

Financial Integration and Monetary Policy Coordination

Javier Bianchi¹ Louphou Coulibaly²

¹Federal Reserve Bank of Minneapolis

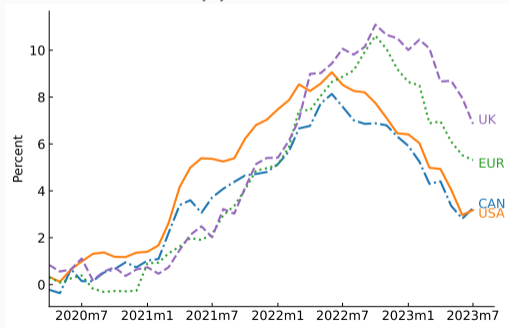
²University of Wisconsin-Madison and NBER

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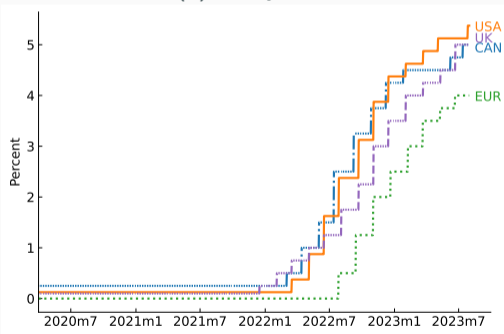
Motivation

- Surge in inflation followed by synchronized tightening of monetary policy

(a) Inflation



(b) Policy rates



Motivation (ctd)

Concerns about synchronized tightening leading to global recession

Central banks nearly everywhere feel accused of being on the back foot. The present danger, however, is [...] they collectively go too far and drive the world economy into an unnecessarily harsh contraction... **By simultaneously all going in the same direction, they risk reinforcing each other's policy impacts without taking that feedback loop into account.**

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Questions:

- What are the benefits from monetary policy cooperation?
- Does cooperation necessarily call for less tightening?

Monetary Policy Coordination

- Focus of modern literature: [terms-of-trade manipulation](#)

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 - Monetary policy affects capital flows and R^* \Rightarrow macro spillovers abroad

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 - Benefits from coordination even in the absence of financial flows
- Today: benefit from cooperation from an intertemporal perspective
 - Monetary policy affects capital flows and R^* \Rightarrow macro spillovers abroad
- Bianchi and Coulibally (2021):
 - Countries use monetary policy to \uparrow NFA and prevent ZLB
 - In general eqm. $\downarrow R^*$ \Rightarrow incentives to \uparrow borrow \Rightarrow countries deviate from efficient Y
- Fornaro and Romei (2022):
 - Cooperative monetary policy under inflation-output tradeoff
 - Under-tightening in response to reallocation shock

Preview of Results

- **Cooperation may call for lower or higher nominal rates**
- **Three sufficient statistics:** (i) output gap; (ii) sectoral differences in labor intensity for tradables (T) and non-tradables (N); (iii) the trade balance response to changes in nominal rates

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General logic:

- Countries do not internalize how managing trade balance affects R^* and welfare abroad
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- If recession and N are more labor intensive: $\frac{\partial \mathcal{U}}{\partial R^*} < 0$
 - Central bank wants to shift employment towards high-labor intensive sector (N) because of lower elasticity of marginal cost wrt to output (helps lower π)
 - $\downarrow R^*$ leads to more inflows and more demand (and more employment) for N

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Signs revert when $dTB/dR > 0$ (or T are more labor intensive) \Rightarrow under-tightening

Main Elements of the Model

- Deterministic, infinite horizon
- Continuum of identical small open economies
 - Each country populated by continuum of households
- Two goods: tradable (T) and non-tradable (N)
 - Law of one price for tradables
- Sticky wages in period 0
 - Flexible wages for $t > 0$
- Perfect capital mobility
 - Global asset pays R^* in units of T

$$\sum_{t=0}^{\infty} \beta^t \left[U(c_t) - \kappa_t h_t - \frac{\chi}{2} (\hat{\pi}_t)^2 \right]$$

$$c_t = \left[\phi^T (c_t^T)^{\frac{\gamma-1}{\gamma}} + \phi^N (c_t^N)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \quad h_t = h_t^T + h_t^N, \quad \hat{\pi}_t \text{ deviation from CPI target}$$

