Reserve Requirements and Optimal Chinese Stabilization Policy[1]

Chun Chang[1] Zheng Liu[2] Mark M. Spiegel[2]
Jingyi Zhang[1]

[1]Shanghai Jiao Tong University, [2]FRB San Francisco

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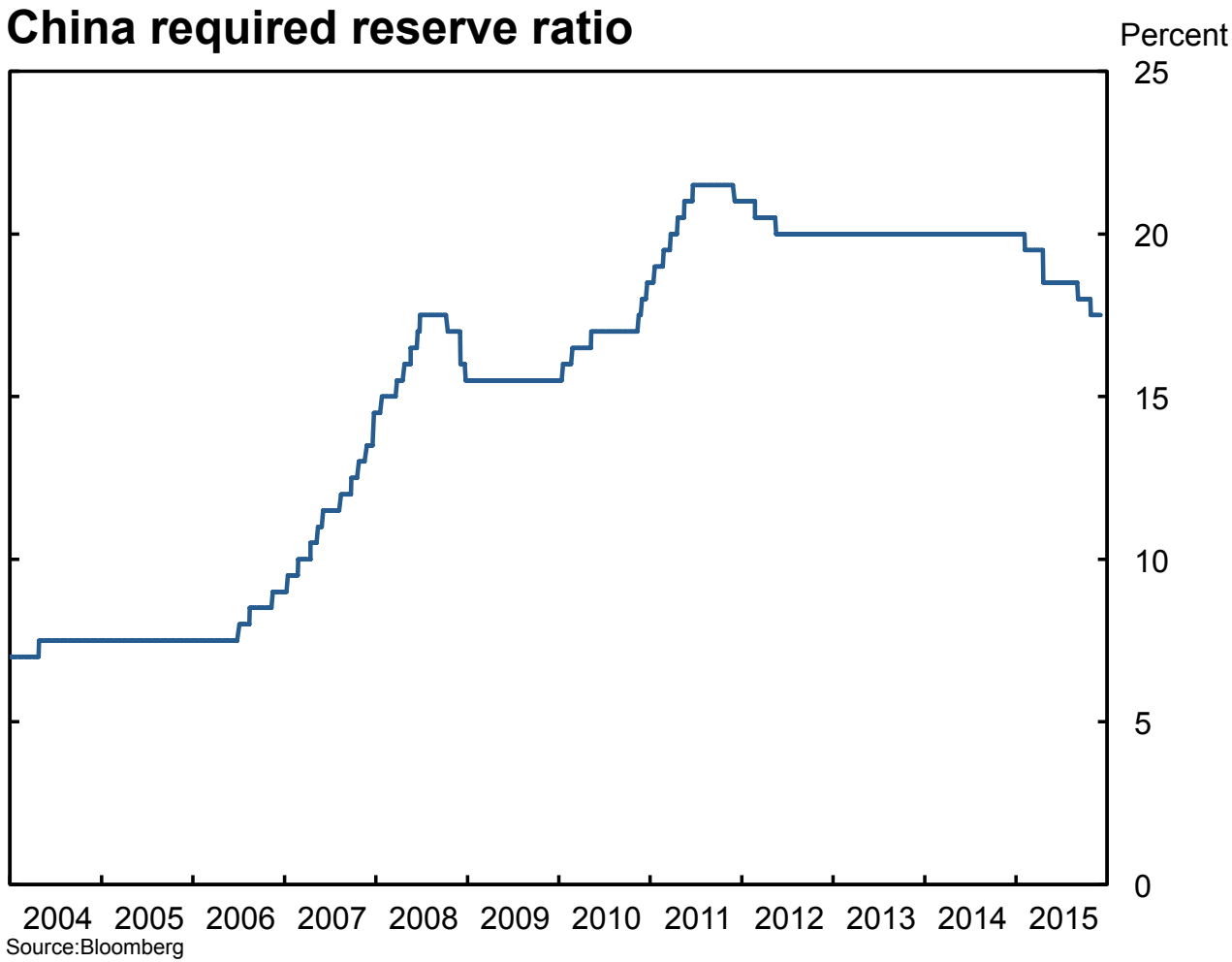
[1]The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco or the Federal Reserve System.

The PBOC frequently adjusts reserve requirements (RR)



- Since 2005, adjusted RR 40 times
- Between 2006 and 2011, RR rose from 8.5% to 21.5%

RR play a role in managing external imbalances in China

- Mop up foreign exchange reserves under closed capital account (Ma, et al. (2013))
- Cheaper alternative to sterilization since global financial crisis (e.g., Chang, Liu, and Speigel (2015))
- May therefore be understood as an expedient way for alleviating inflation pressures while reducing sterilization cost

RR increases encourage shadow banking activity

- Shadow bank lending increased over 30% per year between 2009 and 2013
  - Unregulated, kept off of banks' balance sheet (e.g., wealth management products)
  - Reduces costs of financial services but increases financial risks [Gorton and Metrick (2010), Elliott, et al (2015)]
- Shadow banking expansions attributable to tightened banking regulations (Elliott, et al (2015); Hachem and Song (2016); Chen, Ren, and Zha (2016))
  - binding loan/deposit caps
  - Interest rate controls
  - Increases in RR (only affect formal banking)

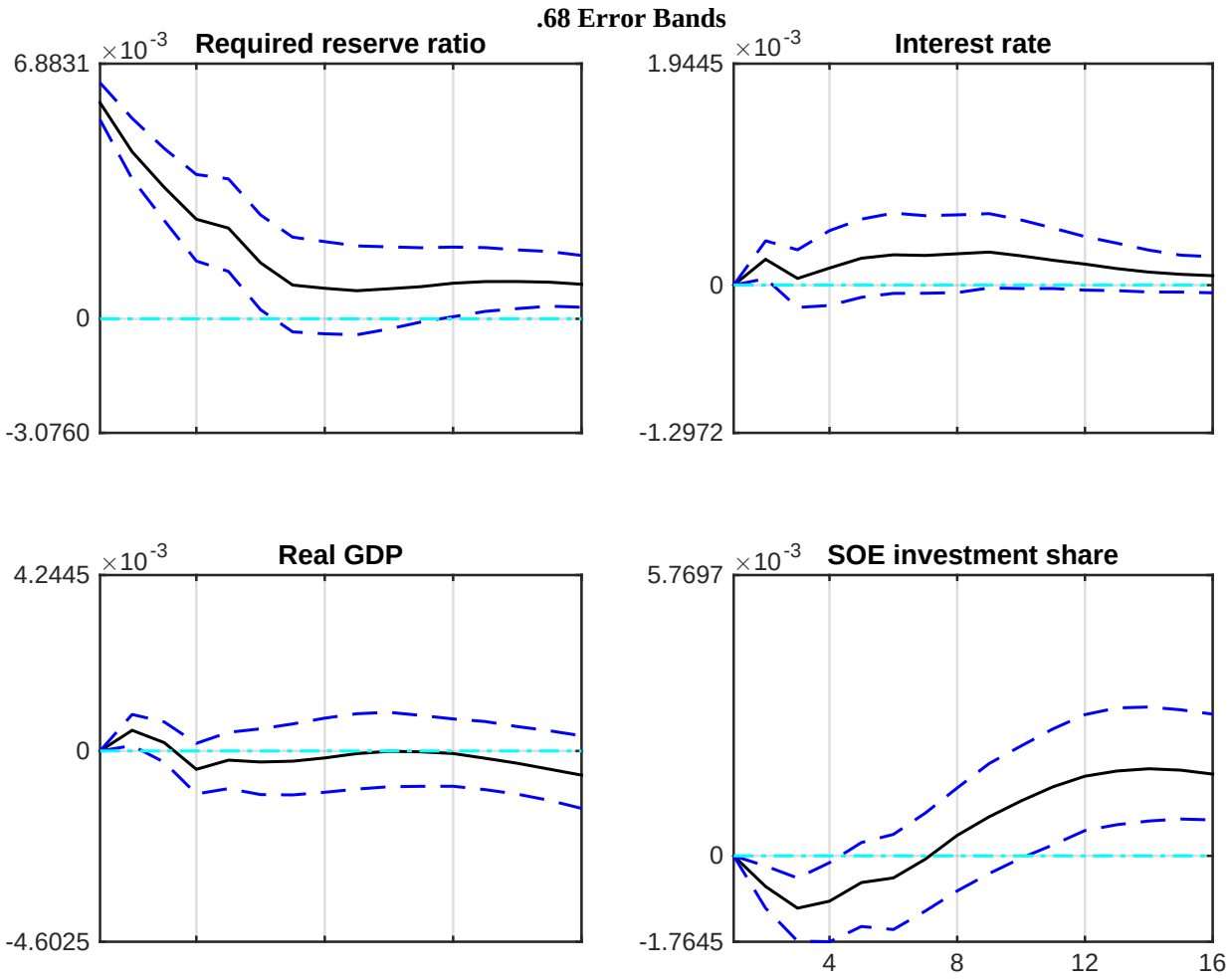
Impact of RR on financing costs affects resource allocations

