Monetary Policy in a DSGE Model with Chinese Characteristics[1]

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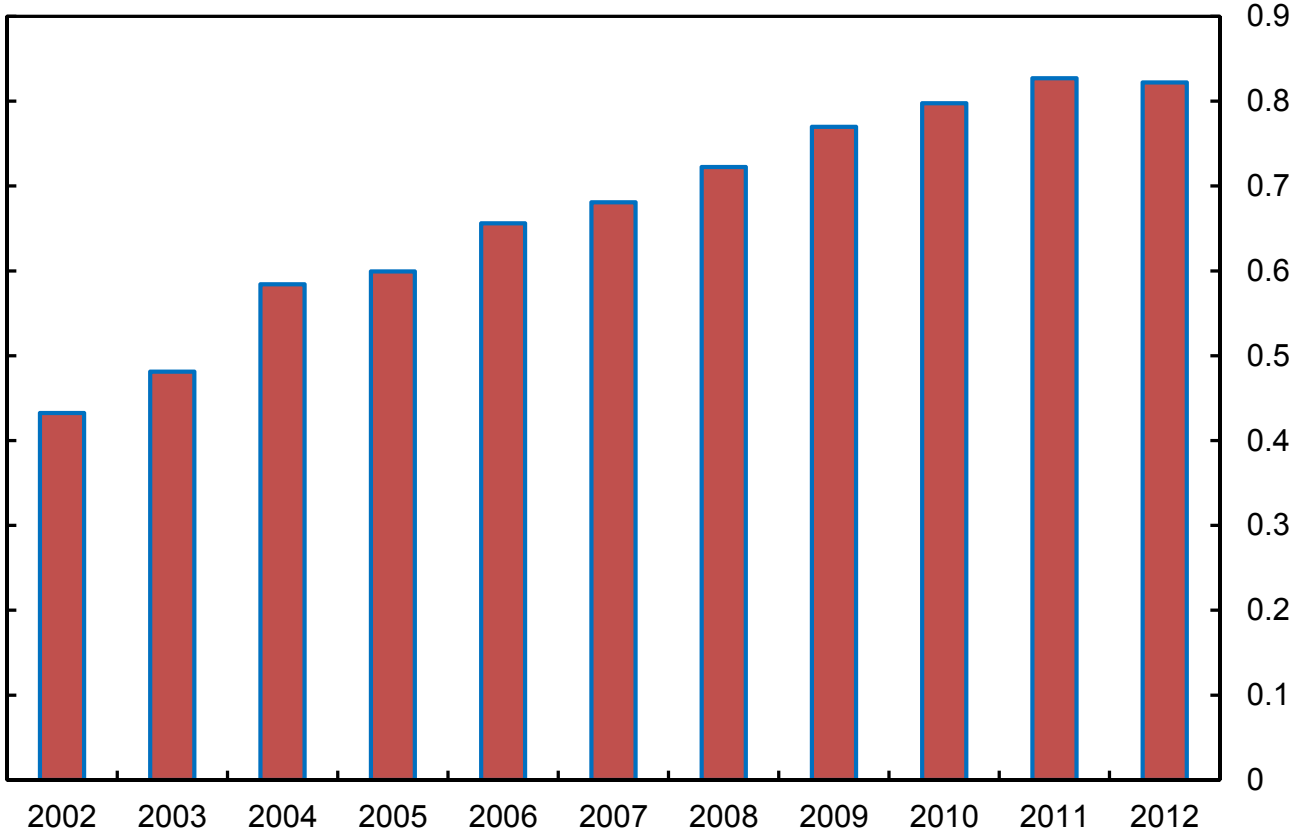
[1]The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco or the Federal Reserve System.

China's monetary policy constrained by trade policy

- Existing trade policy regime:
  1. Nominal exchange rate pegs
  2. Closed capital account
- Undervalued currency ⇒ persistent trade surpluses and foreign capital inflows.
- Capital controls ⇒ rapid accumulation of foreign reserves on CB balance sheet ⇒ Chinese monetary policy sensitive to global financial conditions

Foreign reserves as share of PBOC assets



Source: The People's Bank of China. Value for 2012 is based on data up to June.