- Budget constraint:

$$P_t^T c_t^T + P_t^N c_t^N + \frac{b_{t+1}}{R_t} + P_t^T \frac{b_{t+1}^*}{R_t^*} = W_t (h_t^T + h_t^N) + \Psi_t + b_t + P_t^T b_t$$

- Off labor supply at $t = 0$

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- See paper for microfoundation of inflation costs

- Production for tradables (T) and non-tradables (N)

$$F^T(h_t^T, A_t^T) = A_t^T (h_t^T)^{\alpha^T}, \quad F^N(h_t^N, A_t^N) = A_t^N (h_t^N)^{\alpha^N}$$

- Optimality

$$P_t^T \alpha^T A_t^T (h_t^T)^{\alpha^T - 1} = P_t^N \alpha^N A_t^N (h_t^N)^{\alpha^N - 1} = W_t$$

- For $t > 0$, assume central bank stabilizes price level
- For $t = 0$, optimal choice of $\{R_0\}$

Competitive Equilibrium in the Global Economy

Given b_0^* , a sticky wage W , and a sequence of policies $\{R_t\}$ in each country k , an equilibrium is a sequence of world real rates $\{R_t^*\}$, prices $\{P_t^T, P_t^N, W_t, e_{k,t}^j\}$ and allocations $\{c_t^T, c_t^N, h_t^T, h_t^N, b_{t+1}, b_{t+1}^*\}$ in each country k such that:

- In each country:
 - (i) Households and firms optimize
 - (iii) Market clears for non-tradables $F^N(h_t^N, A_t^N) = c_t^N$, local currency bonds $b_{t+1} = 0$.
and labor for $t \geq 1$
- Law of one price holds for tradables: $P_{kt}^T = e_{kt}^j P_{jt}^T$ for any country-pair k, j
- Market for real assets clear globally: $\int b_{kt+1}^* dk = 0$ for $t \geq 0$.

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In a symmetric equilibrium: $b_{t+1}^* = 0$ for all k, t and $e_{kt}^j = 1$

First-best allocation

$$\max_{\{h_t^N, h_t^T\}} \sum_{t=0}^{\infty} \beta^t \left[u \left(F^T(h_t^T, A_t^T), F^N(h_t^N, A_t^N) \right) - \kappa_t \left(h_t^T + h_t^N \right) \right].$$

Ratio of first-best employment levels:

$$\frac{\bar{h}_t^N}{\bar{h}_t^T} = \frac{\alpha^N \phi^N}{\alpha^T \phi^T}$$

Neutral wage and output gaps

$$W_t^n = (1 + \bar{\pi}_t) P_{-1} \left[\prod_{i=T,N} (\alpha^i A_t^i)^{\phi^i} (\bar{h}_t^i)^{-(1-\alpha^i)\phi^i} \right]$$

Output gaps:

$$\hat{h}_t^N \equiv \frac{h_t^N}{\bar{h}_t^N} - 1, \quad \hat{h}_t^T \equiv \frac{h_t^T}{\bar{h}_t^T} - 1$$

Problem for individual central bank in SOE

Households and firms' optimality

$$\frac{P_t^N}{P_t^T} = \frac{\omega^N c_t^T}{\omega^T c_t^N}, \quad \frac{P_t^N}{P_t^T} = \frac{\alpha^T (h^T)^{\alpha^T - 1}}{\alpha^N (h_t^N)^{\alpha^N - 1}}$$

Households and firms' optimality

$$\frac{h^N}{h^T} = \left(\frac{\alpha^N \omega^N}{\alpha^T \omega^T} \right) \left(1 - \frac{R_0^* b_1}{h_T^{\alpha^T}} \right)$$

Households and firms' optimality

$$\frac{h_t^N}{h_t^T} = \frac{\bar{h}^N}{\bar{h}^T} \left(1 - \frac{b_{t+1}^*}{R_t^* F(h^T, A^T)} \right)$$

