Worldwide Macroeconomic Stability and Monetary Policy Rules

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John Taylor and Monetary Policy—FRB Dallas

[1] Any views expressed are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of St. Louis or the Federal Reserve System.

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- An alternative theory: *improved monetary policy*.
  - A more aggressive response to inflation.
  - "In my view, that change in policy has been the key to keeping the real economy stable." (Taylor, again in the *Homer Jones Lecture*.)

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2. ... but stresses that one needs to take a *worldwide perspective* to properly assess this idea ...
3. ... and, provides *a cautionary tale* about the quality of current monetary policy worldwide—it may not be as good as you think.

Policy-induced indeterminacy

- NK macroeconomics—Woodford (2003, *Interest and Prices*).
- Close the model with a Taylor-type rule:

$$r_t = \varphi_\pi E_t \pi_{t+1} + \varphi_y E_t \tilde{y}_{t+1} + \varphi_r r_{t-1} \tag{1}$$

- Inappropriate choice of policy parameters φ_π, φ_y, and φ_r could induce indeterminacy.
  - A coherent way to talk about "bad policy" and, potentially, endogenous volatility.
- An interest rate peg $\varphi_\pi = \varphi_y = \varphi_r = 0$ creates indeterminacy. "Sargent-Wallace."
- The *Taylor principle* is necessary for determinacy. Approximately, $\varphi_\pi + \varphi_r > 1$.

A famous paper

- Clarida, Gali, Gertler (2000, *QJE*).
- Simple, closed, New Keynesian economy.
- Estimated Taylor-type monetary policy rules for the 1970s and 1990s.
- Suggested that monetary policy in the 1970s was too passive and hence consistent with indeterminacy.
- *Influential*.
  - Poor policy as one source of high volatility in the 1970s.
- Lots of attempts to re-estimate the 1970s policy, e.g., Orphanides (2005) and Lubik and Schorfheide (2004).

Large open economy considerations

- This paper is a "worldwide" version of Clarida, Gali, and Gertler (2000, *QJE*).
- Many possible extensions of model to the open economy.
  - We use the Clarida, Gali, Gertler (2002, *JME*) extension.
- Collapses to closed NK economy in a simple way.
- There are now multiple policymakers.
- There is now a worldwide rational expectations equilibrium.
- What are the determinacy conditions for the worldwide equilibrium?

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3. Study transmission of sunspot shocks across borders.
4. Look for empirical evidence on policy rules worldwide.

Preview of main findings

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- Endogenous volatility can be transmitted across borders.
- Transmission depends on the size of the country following the policy inconsistent with worldwide determinacy.
    - In line with much intuition of central bankers.

Empirical findings

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  - Lesson: Unlikely that all countries pursue policy consistent with worldwide determinacy all at the same time.
  - *We are exposed to endogenous volatility even today*!

Recent related literature

- Indeterminacy in small open economy settings: De Fiore and Liu (2005), Zanna (2003).
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- International monetary policy cooperation: Benigno and Benigno (2006b), Obstfeld and Rogoff (2002), Corsetti and Pesenti (2005).
- Estimates of Taylor-typle policy rules: Orphanides (2001, 2005), Clarida, Gali, Gertler (1998, 2000), Lubik and Schorfheide (2004).
- Globalization: Woodford (2007).

Environment

- Clarida, Gali, Gertler (2002, *JME*).
- World economy has n countries. Country j has mass γ_j.
- Each country has a continum of infinitely-lived households.
- Countries produce both intermediate and final goods but only final goods are traded.
- *Countries differ only in their size and their monetary policy rule*.

Households

- Households maximize standard preferences.
- $C_t^j = \prod_{k=1}^{n} C_{j,k,t}^{\gamma_k}$, is the consumption index.
- Depends on γ_k.

Production and pricing

- Monopolistically competitive intermediate goods firms produce differentiated products and face Calvo frictions in setting prices.
- Final goods producers are competitive.
- Law of one price holds with producer currency pricing.

Exchange rates and terms of trade

- Exchange rates are flexible.
- Important distinction between PPI and CPI

$$\pi^{C}_{j,t} = \pi^{j}_{t} + \sum_{i=1, i \neq j}^{n} \gamma_i \Delta s_{j,i,t} \tag{2}$$

  where $\Delta s_{j,i,t}$ is the rate of change in terms of trade.
- CPI-based purchasing power parity.