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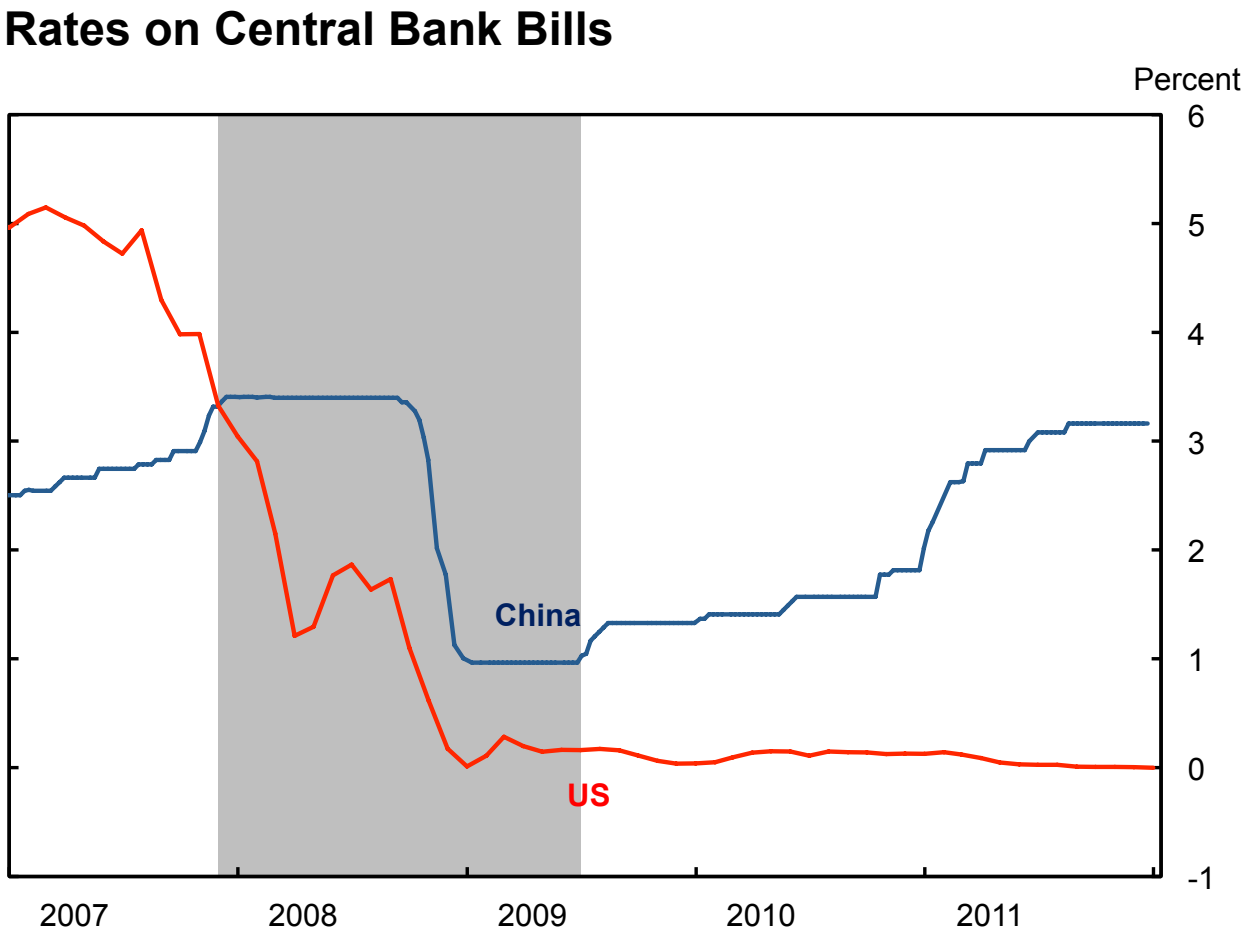
Capital controls and sterilized interventions

- Under capital controls, private agents restricted from holding foreign assets
- Exporters sell foreign-currency revenues to PBOC (China's CB) at prevailing exchange rate
- PBOC sterilizes purchases by selling domestic bonds (to avoid increases in money supply)
- Relative yields of foreign reserves vs domestic bonds determine if PBOC incurs gains or losses in sterilizing.

Global financial crisis changed PBOC's sterilization calculus

- Prior to crisis, Chinese rates lower than foreign rates ⇒ marginal fiscal benefits to sterilization [e.g. Prasad and Wei (2007)]
- Global financial crisis and unconventional monetary policy in advanced economies ⇒ large drops in global interest rates
- Low rates in developed economies and elevated rates in China ⇒ marginal fiscal costs of sterilization
- PBOC now faces tradeoff between costs of sterilization and inflation

Global crisis and the "reversal of fortune" for PBOC



"The dollar is our currency, but your problem." [John Connally, U.S. Treasury Secretary, 1971]

What we do in this paper

- Build a DSGE model with "Chinese characteristics"
  1. Capital controls
  2. Exchange rate pegs
  3. Sterilized interventions
- Derive optimal monetary policy responses to a persistent decline in foreign interest rate

Examine liberalizations of Chinese policy

- Consider same declines in foreign rates under three regimes
  1. Partially lifting capital controls while maintaining exchange rate pegs
  2. Floating exchange rate but keep capital account closed
  3. Full liberalization: lifting both capital controls and exchange rate pegs
- Unified DSGE framework allows consistent comparisons across regimes

Main findings

- Benchmark model
  - Decline in foreign interest rates raises sterilization costs
  - Optimal policy calls for less sterilization
  - Results in easing of monetary policy and increase in Chinese inflation.