- RR act as a tax on commercial banks
- Disproportionately affects State-owned enterprises (SOEs)
  - SOEs enjoy implicit government guarantees on loans
  - Superior access to bank loans despite lower average productivity
- Shadow banking not subject to RRs
  - Main source of financing for privately-owned enterprises (POEs) (Lu, et al. (2015))
- ↑ RRs reallocates resources from SOEs to POEs
  - Reduces SOE activity relative to POE
  - POEs have higher average productivity (Hsieh-Klenow, 2009)
  - Thus, raising RR increases aggregate TFP

Illustrative macro evidence of RR's reallocation effects

- Simple BVAR with RR, 3-mo deposit rate, log real GDP, SOE investment share
- Data 1995:Q1 to 2013:Q4
- 4-qtr lags with Sims-Zha priors
- Ordering implies RR responds to all shocks in impact period
  - Results show positive shock to RR reduces SOE investment share
  - Increase in GDP surprising, but possible due to increased TFP
- Results robust to RR being ordered last

BVAR: ↑ RR reallocates investment away from SOEs



Corroborating micro evidence of RR's reallocation effects

- Do RR increases reduce SOE stock returns relative to POE?
- Consider regression model:

$$\sum_{h=-H}^{H} R^e_{j,t+h} = a_0 + a_1 RR_{t-1} + a_2 SOE_{jt} \times RR_{t-1} + a_3 SOE_{jt} + bZ_{jt} + \varepsilon_{jt}$$

  where $R^e_{j,t+h} = R_{j,t+h} - \hat{\beta}_j R_{m,t+h}$ denotes risk-adjusted excess return, RR_{t-1} denotes changes in RR, and Z_{jt} is a vector of controls (size, book-to-market, industry fixed effects, year fixed effects)
- Focus on *relative* effects on SOEs ($a_2 < 0$?)
- Daily data for non-financial firms listed on Shanghai/Shenzhen stock exchanges, 2005-2015
- Identification: event study of RR announcement effects

RR announcements effects on stock returns

Event window	1-day (H=0)	3-day (H=1)	5-day (H=2)
RR_{t-1}	0.00206	0.00479	0.01057
	(7.20)	(9.21)	(15.74)
$\mathbf{SOE_{jt} \times RR_{t-1}}$	**-0.0012**	**-0.00225**	**-0.00442**
	(-3.21)	**(-3.32)**	**(-5.05)**
SOE_{jt}	-0.00007	-0.00026	-0.00041
	(-2.60)	(-5.29)	(-6.47)
$Size_{jt}$	-0.00034	-0.00099	-0.00155
	(-27)	(-43)	(-53)
BM_{jt}	0.00009	0.00024	0.00047
	(2.22)	(3.29)	(4.96)
Sample size	4119971	4079847	4000353
R^2	0.00071	0.00182	0.00288

What we do

- Build a DSGE model with financial frictions and Chinese characteristics to study:
  1. implications of RR policy for allocation efficiency, aggregate productivity, and social welfare
  2. role of RR policy in stabilizing business cycle fluctuations
  3. optimal RR under simple policy rules and interactions with interest-rate policy

Two sector DSGE model

- State-owned enterprises (SOEs) and privately-owned enterprises (POEs)
  - Identical ex ante production technology, POEs have higher average productivity
  - Both sectors require financing for working capital
    - Follow BGG (1999) framework
    - Costly state verification induces financial friction
- SOEs enjoy superior access to commercial bank borrowing
  - Stems from implicit guarantees
- Private firms finance working capital with shadow banks

Creditors specialize in lending activity

- Conventional commercial banks
  - Specialize in lending to SOEs
  - Subject to government reserve requirements
  - Government guarantee on SOE debt
    - Underfunded SOEs are liquidated, but government pays lender to make up loan losses
    - SOE bankruptcy still incurs monitoring costs, as in BGG
- Informal shadow banks
  - Specialize in lending to POEs
  - Exempt from RR regulation and receive no government guarantees
  - If POE underfunded, undergoes costly liquidation
- Complete separation in financial activity assumed for simplicity, but captures reality

Allocative and welfare implications of RR policy

- Raising RR improves aggregate productivity
  - Adversely impacts SOE sector dependent on bank finance
  - Diverts resources to POE sector
  - Raises aggregate productivity (since POE productivity higher)
- Welfare outcomes unclear
  - Higher incidence of SOE bankruptcies $\rightarrow$ higher bailout costs
  - Ambiguity surprising given productivity advantage of POEs

Compare stabilizing performances of interest rate and reserve requirement policy rules

- Can't solve Ramsey, so concentrate on simple policy rules
  - Coefficients chosen to maximize household welfare
  - Tradeoff between reallocating resources from SOEs to POEs and social default costs
- Results
  - Interest rate rule more effective for stabilizing inflation and output
  - RR rule more effective for reallocating resources
  - Welfare substantially higher when optimize over both rules

Households (1)

- Representative household utility function

$$U = \mathrm{E} \sum_{t=0}^{\infty} \beta_t \left[\ln(C_t) - \Psi \frac{H_t^{1+\eta}}{1+\eta} \right],$$