Equilibrium

- For country j, log linearization about the steady state gives

$$\tilde{y}_t^j = E_t \tilde{y}_{t+1}^j - \sigma_{j,o}^{-1} \left[r_t^j - E_t \pi_{t+1}^j - \overline{rr}_t^j \right], \quad (3)$$

$$\pi_t^j = \beta E_t \pi_{t+1}^j + \lambda_{j,o} \tilde{y}_t^j + u_t^j \quad (4)$$

  - where $\sigma_{j,o} = \sigma - \kappa_{j,o}$,
  - $\kappa_{j,o} \equiv (1 - \gamma_j)(\sigma - 1)$,
  - $\lambda_{j,o} = \delta \kappa_{j,j}$, $\kappa_{j,j} = \sigma + \phi - \kappa_{j,o}$,
  - $\delta = (1 - \theta)(1 - \beta\theta)/\theta$.

- Open economy effects come through $\sigma_{j,o}$ and $\lambda_{j,o}$.
- Special case $\gamma_j \to 1$ implies Woodford (2003).

Monetary policy rules

- Each country j follows a monetary policy rule

$$r_t^j = \varphi_\pi^j E_t \pi_{j,t+1}^C + \varphi_y^j E_t \tilde{y}_{t+1}^j + \varphi_r^j r_{t-1}^j \tag{5}$$

- Forward-looking rule with interest rate smoothing following CGG (2000, *QJE*).
- Policy implicitly reacts to foreign inflation and the foreign output gap through CPI inflation.
- The fact that policymakers react to CPI inflation provides linkages between countries that would otherwise not exist.
- Allow the policy parameters to be different across countries.

More on monetary policy rules

- The reaction to CPI inflation means terms of trade terms enter the rule. The terms of trade is related to the output gap differential

$$s_{j,i,t} = \tilde{y}^j_t - \tilde{y}^i_t + \bar{s}_{j,i,t}.$$

- Substituting appropriately implies:

$$r^j_t = \varphi^j_\pi E_t \pi^j_{t+1} + \varphi^j_y E_t \tilde{y}^j_{t+1} + \sum_{i=1, i\neq j}^{n} \varphi^j_{s,i} (E_t \tilde{y}^j_{t+1} - \tilde{y}^j_t)$$
$$- \sum_{i=1, i\neq j}^{n} \varphi^j_{s,i} (E_t \tilde{y}^i_{t+1} - \tilde{y}^i_t) + \sum_{i=1, i\neq j}^{n} \varphi^j_{s,i} E_t \Delta \bar{s}_{j,i,t+1} + \varphi^j_r r^j_{t-1}.$$

where $\varphi^j_{s,i} = \varphi^j_\pi \gamma_i$.

The dynamic system

- Putting predetermined variables in $\mathcal{X}_t^2$, free variables in $\mathcal{X}_t^1$, and shock terms in U_t

$$\begin{aligned} \mathcal{X}_t^1 &= B_1 E_t \mathcal{X}_{t+1}^1 + C\mathcal{X}_t^2 \\ \mathcal{X}_t^2 &= R\mathcal{X}_{t-1}^1 + S\mathcal{X}_{t-1}^2 + U_t. \end{aligned}$$

- Let $\eta_{t+1} = \mathcal{X}_{t+1}^1 - E_t\mathcal{X}_{t+1}^1$, and write the dynamic system as

$$\mathcal{X}_t^1 = B_1\mathcal{X}_{t+1}^1 + C\mathcal{X}_t^2 - B_1\eta_{t+1}$$

$$\mathcal{X}_{t+1}^2 = R\mathcal{X}_t^1 + S\mathcal{X}_t^2 + U_{t+1}$$

More on the dynamic system

- As a vector autoregressive process

$$\begin{bmatrix} \mathcal{X}_t^1 \\ \mathcal{X}_t^2 \end{bmatrix} = J \begin{bmatrix} \mathcal{X}_{t+1}^1 \\ \mathcal{X}_{t+1}^2 \end{bmatrix} + L \begin{bmatrix} U_{t+1} \\ \eta_{t+1} \end{bmatrix}$$

  where

$$J = \begin{bmatrix} I & -C \\ R & S \end{bmatrix}^{-1} \begin{bmatrix} B_1 & 0 \\ 0 & I \end{bmatrix}.$$

- Equilibrium is determinate if the number of eigenvalues of J inside the unit circle is equal to the number of free variables.