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Lemma *In any symmetric competitive equilibrium, the output gaps in the tradable and non-tradable sectors are equalized $\hat{h}_t^T = \hat{h}_t^N = \hat{h}_t$. Furthermore, the employment ratio in the first-best allocations coincides with those in a competitive symmetric equilibrium for any monetary policy.*

Implementability (ctd)

$$P_t = \left(\frac{P_t^T}{\phi^T} \right)^{\phi^T} \left(\frac{P_t^N}{\phi^N} \right)^{\phi^N}$$

Replacing firms' optimality and using π and W^n

$$\frac{\hat{\pi}_0}{1 + \bar{\pi}} = \frac{W}{W_0^n} \left(\frac{h_0^T}{\bar{h}_0^T} \right)^{(1-\alpha^T)\phi^T} \left(\frac{h_0^N}{\bar{h}_0^N} \right)^{(1-\alpha^N)\phi^N} - 1$$

Finally, households Euler:

$$u_T \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) = \beta R_0^* u_T(c_{t+1}^T, c_{t+1}^N)$$

Central Bank Problem at $t = 1$

$$V_1(b_1^*) = \sum_{t=0}^{\infty} \beta^t \left[u(c_t^T, F^N(h_t^N, A_t^N)) - \kappa_t(h_t^T + h_t^N) \right]$$

subject to

$$F_h^T(h_t^T, A_t^T) u_T \left(F^T(h_t^T, A_t^T), F^N(h_t^N, A_t^N) \right) = \kappa_t.$$
$$F_h^N(h_t^T, A_t^N) u_N \left(F^T(h_t^T, A_t^T), F^N(h_t^N, A_t^N) \right) = \kappa_t,$$

$$b_1^* = - \sum_{t=1}^{\infty} \frac{F^T(h_t^T, A_t^T) - c_t^T}{\prod_{j=1}^{t-1} R_j^*}$$

Problem at $t = 0$

$$\max_{h_0^T, h_0^N, b_1^*} u \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) - \kappa_0(h_0^T + h_0^N) - \frac{\chi}{2}(\hat{\pi}_0)^2 + \beta V_1(b_1^*)$$

$$\text{s.t.} \quad \frac{\hat{\pi}_0}{1 + \bar{\pi}} = \frac{W}{W_0^n} \left(\frac{h_0^T}{\bar{h}_0^T} \right)^{(1-\alpha^T)\phi^T} \left(\frac{h_0^N}{\bar{h}_0^N} \right)^{(1-\alpha^N)\phi^N} - 1$$

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$$u_T \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) = \beta R_0^* u_T(C^T(b_1^*), C^N(b_1^*))$$

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$$\begin{aligned} \max_{h_0^T, h_0^N, b_1^*} \quad & u \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) - \kappa_0(h_0^T + h_0^N) - \frac{\chi}{2}(\hat{\pi}_0)^2 + \beta V_1(b_1^*) \\ \text{s.t.} \quad & \frac{\hat{\pi}_0}{1 + \bar{\pi}} = \frac{W}{W_0^n} \left(\frac{h_0^T}{\bar{h}_0^T} \right)^{(1-\alpha^T)\phi^T} \left(\frac{h_0^N}{\bar{h}_0^N} \right)^{(1-\alpha^N)\phi^N} - 1 \\ & \frac{h_0^N}{h_0^T} = \frac{\bar{h}_0^N}{\bar{h}_0^T} \left(1 - \frac{b_1^*}{R_0^* F(h_0^T, A_0^T)} \right) \\ & u_T \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) = \beta R_0^* u_T(C^T(b_1^*), C^N(b_1^*)) \end{aligned}$$

- Absent inflation costs, first-best \bar{h}^T, \bar{h}^N can be implemented for any natural wage W_0^n
 - Align real wage consistent that implements \bar{h}^T, \bar{h}^N

Problem at $t = 0$

$$\max_{h_0^T, h_0^N, b_1^*} u \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) - \kappa_0(h_0^T + h_0^N) - \frac{\chi}{2}(\hat{\pi}_0)^2 + \beta V_1(b_1^*)$$

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- By $\downarrow b_1^*$, country can raise demand for T and N goods
 \Rightarrow Higher borrowing reallocate employment toward N
- If $\alpha^N > \alpha^T$, this helps $\downarrow \hat{\pi}_0$
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Does cooperative monetary policy call for higher or lower nominal rates?