- Imperfect mobility of labor across sectors

$$H_t = (\mu H_{s,t}^{1+\sigma_L} + (1-\mu) H_{p,t}^{1+\sigma_L})^{\frac{1}{1+\sigma_L}}.$$

where H_s and H_p denote labor supplied to SOEs and POEs, respectively

Households (2)

- Budget constraints

$$C_t + I_t + \frac{D_{st} + D_{pt}}{P_t} = w_{st} H_{st} + w_{pt} H_{pt} + r_t^k K_{t-1}$$
$$+ R_{t-1} \frac{D_{s,t-1} + D_{p,t-1}}{P_t} + T_t$$

  where I_t is capital investment, D_{st} and D_{pt} deposits in banks and nonbanks, and T_t lump-sum transfers

- Capital accumulation with adjustment costs (CEE 2005)

$$K_t = (1 - \delta) K_{t-1} + [1 - \frac{\Omega_k}{2} \left(\frac{I_t}{I_{t-1}} - g_I \right)^2] I_t,$$

Retail sector

- Final good Y^f CES composite of differentiated retail products
- Each retailer is price-taker in input markets and monopolistic competitor in product markets
- Demand curve facing each retailer

$$Y_t(z) = \left(\frac{P_t(z)}{P_t} \right)^{-\epsilon} Y_t^f$$

- Retailer takes demand schedule as given and sets price $P_t(z)$
- Quadratic price adjustment costs as in Rotemberg (1982)

$$\frac{\Omega_p}{2} \left(\frac{P_t(z)}{\pi P_{t-1}(z)} - 1 \right)^2 C_t$$

Intermediate goods

- Two sectors: $j = p$ for POE and $j = s$ for SOE
- Production function for sector-j firm:

$$Y_{jt} = A_t \bar{A}_j \omega_{jt} K_{jt}^{1-\alpha} \left[(H_{jt}^e)^{1-\theta} H_{jt}^{\theta} \right]^{\alpha}$$

- where K_j = capital, H_j = household labor, H_j^e = managerial labor
- $\omega_{jt} \sim F_{jt}(\cdot)$ idiosyncratic productivity shock, realized after production and freely observable only to firm
- A_t = aggregate productivity shock; $\bar{A}_j$ = scale of TFP in sector-j (a constant)

Financial frictions

- Firms finance working capital with net worth $N_{j,t-1}$ and external debt B_{jt} (BGG)
- Working capital constraint satisfies

$$\frac{N_{j,t-1} + B_{jt}}{P_t} = w_{jt} H_{jt} + w^e_{jt} H^e_{jt} + r^k_t K_{jt}$$

where w^e_{jt} is the real wage rate of managerial labor

- Constant returns implies that revenue linear in net worth

$$\frac{Y_{jt}}{x_t} = \tilde{A}_{jt} \omega_{jt} \frac{N_{j,t-1} + B_{jt}}{P_t}$$

where ω_{jt} denotes idiosyncratic productivity and $\tilde{A}_{jt}$ is rate of return on firm investment (in consumption units)

Defaults

- Firms default when they are unable to pay their debts
- Occurs if realized productivity ω_{jt} sufficiently low:

$$\omega_{jt} < \bar{\omega}_{jt} \equiv \frac{Z_{jt} B_{jt}}{\tilde{A}_{jt}(N_{j,t-1} + B_{jt})}$$

  where $Z_{j,t}$ is contractual rate of interest
- If firm defaults, liquidated by lender with fraction m_{jt} lost output
- Government covers SOE (not POE) loan losses using lump sum taxes

Financial intermediaries

- Commercial banks:
  - Take deposits from household at rate R_t, subject to RR
  - Government guarantees imply risk-free loan rate R_{st} for SOEs

$$(R_{st} - 1)(1 - \tau_t) = (R_t - 1).$$

  - RR drives wedge between loan and deposit rate
- Shadow banks:
  - Not subject to RR, $R_{pt} = R_t$
  - No government guarantees on POE debt $\Rightarrow$ default premium over funding cost (i.e., credit spread) on private loans

Financial contracts

- Optimal financial contract is a pair $(\bar{\omega}_{jt}, B_{jt})$ that solves

$$\max \tilde{A}_{jt}(N_{j,t-1} + B_{jt}) f(\overline{\omega}_{jt})$$

- subject to the lender's participation constraint

$$\tilde{A}_{jt}(N_{j,t-1} + B_{jt}) g(\overline{\omega}_{jt}) \geq R_{jt} B_{jt}$$

where B_{jt} denotes loan amount and $\bar{\omega}_{jt}$ is cutoff productivity for firm solvency

- Defaults socially costly:

$$f(\overline{\omega}_{jt}) + g(\overline{\omega}_{jt}) = 1 - m_{jt} \int_0^{\overline{\omega}_{jt}} \omega dF(\omega) + l_j \int_0^{\overline{\omega}_{jt}} [\overline{\omega}_{jt} - (1 - m_{jt})\omega] dF(\omega)$$

where $l_s = 1$ and $l_p = 0$ are fractions of government guarantees

Monetary policy

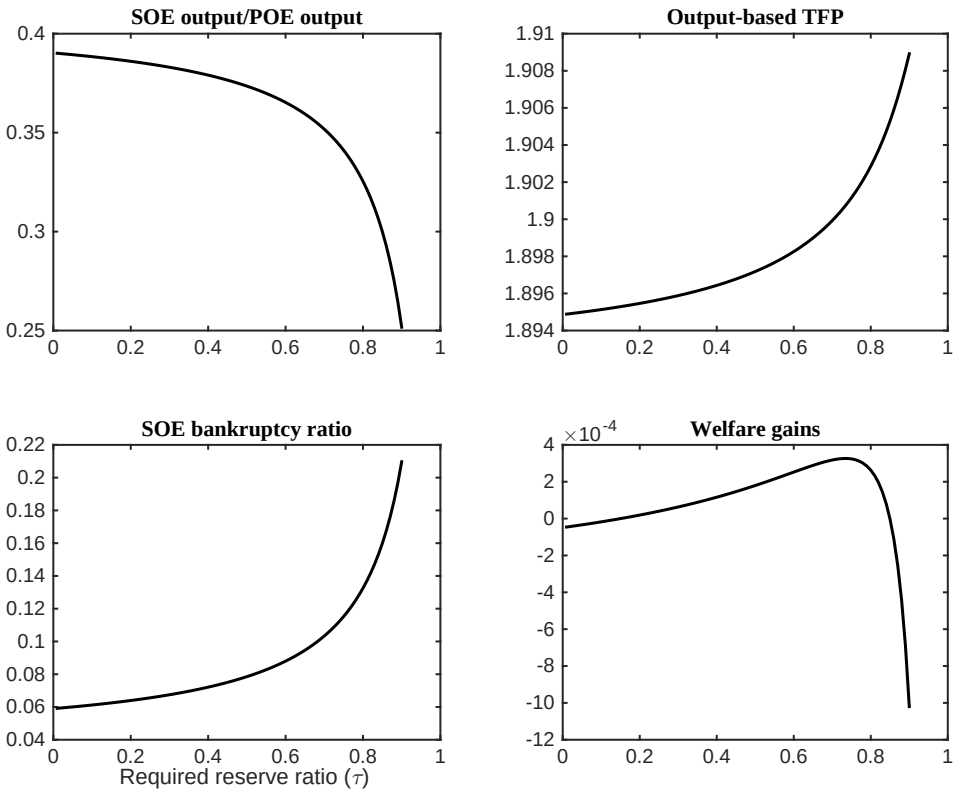
- Two instruments for monetary policy: deposit rate and RR
  - Consider two types of simple (Taylor-like) policy rules
  - Interest rate rule

$$\ln\left(\frac{R_t}{R}\right) = \psi_{rp} \ln\left(\frac{\pi_t}{\bar{\pi}}\right) + \psi_{ry} \ln\left(\frac{GDP_t}{GDP_{t-1}g}\right)$$