Stationary non-fundamental equilibria

- To characterize non-fundamental equilibria: Let $Q^{-1}JQ = \Lambda$ and partition Q^{-1} and $(\mathcal{X}_t^{1\prime}, \mathcal{X}_t^{2\prime})'$ such that

$$\begin{bmatrix} \mathcal{X}_t^1 \\ \mathcal{X}_t^2 \end{bmatrix} = \begin{bmatrix} \mathcal{X}_t^{1,*} \\ \mathcal{X}_t^{1,\#} \\ \mathcal{X}_t^2 \end{bmatrix}.$$

  where $\mathcal{X}_t^{1,*}$ is associated with the eigenvalues inside the unit circle and $\mathcal{X}_t^{1,\#}$ is associated with the eigenvalues outside the unit circle.
- The partitioned system can be used to simulate sunspot equilibria.

Calibration

- Calibrate to ensure that each economy looks like Woodford (2003) if it is closed.
- $\beta = 0.99, \sigma = 0.157, \phi = 0.11, \delta = 0.09, \theta = 0.745.$
- γ_i left open for now.

Determinacy conditions for closed economies

- Bullard and Mitra (2006) closed economy, forward-looking rule with inertia; necessary and sufficient conditions (their notation) are

$$\kappa(\varphi_\pi + \varphi_r - 1) + (1-\beta)\varphi_y > 0, \tag{6}$$

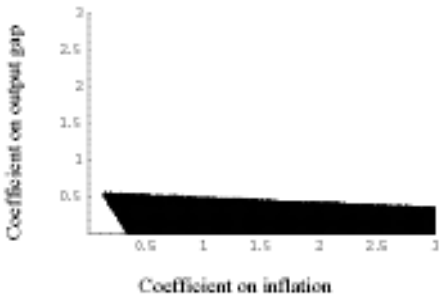
$$[\kappa\sigma + 2(1+\beta)]\varphi_r + 2(1+\beta) > \sigma[\kappa(\varphi_\pi - 1) + (1+\beta)\varphi_y]. \tag{7}$$

  where σ corresponds to $\sigma_{j,o}^{-1}$ and κ corresponds to $\lambda_{j,o}$.
- Equation (6) is a version of the *Taylor Principle*.
- Equation (7) is an extra condition that arises due to policy inertia.

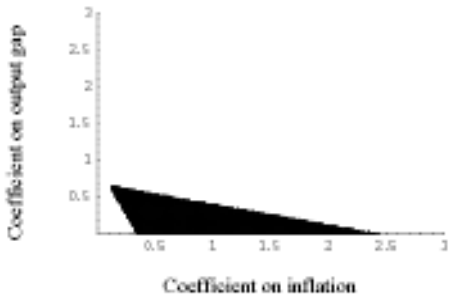
Determinacy conditions for large open economies

- How do the determinacy conditions change when the degree of openness varies for the home country?
- Figure 1.