Main findings

- Benchmark model
  - Decline in foreign interest rates raises sterilization costs
  - Optimal policy calls for less sterilization
  - Results in easing of monetary policy and increase in Chinese inflation.
- Alternative regimes
  - Opening capital account improves macro stability because it eliminates needs for sterilization
  - Letting exchange rate float also helps because it provides flexibility for restoring external balance
  - Full liberalization achieves best macro stability, but not necessary; each individual reform goes a long way for achieving macro stability

Model features

- Two-country model: China and the rest of the world.
  - Treat China as "small": world interest rates are exogenous
  - But foreign demand for Chinese exports is downward sloping
- Sticky prices and nominal wages
- Segmented asset markets and restricted private holdings of foreign assets (capital controls)
- CB targets pace of nominal exchange rate appreciation
- CB sterilizes foreign capital inflows by issuing domestic bonds

Aggregation sector

- Aggregation technologies

$$Y_t = \left[\int_0^1 Y_t(j)^{\frac{\theta_p - 1}{\theta_p}} dj \right]^{\frac{\theta_p}{\theta_p - 1}}, \quad L_t = \left[\int_0^1 L_t(i)^{\frac{\theta_w - 1}{\theta_w}} di \right]^{\frac{\theta_w}{\theta_w - 1}}$$

- Demand schedules

$$Y_t^d(j) = \left[\frac{P_t(j)}{P_t} \right]^{-\theta_p} Y_t, \quad L_t^d(i) = \left[\frac{W_t(i)}{W_t} \right]^{-\theta_w} L_t$$

Households

- Utility function

$$U = \mathrm{E}\sum_{t=0}^{\infty}\beta^t\left\{\ln C_t + \Phi_m \ln\frac{M_t}{P_t} - \Phi_l\frac{\left(L_t^d(i)\right)^{1+\eta}}{1+\eta}\right\}$$

- Budget constraints

$$\begin{aligned} C_t + \frac{M_t}{P_t} + \frac{B_t + e_t B_{pt}^*}{P_t}\left[1 + \frac{\Omega_b}{2}\left(\frac{B_t}{B_t + e_t B_{pt}^*} - \bar{\psi}\right)^2\right] \\ \leq \frac{W_t(i)}{P_t}L_t^d(i) - \frac{\Omega_w}{2}\left(\frac{W_t(i)}{\pi^w W_{t-1}(i)} - 1\right)^2 C_t + \frac{M_{t-1}}{P_t} \\ + \frac{R_{t-1}B_{t-1} + e_t R_{t-1}^* B_{p,t-1}^*}{P_t} + \frac{D_t}{P_t}, \end{aligned}$$

- Domestic bond imperfect substitute for foreign bond

Retail goods sector: monopolistic competition in product markets

- Production function

$$Y_t(j) = \Gamma_t(j)^{\phi}(Z_t L_t(j))^{1-\phi}, \quad j \in [0,1]$$

- Real marginal cost

$$v_t = \tilde{\phi} q_{mt}^{\phi} \left(\frac{w_t}{Z_t}\right)^{1-\phi}$$

- Pricing decision: Choose $P_t(j)$ to maximize profit

$$E_t \sum_{k=0}^{\infty} \beta^k \frac{C_t}{C_{t+k}} \left[\left(\frac{P_{t+k}(j)}{P_{t+k}} - v_{t+k} \right) Y_{t+k}^d(j) - \frac{\Omega}{2} \left(\frac{P_{t+k}(j)}{\pi P_{t+k-1}(j)} - 1 \right)^2 C_{t+k} \right]$$

Intermediate goods producers: price takers

- Production function

$$\Gamma_t = \Gamma_{ht}^{\alpha} \Gamma_{ft}^{1-\alpha}$$

- Relative price of intermediate goods

$$q_{mt} = \tilde{\alpha} \left(\frac{e_t P_t^*}{P_t} \right)^{1-\alpha}$$

- Real exchange rate

$$q_t = \frac{e_t P_t^*}{P_t}$$

Current account and external demand

- Current account

$$ca_t = X_t - q_t \Gamma_{ft} + \frac{e_t(R^*_{t-1} - 1)B^*_{t-1}}{P_t}$$

- Foreign demand for exported goods

$$X_t = q_t^{\theta} \tilde{X}^*_t Z^p_t$$

- Foreign capital inflows

$$e_t(B^*_t - B^*_{t-1}) = P_t ca_t$$

Government/central bank

- Flow of funds constraint

$$e_t(B^*_{gt} - R^*_{t-1}B^*_{g,t-1}) \leq B_t - R_{t-1}B_{t-1} + M^s_t - M^s_{t-1}$$

