ_1^c}{dK_1^c} + (1-\theta)\left(\frac{dR_{b,1}^{eme}}{dK_1^c}F_1^{ab} + R_{b1}^{eme}\frac{dF_1^{ab}}{dK_1^c}\right)\right.}^{\text{contemporaneous component}}$$
$$\underbrace{\left. + \frac{1}{R_2}\left[\gamma_2\frac{dK_2^c}{dK_1^c} + \frac{B_2^c}{R_2}\frac{dR_2}{dK_1^c} + \gamma_3\frac{dQ_2^c}{dK_1^c} + \left(\frac{dR_{b2}^{eme}}{dK_1^2}F_2^{ab} + R_{b2}^{eme}\frac{dF_2^{ab}}{dK_1^c}\right)\right]\right\}}_{\text{forward looking component}} + \frac{\alpha\theta-1}{\alpha\theta}$$

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

# Other Optimal Cooperative taxes

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

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 $\omega_3$ is consistent the fact a cooperative planner sets higher subsidies with the EMEs instruments. 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 $\{\tau_t^{-i\ *}\}_{t=0}^{\infty}\dots$

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 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: $\bar{\boldsymbol{\tau}} = \arg\min_{\tau} \mathbf{u}$

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# Consumption Equivalent Variation

$\lambda$: 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

# 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) ⟶ Models with multiple solutions: when C plays individually (Nash and CoopEMEs).

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

| | 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

# 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

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# Time consistency

Policy problem in Lagrangian form (Nash):

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

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).

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# 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 $\tau$ 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

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# 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:

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

(ii) Curb procyclicality imposed by financial markets ≡ mitigate Financial Accelerator mechanism

≈ set countercyclical taxes to discourage (encourage) borrowing in booms (busts)

≈ smooth the credit cycles

② **Procyclical Component of MaP Policies:** Many MaP tools are micro-prudential requirements, set in terms of ratios that co-move with the cycle and boost lending during booms.

Examples: LTV, DTI, Leverage caps ⟶ denominator grows with the cycle and allows for more intermediation

**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

- Optimal MaP is countercyclical: Bianchi (2011), it limits overborrowing

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).

**In my setup:**

- 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.

**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.