  - Reserve requirement rule

$$\ln\left(\frac{\tau_t}{\tau}\right) = \psi_{\tau p} \ln\left(\frac{\pi_t}{\bar{\pi}}\right) + \psi_{\tau x} \ln\left(\frac{GDP_t}{GDP_{t-1}g}\right)$$

Steady state impact of RR increase

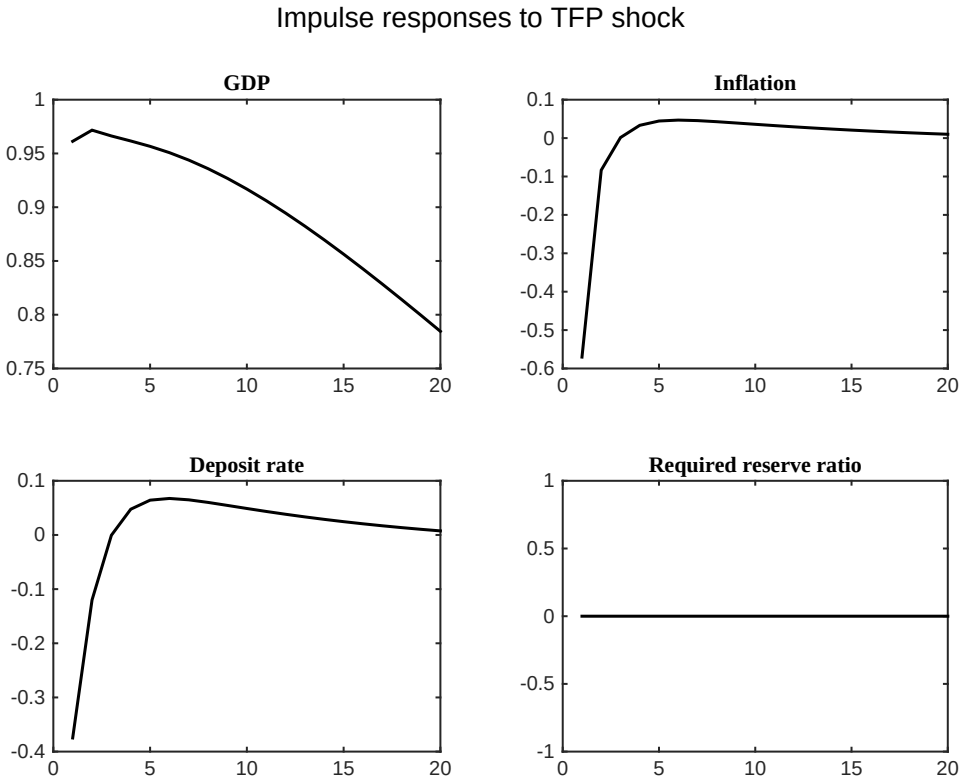


- Reallocation from SOE to POE improves TFP
- Higher funding costs increase SOE bankruptcies
- Tradeoff $\Rightarrow$ interior optimum $\tau^* = 0.73$ under our calibration

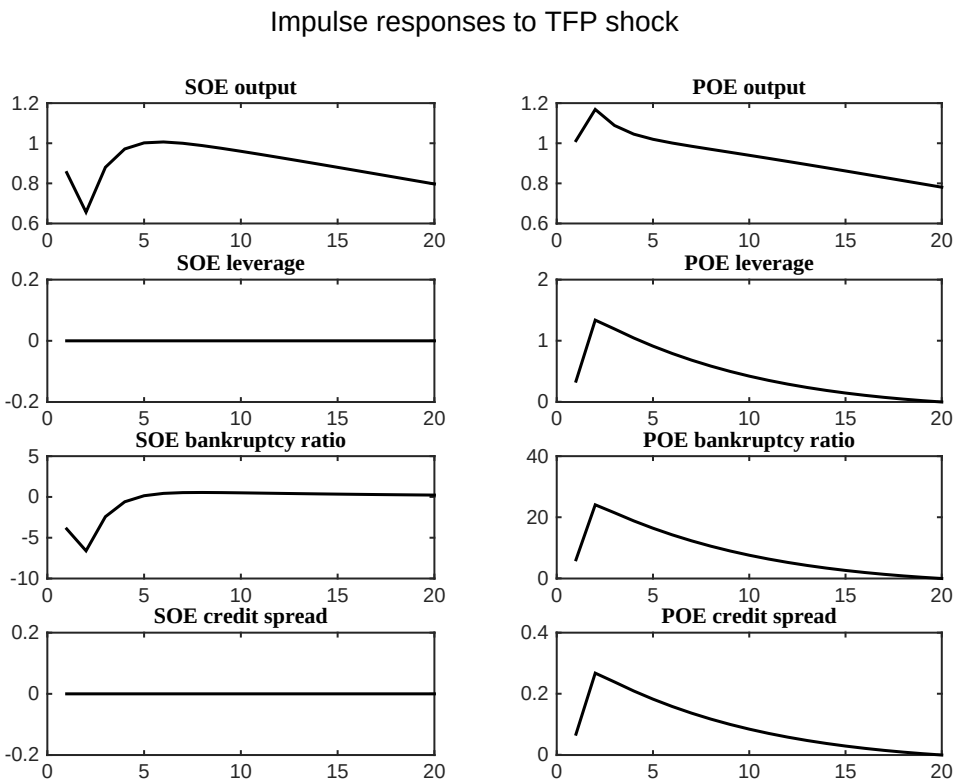
Compare macro stability and welfare under 4 policy rules

- Benchmark policy: Taylor rule with $\psi_{rp} = 1.5$ and $\psi_{ry} = 0.5$ and constant τ
- Optimal interest-rate rule: ψ_{rp} and ψ_{ry} set optimally to max welfare, and τ kept constant
- Optimal reserve-requirement rule: $\psi_{\tau p}$ and $\psi_{\tau y}$ set optimally, Taylor rule coefficients kept at benchmark values
- Jointly optimal rule: Coefficients for both interest rates and reserve requirements set optimally
- Consider 2 shocks: TFP and government spending