- Maintains exchange rate target and capital controls
- Under capital controls, households are restricted from accessing foreign assets: $\vartheta \equiv \frac{B^*_p}{B^*} = 0.05$ (small leakage)
- CB sterilizes purchases of foreign assets by issuing domestic currency bonds

Market clearing and equilibrium

- Final goods market clears:

$$Y_t = C_t + \Gamma_{ht} + X_t + AC_t$$

  where AC_t denotes the sum of adjustment costs (for prices, wages, and private portfolios)

- Labor and intermediate good markets clear

$$L_t = \int_0^1 L_t(j)dj, \quad \Gamma_t = \int_0^1 \Gamma_t(j)dj.$$

- Foreign asset holding

$$B_t^* = B_{pt}^* + B_{gt}^*$$

- Real GDP

$$GDP_t \equiv C_t + X_t - q_t \Gamma_{ft}$$

Optimal monetary policy problem

- Loss function for Ramsey planner

$$\mathcal{L} = \sum_{t}^{\infty} \left[\hat{\pi}_t^2 + \lambda_y \hat{GDP}_t^2 + \lambda_q \hat{q}_t^2 + \lambda_b \hat{b}_{yt}^{*2} \right]$$

($\hat{b}_{yt}^{*}$= ratio of privately held foreign bond to GDP)

- Loss function reflects desires for
  1. inflation and output stability (e.g., Woodford, 2003; Svensson, 2010)
  2. "maintaining stability of the value of the currency" (stated objective of PBOC)
  3. financial stability (avoid portfolio adjustment costs)

- Ramsey planner minimizes loss function subject to private sector's optimizing conditions

Parameter calibration (highlights)

- Average growth rate: 8 percent per year
- Price contract duration: 3 quarters (Nakamura-Steinsson, 2008)
- wage contract duration: 4 quarters (Barattieri, Basu, and Gottschalk, 2011)
- Loss function: $\lambda_y = 0.5$, $\lambda_q = 0.5$, $\lambda_b = 0.01$
- Steady-state $R = 1.0075$ and $R^* = 1.01$; $R < R^*$ captures financial repression and pre-crisis experience (e.g., Prasad and Wei, 2007)
- Steady-state trade surplus of 3 percent of GDP (average of 1990-2009)
- Steady-state share of foreign assets held by private sector: $\vartheta = 0.05$ (capital controls with limited leakage)

Calibration Details

Modified UIP condition

- Private optimizing decisions for B and B_p^* lead to modified UIP condition

$$\hat{R}_t - \hat{R}_t^* = \mathrm{E}_t \hat{\gamma}_{e,t+1} + \Omega_b \bar{\psi} \hat{\psi}_t$$

where ψ_t = share of domestic bond in private portfolio

- Set $\bar{\psi} = 0.90$ (Coeurdacier-Rey, 2011)
- Calibrate Ω_b, using a sample of 22 EM economies (2001-2011) based on the model-implied relation

$$\log \frac{S_{it}}{S_{i,t-1}} - (R_{i,t-1} - R_{t-1}^*) = a_i - b \log(\psi_{i,t-1})$$

- Estimates imply $b = 0.2 \Rightarrow \Omega_b = \frac{b}{\bar{\psi}} = 0.22$.