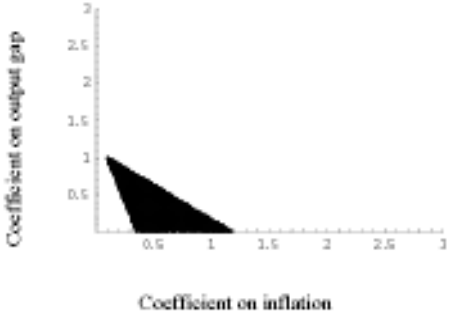
γ_1=0.99



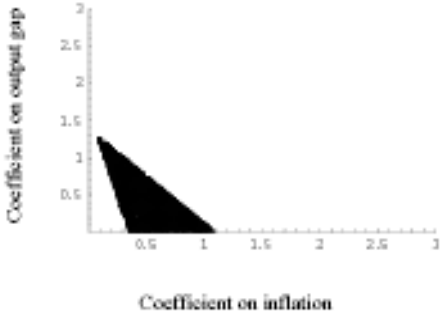
γ_1=0.95



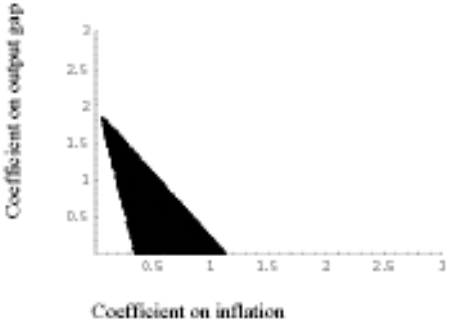
γ_1=0.8



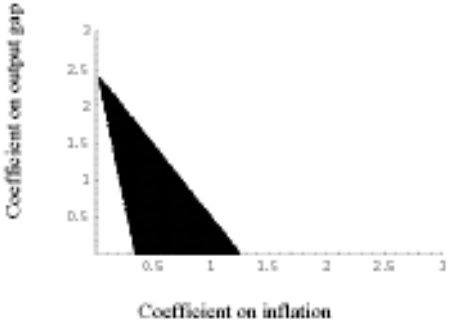
γ_1 =0.7



γ_1 =0.5



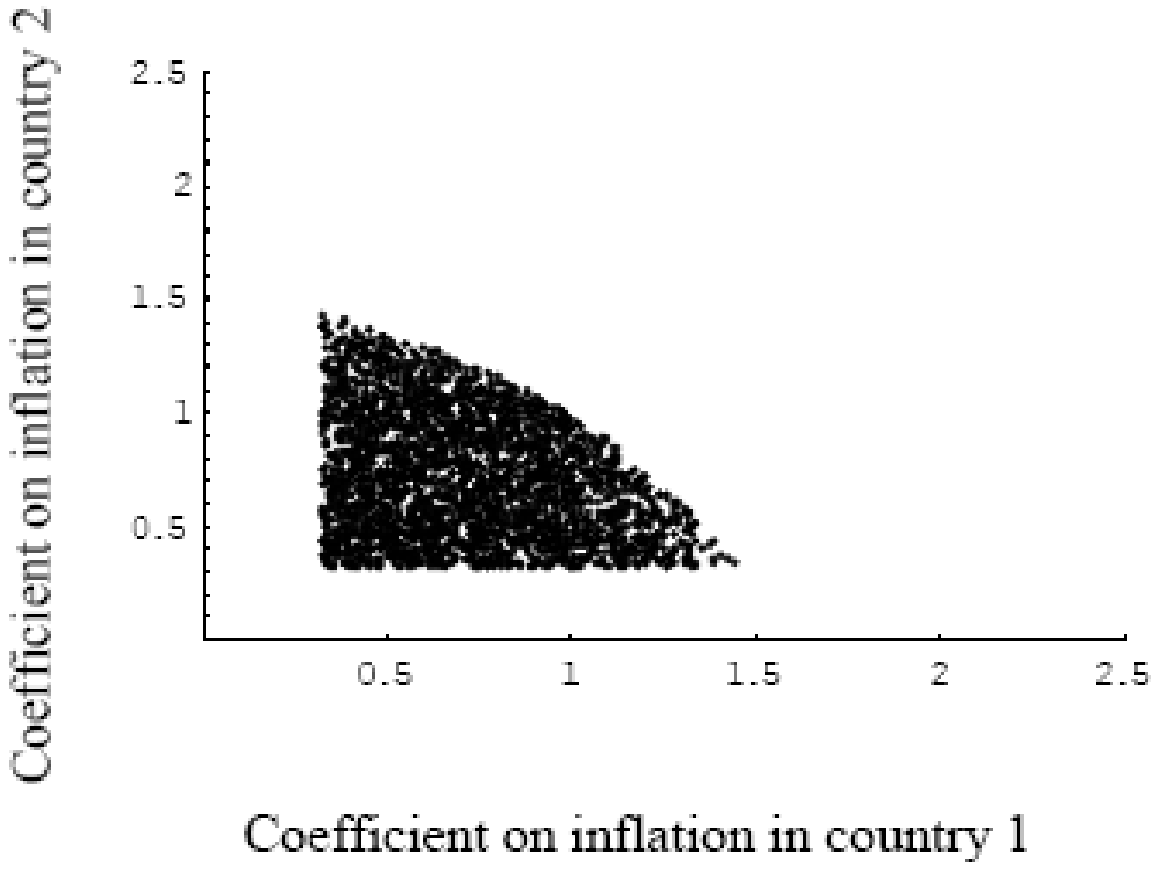
γ_1 =0.33



Intercountry trade-offs

- Can one country take a *simple, unilateral action* to induce determinacy of worldwide equilibrium?
- Fix γ_i, allow φ_π^i to vary.
- Summers-Heston world prices.
- 1970s $\Rightarrow \gamma^{US} = 0.61, \gamma^{G} = 0.16, \gamma^{J} = 0.23.$
- 1990s $\Rightarrow \gamma^{US} = 0.46, \gamma^{EU} = 0.36, \gamma^{J} = 0.18.$
- Figure 2.

$\gamma_1 = 0.46$, $\gamma_2 = 0.36$, and $\gamma_3 = 0.18$



Transmission of sunspot shocks across borders

- Does the sunspot-induced volatility travel across borders?
- No fundamental shocks.
- Sunspot shocks have a standard normal distribution. Interpretation.
- Panel B: Sunspot shock in smallest country, with smallest country policy determinacy-inconsistent.
- Panel C: Sunspot shock in largest country, with largest country policy determinacy-inconsistent.
- With no spillovers, there would be columns of zeroes in the countries pursuing determinacy-consistent policies.