Individual central bank problem

$$\begin{aligned} \max_{h_0^T, h_0^N, b_1^*} & u \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) - \kappa_0(h_0^T + h_0^N) - \frac{\chi}{2}(\hat{\pi}_0)^2 + \beta V_1(b_1^*) \\ \text{s.t.} & \frac{\hat{\pi}_0}{1 + \bar{\pi}} = \frac{W}{W_0^n} \left(\frac{h_0^T}{\bar{h}_0^T} \right)^{(1-\alpha^T)\phi^T} \left(\frac{h_0^N}{\bar{h}_0^N} \right)^{(1-\alpha^N)\phi^N} - 1 \\ & \frac{h_0^N}{h_0^T} = \frac{\bar{h}_0^N}{\bar{h}_0^T} \left(1 - \frac{b_1^*}{R_0^* F(h_0^T, A_0^T)} \right) \\ & u_T \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) = \beta R_0^* u_T(c^T(b_1^*), c^N(b_1^*)) \end{aligned}$$

All spillovers through R_0^* :

- No terms of trade (single tradable good)
- Inflationary pressures through exchange rates can be offset by monetary policy

Individual central bank problem

$$\begin{aligned} \max_{h_0^T, h_0^N, b_1^*} & u \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) - \kappa_0(h_0^T + h_0^N) - \frac{\chi}{2}(\hat{\pi}_0)^2 + \beta V_1(b_1^*) \\ \text{s.t.} & \frac{\hat{\pi}_0}{1 + \bar{\pi}} = \frac{W}{W_0^n} \left(\frac{h_0^T}{\bar{h}_0^T} \right)^{(1-\alpha^T)\phi^T} \left(\frac{h_0^N}{\bar{h}_0^N} \right)^{(1-\alpha^N)\phi^N} - 1 \\ & \frac{h_0^N}{h_0^T} = \frac{\bar{h}_0^N}{\bar{h}_0^T} \left(1 - \frac{b_1^*}{R_0^* F(h_0^T, A_0^T)} \right) \\ & u_T \left(F^T(h_0^T, A_0^T) - \frac{b_1^*}{R_0^*}, F^N(h_0^N, A_0^N) \right) = \beta R_0^* u_T(c^T(b_1^*), c^N(b_1^*)) \end{aligned}$$

All spillovers through R_0^* :

- No terms of trade (single tradable good)
- Inflationary pressures through exchange rates can be offset by monetary policy
- With capital controls, no spillovers in a symmetric eqm. ($b_1 = 0$)

Optimal Monetary Policy under Cooperation

Denote \mathcal{R}^* the real rate as a function of nominal rates R_0

$$\max_{R_0} \mathcal{U}_0(R_0, \mathcal{R}^*(R_0)) \Rightarrow \frac{\partial \mathcal{U}_0(R, R^*)}{\partial R} + \frac{d\mathcal{R}^*}{dR} \frac{\partial \mathcal{U}}{\partial R^*} = 0$$

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$$\left. \frac{\partial \mathcal{U}_0}{\partial R_0^*} \right|_{R_0^* = R_0^{*,NE}} = \frac{1}{R_0^* \psi_\eta} \left[\frac{\phi^T \phi^N}{\delta_0 - \phi^T + \sigma \phi^T} \right] \frac{\alpha^N - \alpha^T}{\psi^{NE}} \hat{h}_0^N$$

Suppose $\alpha^N > \alpha^T$ and $\hat{h}_0^N < 0$: a country benefits from low R^*

- $\downarrow R^*$ higher domestic demand $\Rightarrow \uparrow h^N$ (modest effects on π)