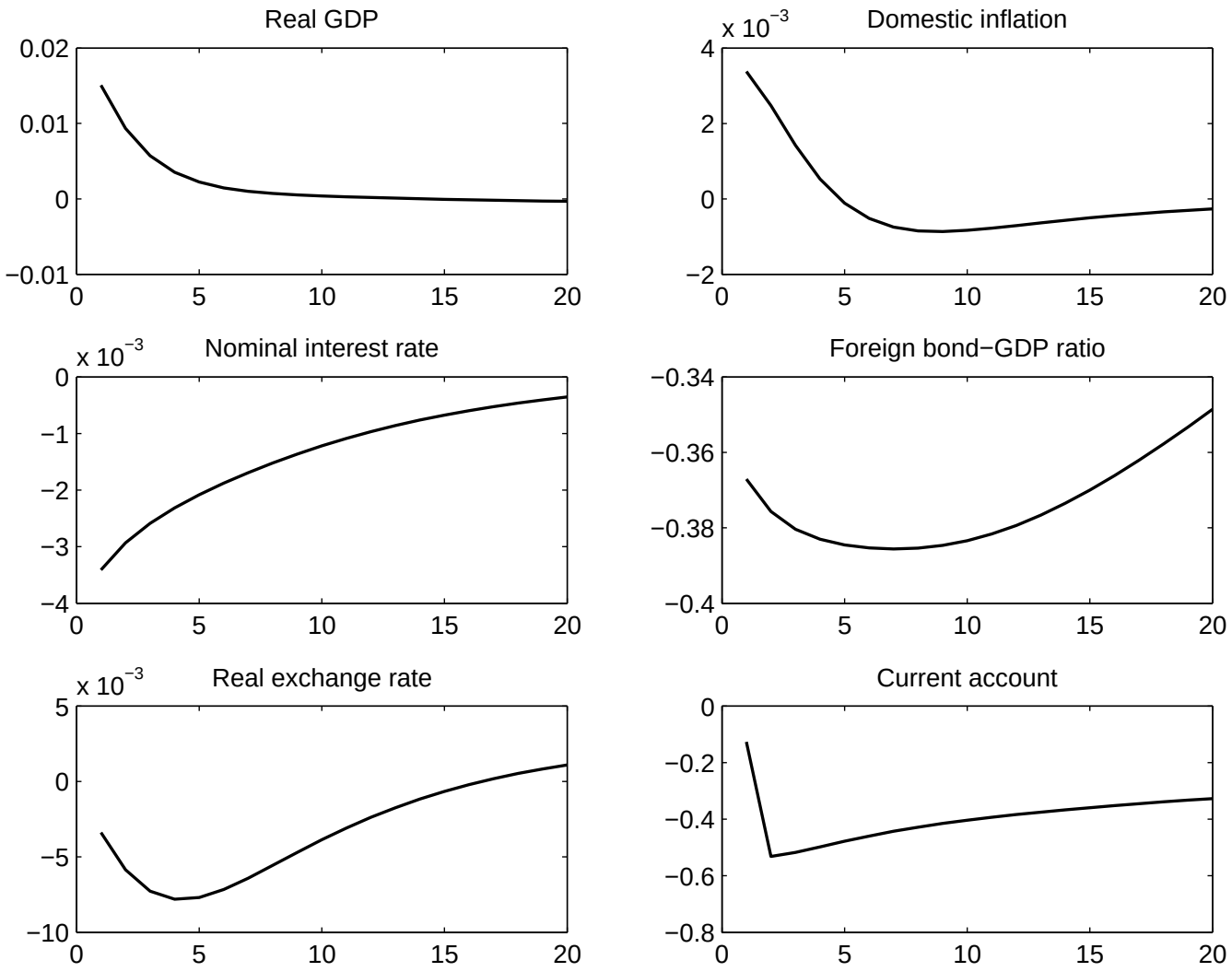
Persistent negative shock to foreign interest rates

- Leading central banks, including Fed and ECB eased monetary policy aggressively since crisis
- Persistent policy easing
  - Fed has conducted 3 rounds of QE (and going to the 4th round)
  - Fed has also kept target rate at zero since early 2009, and intends to stay at zero through mid-2015
- Examine an exogenous and persistent decline in R^* (with $\rho_{r^*} = 0.98$) that captures changes in global financial conditions since crisis

Impact of negative foreign interest rate shock

- Decline in R^* $\Rightarrow$ increase in cost of sterilization
- Absent lump-sum taxes, CB raises money supply to finance purchases of foreign assets; expansionary monetary policy reduces domestic interest rate
- Private portfolio rebalancing reinforces decline in domestic interest rate $\Rightarrow$ aggregate demand rises (intertemporal substitution) $\Rightarrow$ y and π both increase
- Offsetting factor: lower R_t^* implies lower foreign asset earnings in future periods —a negative wealth effect holds down current consumption.