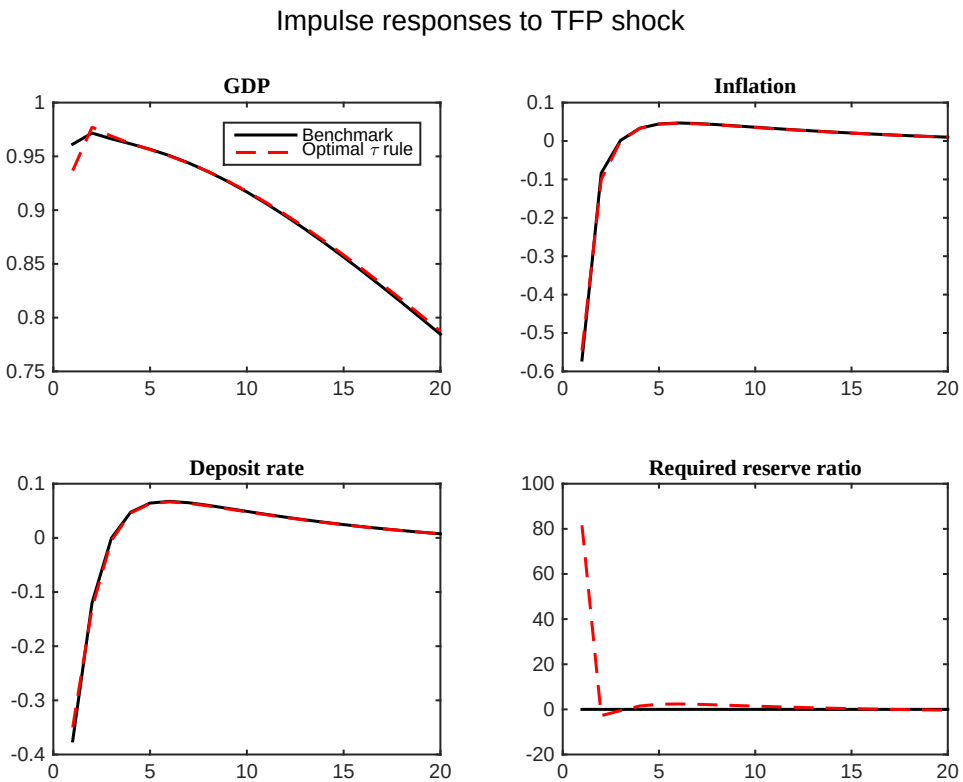
Aggregate Responses to TFP Shock: Benchmark



Sectoral responses to TFP shock: Benchmark



Aggregate Responses to TFP Shock: Benchmark vs optimal τ



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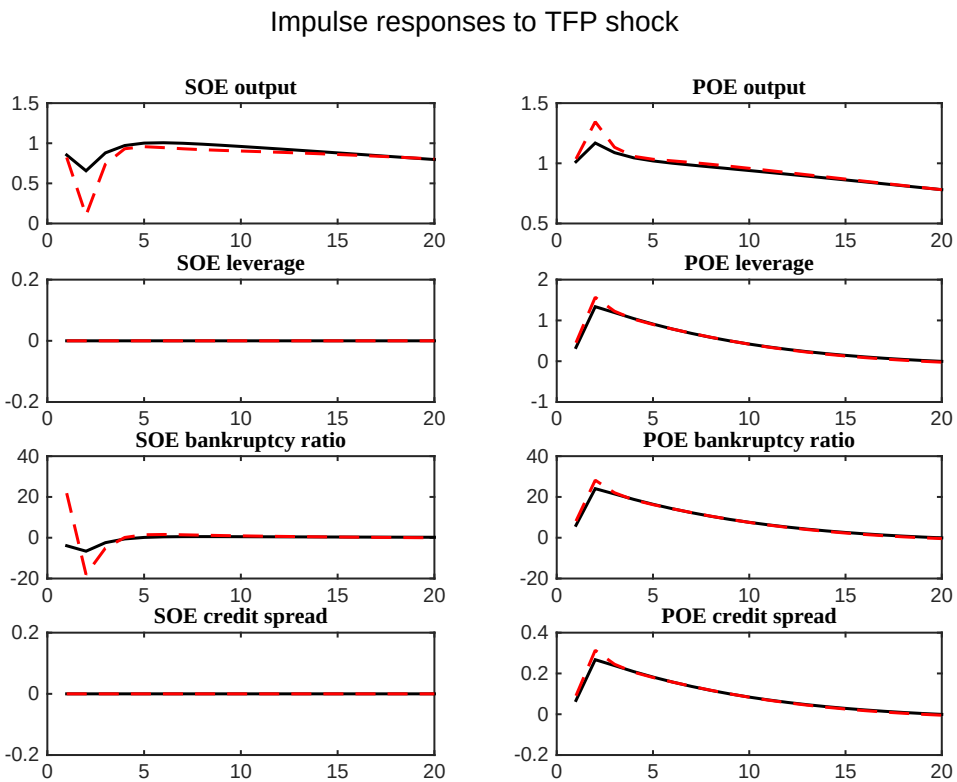
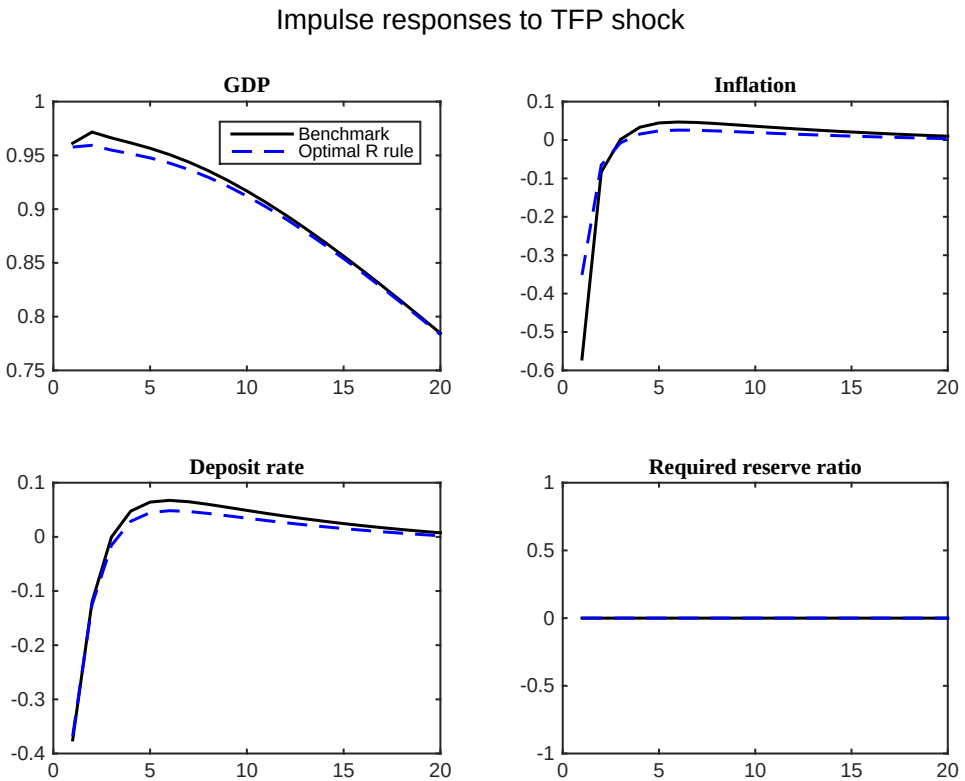