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$$\frac{d\mathcal{R}^*}{d\mathbf{R}} > 0 \iff \sigma > \bar{\sigma} \equiv 1 - \frac{\alpha^T}{\alpha^T \phi^T + \alpha^N \phi^N}$$

\Rightarrow Generalized Marshall Lerner: $dTB/dR < 0$ for relatively low IES $1/\sigma$ or high α^T :

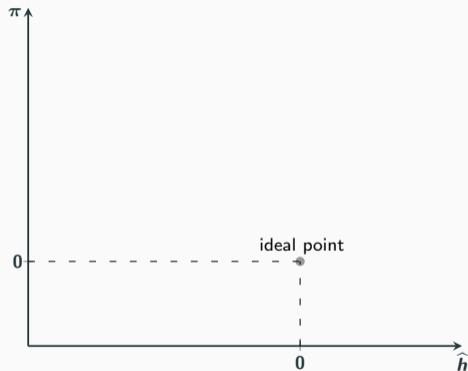
Proposition. Denote h_0^N the output gap in the Nash equilibrium. Then, the Nash equilibrium displays under-tightening $R_0^{NE} < R_0^{GP}$ if and only if $(\alpha^N - \alpha^T)(\sigma - \bar{\sigma})\hat{h}_0^N > 0$.

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- Examples w/ **under-tightening** in Nash-eqm:
 - Overheating, N are more labor intensive & $dTB/dR < 0$
 - Recession, N are more labor intensive & $dTB/dR > 0$
- Examples w/ **over-tightening** in Nash-eqm:
 - Overheating, N are more labor intensive & $dTB/dR > 0$
 - Recession, N are more labor intensive & $dTB/dR < 0$

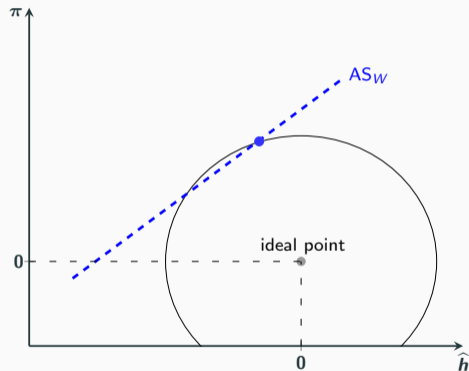
Fornaro and Romei (2022): $\alpha^N = 1, \sigma = 1, \kappa = 0, \Rightarrow b_1/dR < 0, \hat{h} < 0$

Inflation-Output Tradeoff



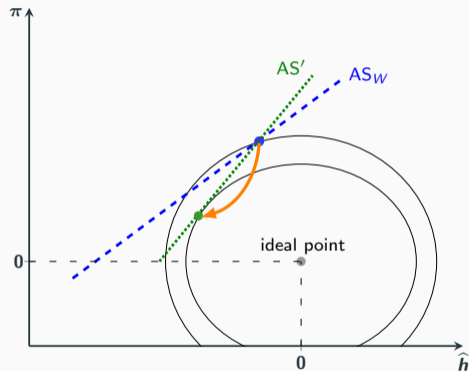
A case with over-tightening: Marshall-Lerner holds, $\alpha^N > \alpha^T$ and recession