Benchmark Model: Negative shock to foreign interest rate



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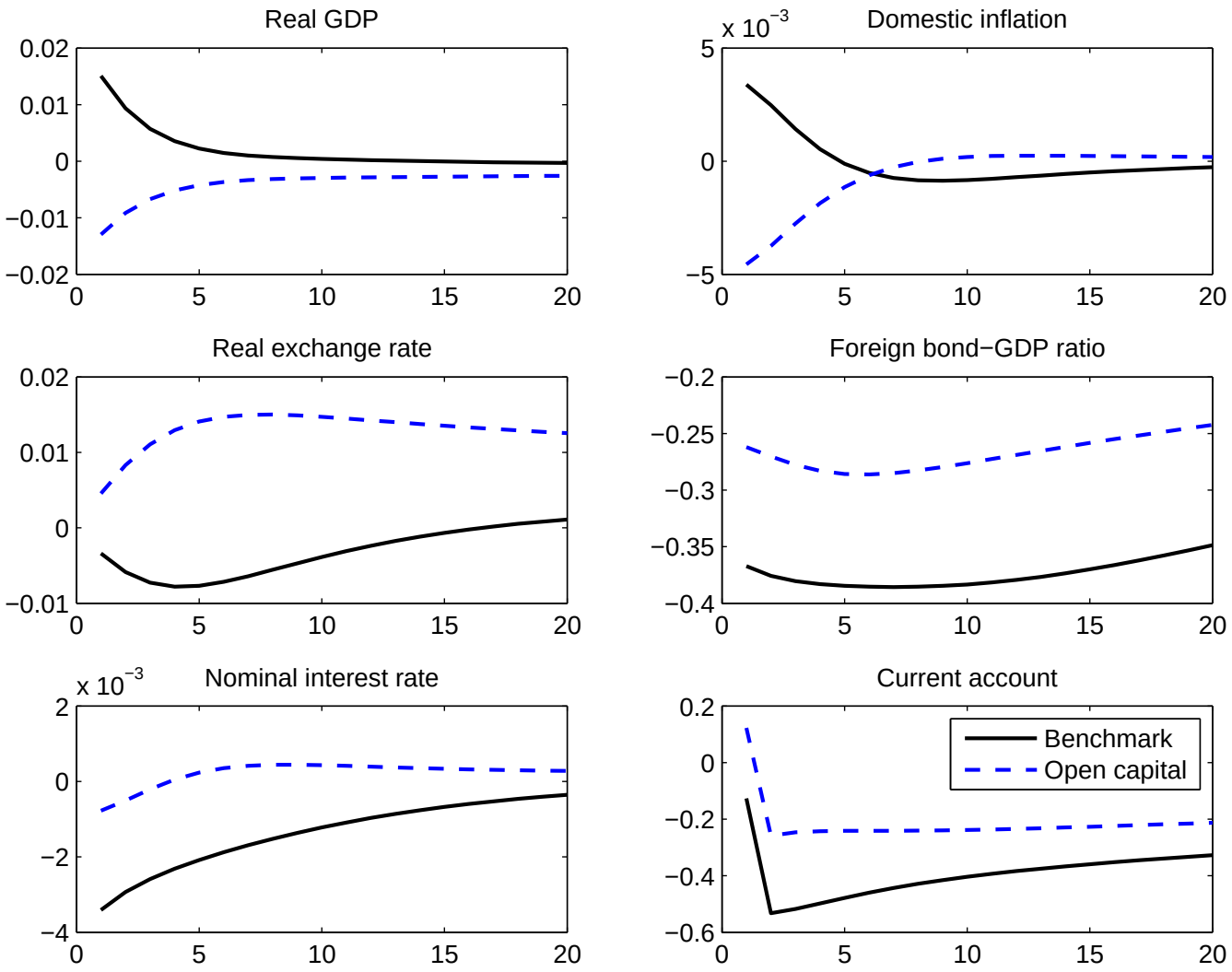
Policy reform 1: opening capital account

- Benchmark model: private agents restricted from holding foreign assets
- Ongoing discussions of policy reform suggests possibility of gradually lifting capital controls
- Opening capital account: high steady-state share of privately held foreign assets ($\vartheta = 0.95$, similar to US)
- Examine Ramsey optimal policy under open capital account