Aggregate Responses to TFP Shock: Benchmark vs optimal R



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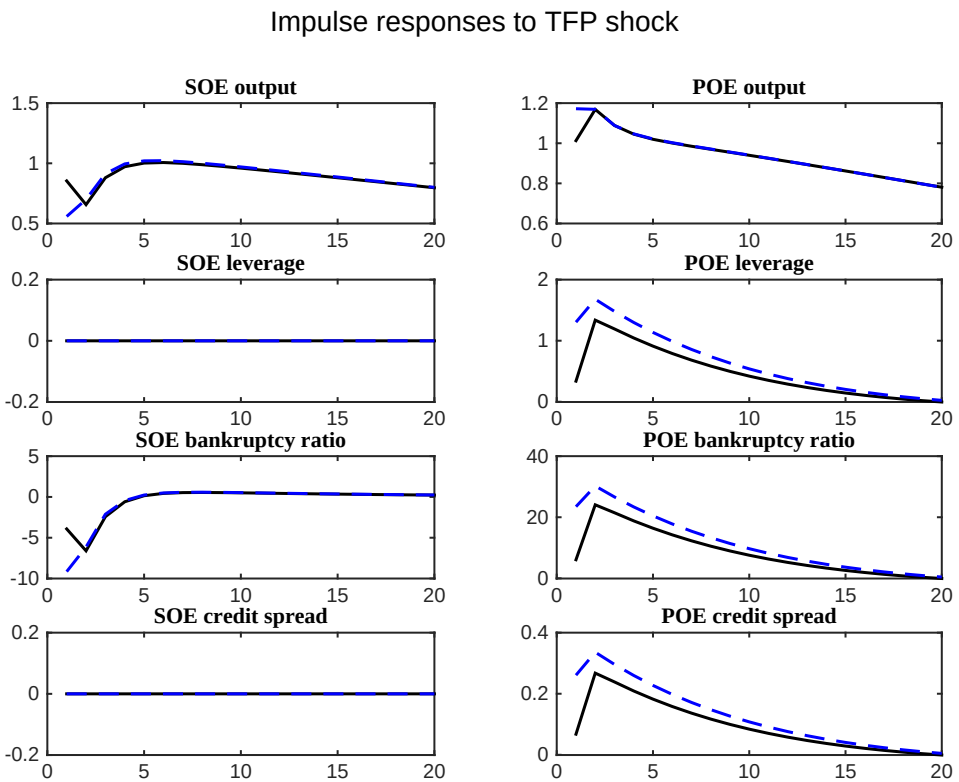


Macro stability and welfare under alternative rules

Variables	Benchmark	Optimal τ rule	Optimal R rule	Jointly optimal rule
Policy rule coefficients				
ψ_{rp}	1.50	1.50	1.93	1.51
ψ_{ry}	0.50	0.50	0.32	-0.14
$\psi_{\tau p}$	0.00	374	0.00	232
$\psi_{\tau y}$	0.00	417	0.00	-913
Macro Volatility				
GDP	5.360%	5.384%	5.329%	5.335%
π	0.624%	0.604%	0.385%	0.406%
C	5.088%	5.085%	5.056%	5.057%
H	0.803%	0.776%	0.848%	0.905%
R	0.543%	0.530%	0.488%	0.734%
Welfare gains relative to benchmark				
C equivalent	—	0.019%	0.023%	0.493%

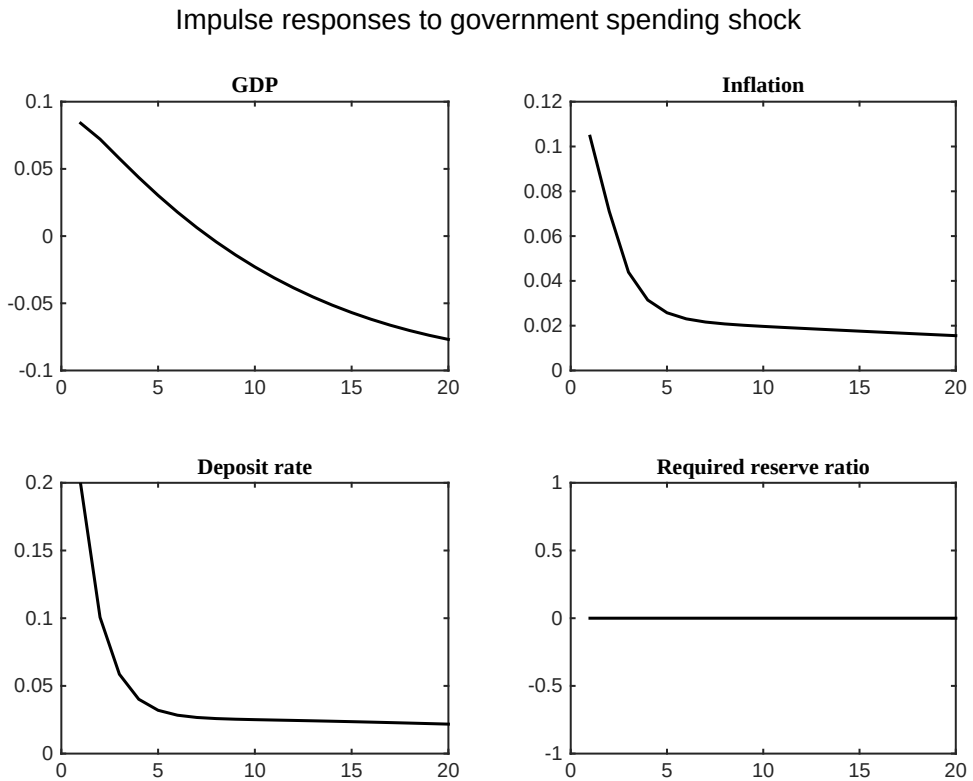
Jointly optimal rule allows for complementary use of policy tools

- Adjust R-rule to stabilize inflation and GDP
- Adjust τ-rule to achieve desired reallocation of resources across sectors
- τ-rule also used to stabilize financial accelerator effects on POEs
- Leads to higher welfare gains than each individually optimal rule $\Rightarrow$ the two policy instruments are complementary