Inflation-Output Tradeoff



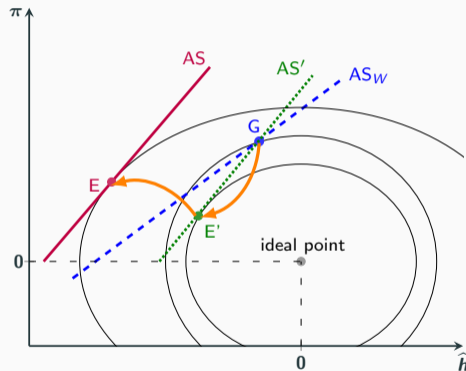
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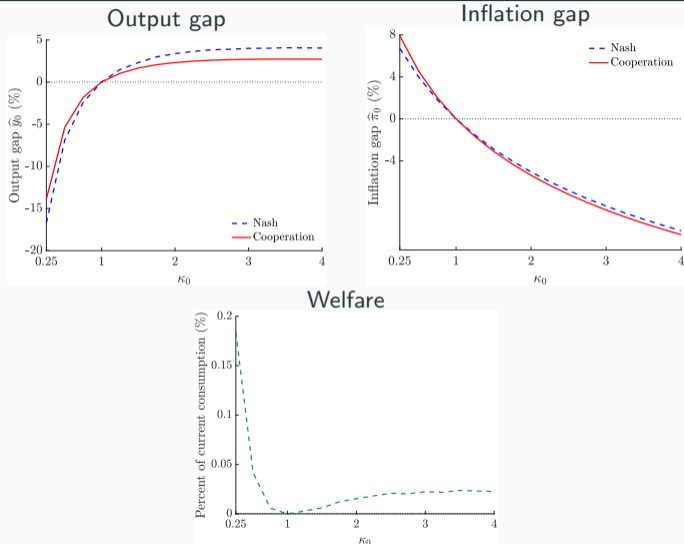
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Inflation-Output Tradeoff



A case with over-tightening: Marshall-Lerner holds, $\alpha^N > \alpha^T$ and recession

Quantitative Gains from Coordination



Parameter values: $\sigma = 5$, $\alpha^N = 0.75$, $\alpha^T = 0.43$, $\phi^T = 0.26$, $\beta = 0.96$, $\chi = 10$.

Anticipated Shocks

- Baseline model features either inflation and recession, or deflation and overheating
 - If $\hat{\pi} > 0$ and $\hat{y} > 0$ raise interest rate
 - If $\hat{\pi} < 0$ and $\hat{y} < 0$, lower interest rate

Anticipated Shocks

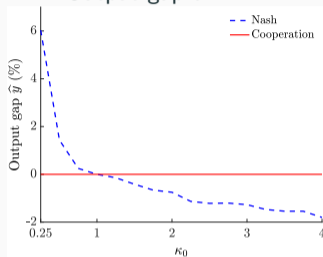
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 - Even if $(0, 0)$ feasible, CB tries to increase trade surplus \Rightarrow generate inflation and overheating

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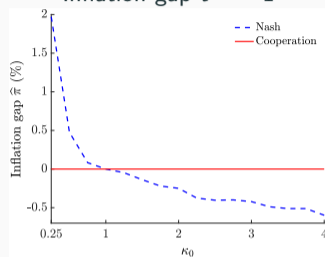
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- Suppose anticipate a recession:
 - Even if $(0, 0)$ feasible, CB tries to increase trade surplus \Rightarrow generate inflation and overheating
- Under cooperation, $\hat{\pi} = \hat{h} = 0$

Quantification with Anticipated Shocks

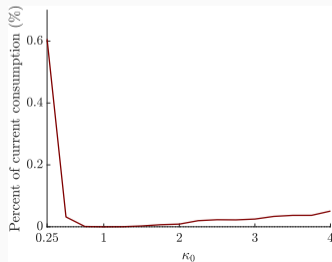
Output gap $t = -1$



Inflation gap $t = -1$



Welfare $t = -1$



Same sufficient statistics with:

- CES aggregator: Marshall-Lerner condition now depends also on T-NT elasticity
- Imperfect labor mobility
- Other factors of production (e.g. oil)
 - Intensity of other factors of production irrelevant as long as their price is flexible
 - Labor intensity remains key

- Theory of monetary policy coordination under financial integration
- Nash equilibrium features over- or under-tightening depending on:
 - the sign of output gap
 - differences in labor intensity
 - response of trade balance to exchange rate depreciations
- Quantitative gains can be significant for large shocks

Extras

$$\hat{\pi} = \hat{w} + \sum_{i=T,N} (1 - \alpha^i) \phi^i \hat{h}^N + \hat{b}_1(\hat{h}^N, \hat{R}^*) \quad (\text{AS})$$

with

$$\hat{b}_1(\hat{h}^N, \hat{R}^*) = a_2 \left[(\sigma - \tilde{\sigma}) \sum_{i=T,N} \alpha^i \phi^i \hat{h}^N + \hat{R}^* \right]$$