Impact of foreign interest shock: Open capital account



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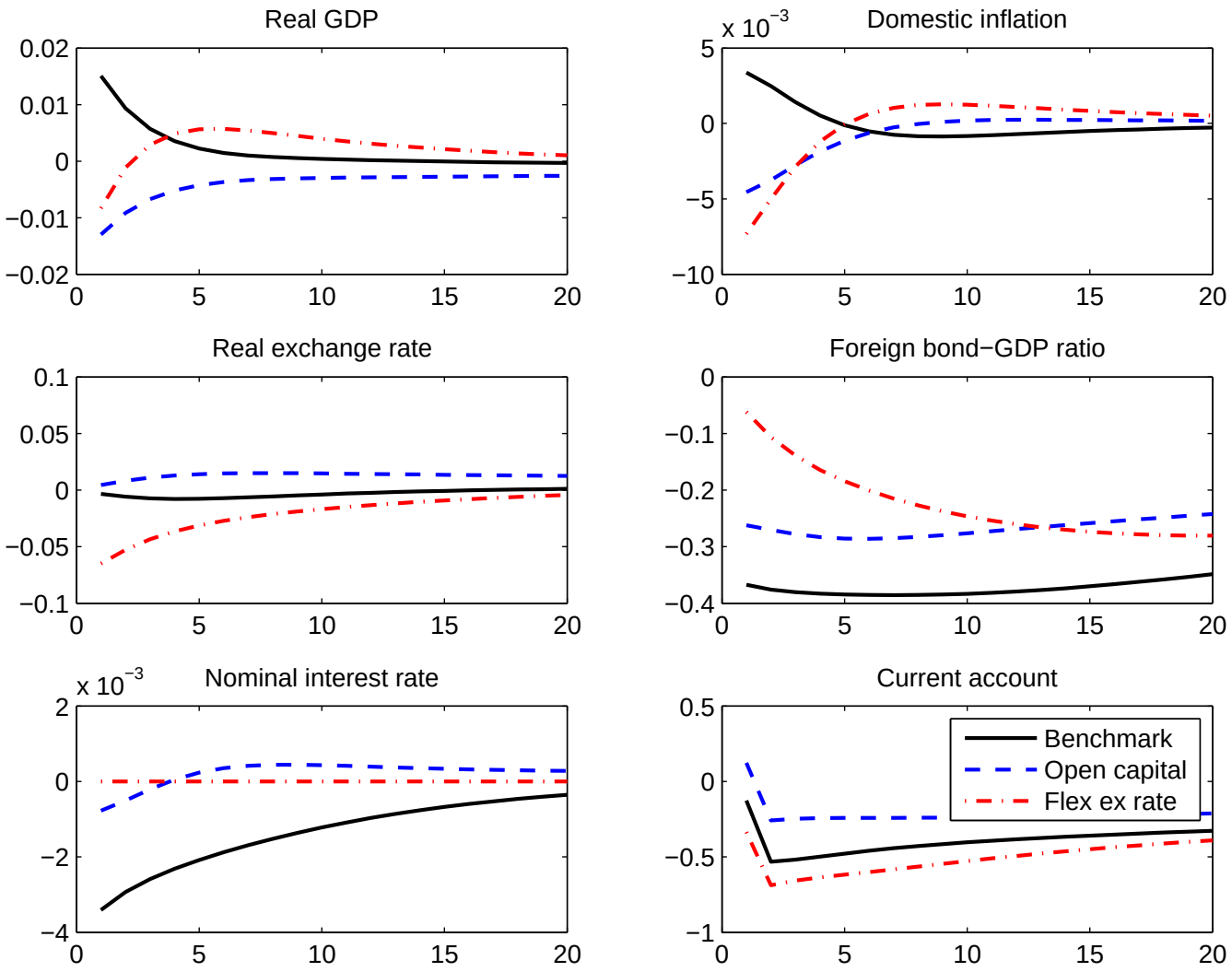
Policy reform 2: Floating exchange rate

- Central bank lifts its exchange rate peg, but maintains capital controls
- Nominal anchor provided by money growth rule
- Solve for Ramsey optimal policy