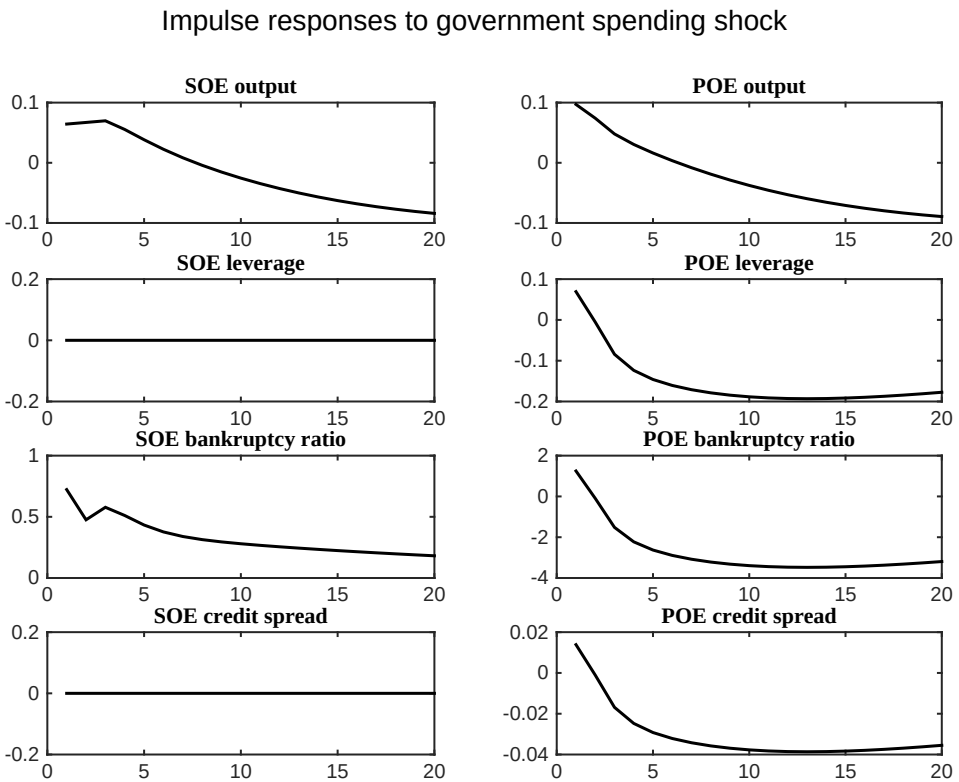
Conclusion

- Examine RR policy in DSGE model with BGG financial accelerator and Chinese characteristics
- Changes in RR incur tradeoff between allocation efficiency and bankruptcy costs
- Reserve requirements and interest rates are complementary policy instruments
  - Interest rate effective for macro stabilization
  - RR more useful for improving allocation efficiency and welfare
- Caveats:
  - Results are "second-best"
  - May change with opening to global capital markets

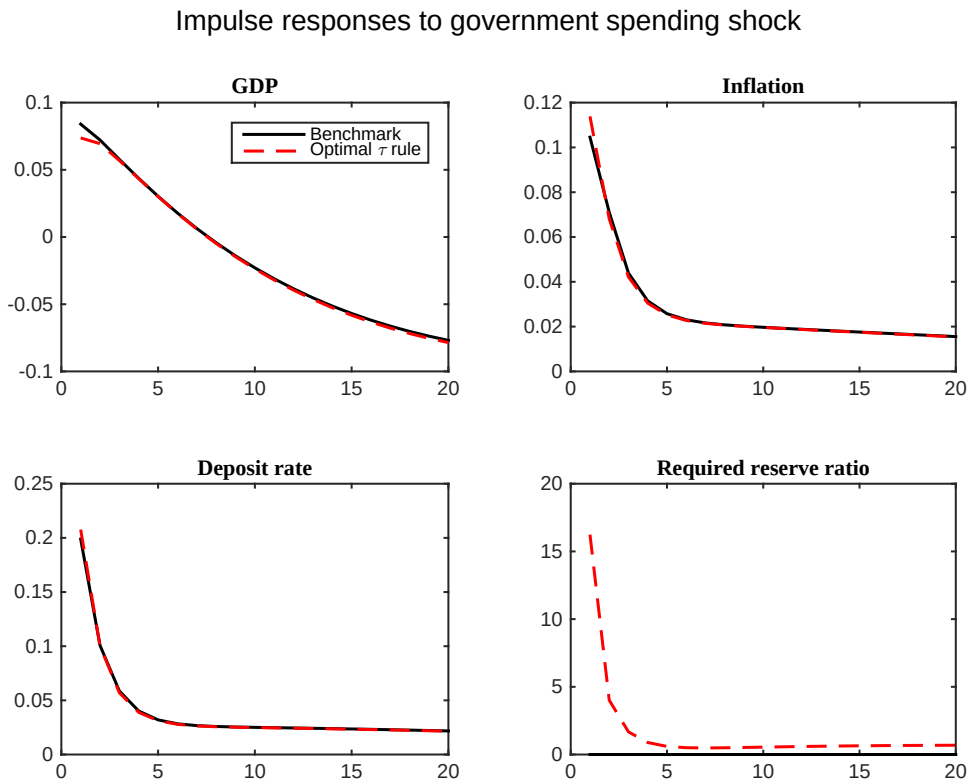
Aggregate responses to govt spending shock: Benchmark



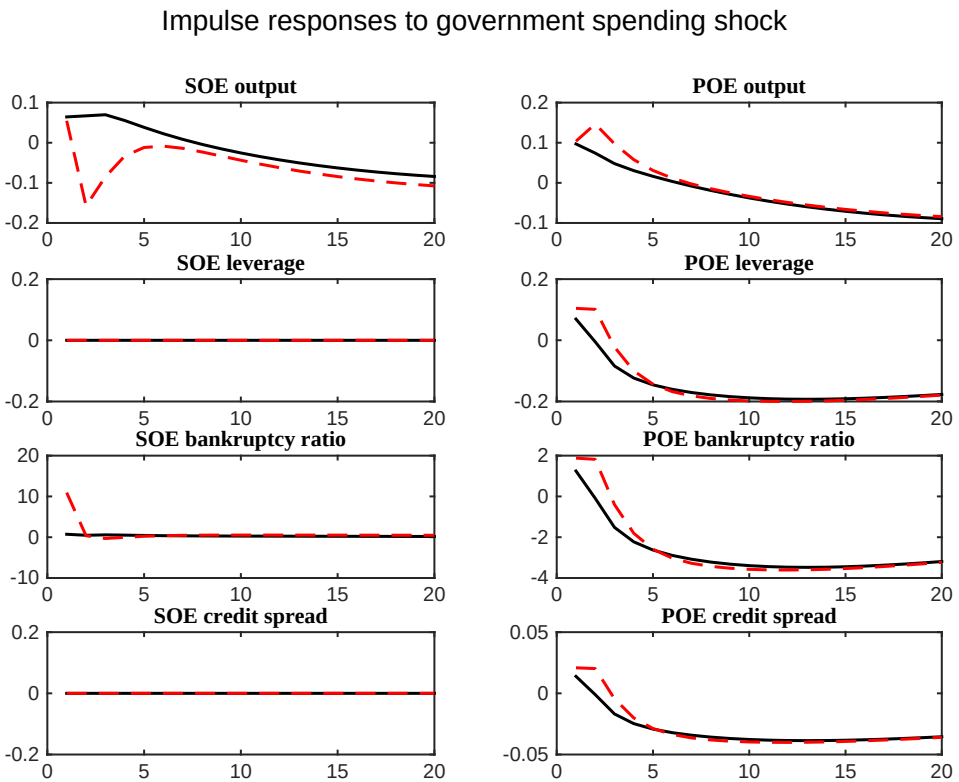
Sectoral responses to government spending shock: Benchmark