TABLE 1. TRANSMISSION OF SUNSPOT SHOCKS

PANEL B

	1970s γ_i			*1990s* γ_i		
	U.S.	Germany	Japan	U.S	Euro-area	Japan
Output gap	0.77	2.70	0.06	0.67	0.49	2.71
Inflation	0.12	2.13	0.02	0.13	0.09	2.13
Interest rate	0.04	1.54	0.04	0.05	0.05	1.55

PANEL C

	1970s γ_i			*1990s* γ_i		
	U.S.	Germany	Japan	U.S.	Euro-area	Japan
Output gap	3.88	3.91	4.47	3.49	2.90	1.78
Inflation	2.38	1.02	1.14	2.32	0.64	0.43
Interest rate	1.94	0.38	0.37	1.81	0.20	0.21

Remarks on the transmission of sunspot shocks

- Sunspot volatility is always transmitted across borders.
- The extent of transmission depends on the size of the country following the determinacy inconsistent policy.
- The effect is acute when a large country follows a determinacy inconsistent policy rule.
- Sunspot shocks could have arbitrary variance and could be correlated with fundamental shocks.

Evidence of postwar sunspot equilibria

- CGG (2000, QJE)-style estimation of Taylor-type policy rules.
- Data from BEA and FRED for the US, and from OECD and IMF for Japan and Euro-area.
- First time period 1969-1979, as in CGG.
- Second time period 1990-2004, not in CGG, seemingly passive policy in Japan.

Estimated equation

- We estimate the following policy rule for each country in each time period

$$r_t = \alpha + \varphi_\pi E_t \pi^C_{t+1} + \varphi_y E_t \tilde{y}_{t+1} + \varphi_r r_{t-1} + \varepsilon_t$$

- Differences from CGG (2000) are to stay consistent with dynamic system.
- Output gap term one period ahead versus contemporaneous.
- Lagged interest rate—first order instead of second order partial adjustment.
- CPI inflation critical in our model.

Estimation procedure

- GMM.
- The set of instruments is similar to CGG (2000) for the U.S. and CGG (1998) for the Euro-area, Japan, and Germany. (CGG (1998) uses data from 1979-1993.)
- Null hypotheses that overidentifying restrictions are satisfied cannot be rejected at conventional levels of significance.
- Estimates of constant term.

Estimates

- 1969-1979 period, Germany and Japan not determinacy-consistent.

Country/coefficient	φ_π	φ_y	φ_r
US	0.27 (0.03)	0.22 (0.03)	0.75 (0.06)
Germany	0.30 (0.10)	0.46 (0.03)	0.58 (0.03)
Japan	0.14 (0.01)	0.04 (0.02)	0.80 (0.02)

- Using exact CGG (2000) specification for 1969-1979, U.S. also is not determinacy-consistent.
- Combined with calibrated values, this joint, worldwide policy produces indeterminacy of worldwide equilibrium.

Estimates

- 1990-2004 period, Japan not determinacy-consistent.

Country/coefficient	φ_π	φ_y	φ_r
US	0.08 (0.10)	0.07 (0.03)	0.94 (0.03)
Euro-area	0.21 (0.05)	0.11 (0.02)	0.91 (0.01)
Japan	-0.04 (0.02)	0.01 (0.01)	0.90 (0.01)

- Combined with calibrated values, this joint, worldwide policy induces indeterminacy of worldwide equilibrium.

Interpretations for the 1970s and the 1990s.

- 1970s was characterized by two dimensional indeterminacy.
- 1990 was characterized by one dimensional indeterminacy.
- Scope for endogenous volatility.
  - Sunspots could, but do not necessarily, play a large role.

Conclusions

- International monetary policies impact determinacy conditions of world equilibrium.
- Limited scope for one country to unilaterally induce determinacy in this model.
- Transmission of endogenous volatility across borders.
  - May be acute if the large country is following the determinacy-inconsistent policy.
- 1970s: two-dimensional indeterminacy. 1990s: one-dimensional indeterminacy.
  - Worldwide economy still at risk.

Policy coordination

- Conventional wisdom: Not a lot of policy coordination going on worldwide.
- Some literature suggests that any gains from jointly optimal policy would be small.
- But a determinacy perspective raises the possibility that failure to coordinate could leave the door open to unnecessary fluctuations.