Impact of foreign interest shock: Floating exchange rate



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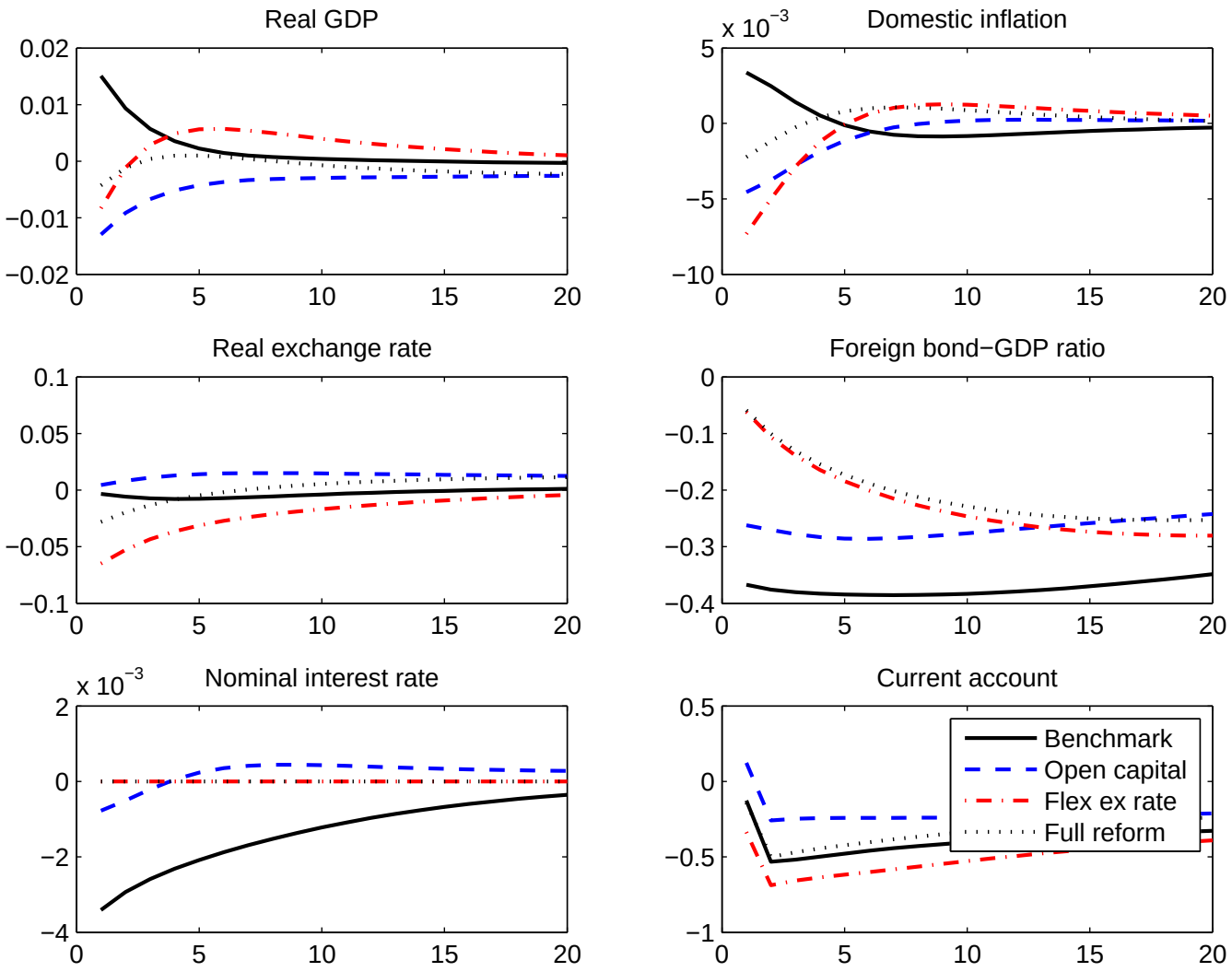
Policy reform 3: Full reform

- Capital controls and exchange rate pegs both lifted
- Nominal anchor provided by money growth rule
- Solve for Ramsey optimal policy

Impact of foreign interest shock: Full reform



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Welfare comparison across regimes: 3 shocks (R^*, X^*, and π^*)

	Welfare	Welfare components			
Regime	Loss	$Var(\pi)$	$0.5Var(GDP)$	$0.5Var(q)$	$0.01Var(b_y^*)$
Benchmark	0.0781	0.0011	0.0007	0.0009	0.0753
Open capital	0.0537	0.0010	0.0004	0.0055	0.0468
Flex ex rate	0.0569	0.0002	0.0002	0.0111	0.0454
Full reform	0.0503	0.0000	0.0002	0.0060	0.0440

Comparisons of policy reforms

- Opening capital account and letting exchange rate float help achieve significantly better macro stability
- Opening capital account removes needs for sterilization and improves macro stability
- Letting exchange rate float provides better flexibility for restoring external balances
- Either reform goes a long way for macro stability; full reform performs best, but additional gains small

Conclusion

- Under capital controls, optimal monetary policy in China responds to sterilization costs
- Declines in foreign interest rate discourage sterilization and raise inflation in the short run
- Examined alternative liberalizations:
  - Liberalizing capital account avoids cost of sterilization
  - Lifting exchange rate pegs help restore current account balances (and cut down large inflows of foreign assets)
  - Full reform achieves best stability, but not necessary. Either opening capital account or letting exchange rate float brings welfare close to full reform
- Model is stylized, but qualitative results intuitive
- Needed a unified model for consistent comparison

Parameter calibration

Parameter	Description	value
β	Subjective discount factor	0.998
Φ_m	Utility weight on money balances	0.06
η	Inverse Frisch elasticity	10
ϕ	Cost share of intermediate goods	0.50
$\bar{\lambda}_z$	Mean productivity growth rate	1.02
θ_p	Elasticity of substitution between goods	10
Ω_p	Price adjustment cost	30
θ_w	Elasticity of substitution between labor skills	10
Ω_w	Nominal wage adjustment cost	100
α	Share of domestic intermediate goods	0.70
θ	Export demand elasticity	1.5
Ω_b	Portfolio adjustment cost parameter	0.22
ϑ	Share of privately held foreign bonds	0.05 or 0.95
ρ_r	Persistence of foreign interest rate shock	0.98
ρ_x	Persistence of export demand shocks	0.95
ρ_q	Persistence of terms of trade shocks	0.95
σ_k	Standard deviation of shock k	0.01

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