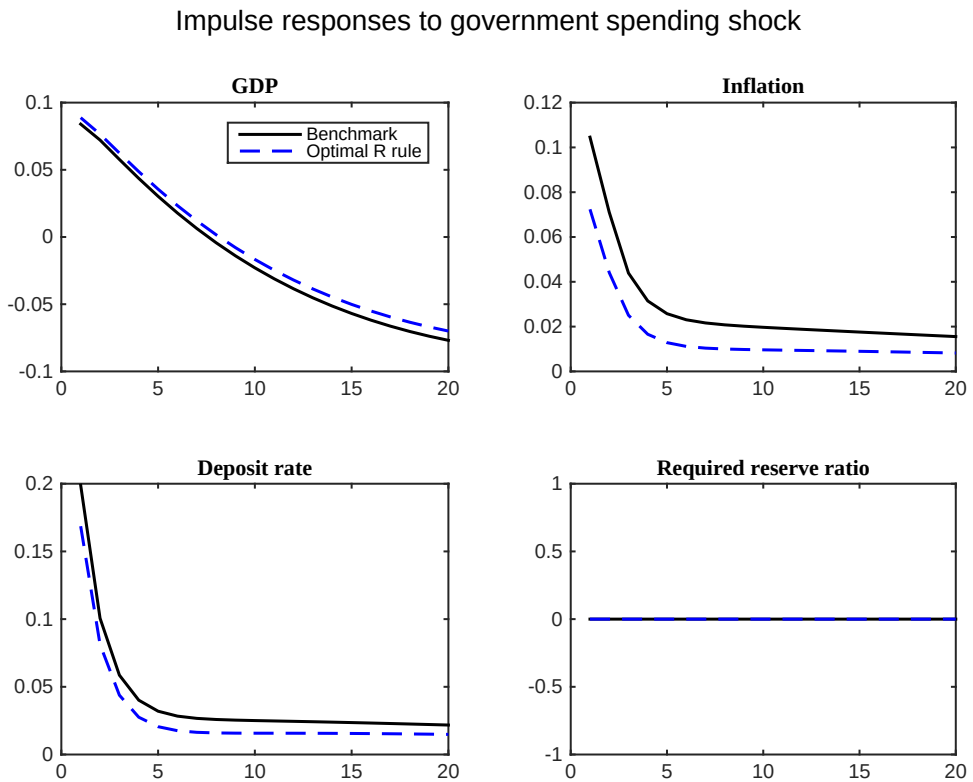
Aggregate responses to Govt spending Shock: Benchmark vs optimal τ



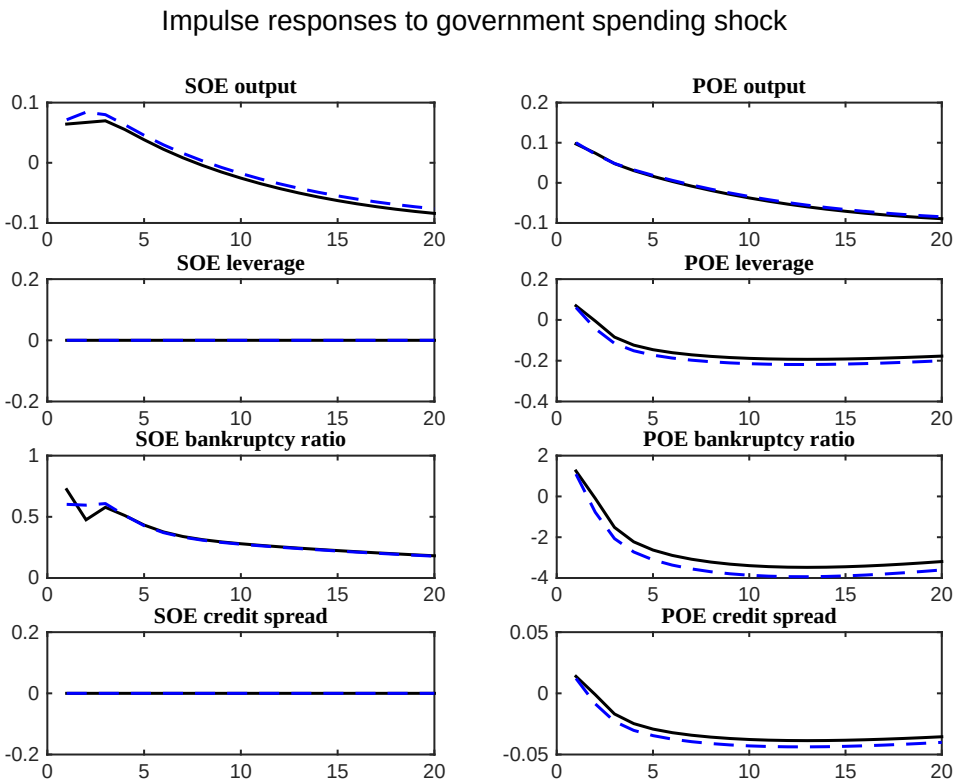
Sectoral responses to government spending shock: Benchmark vs optimal τ



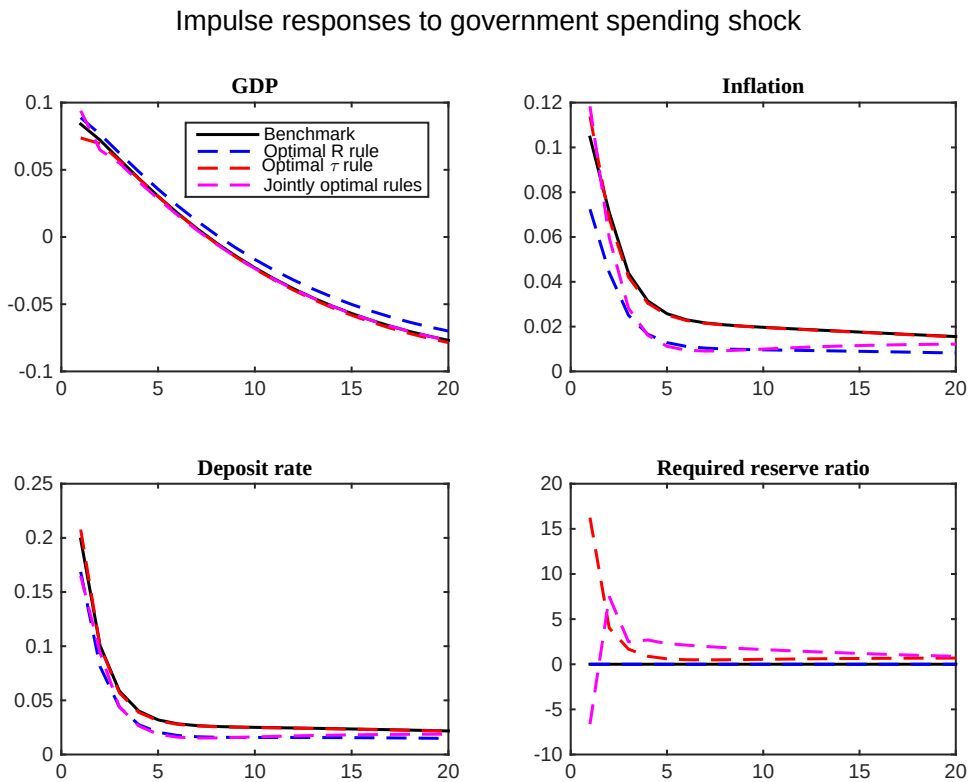
Aggregate responses to govt spending shock: Benchmark vs optimal R



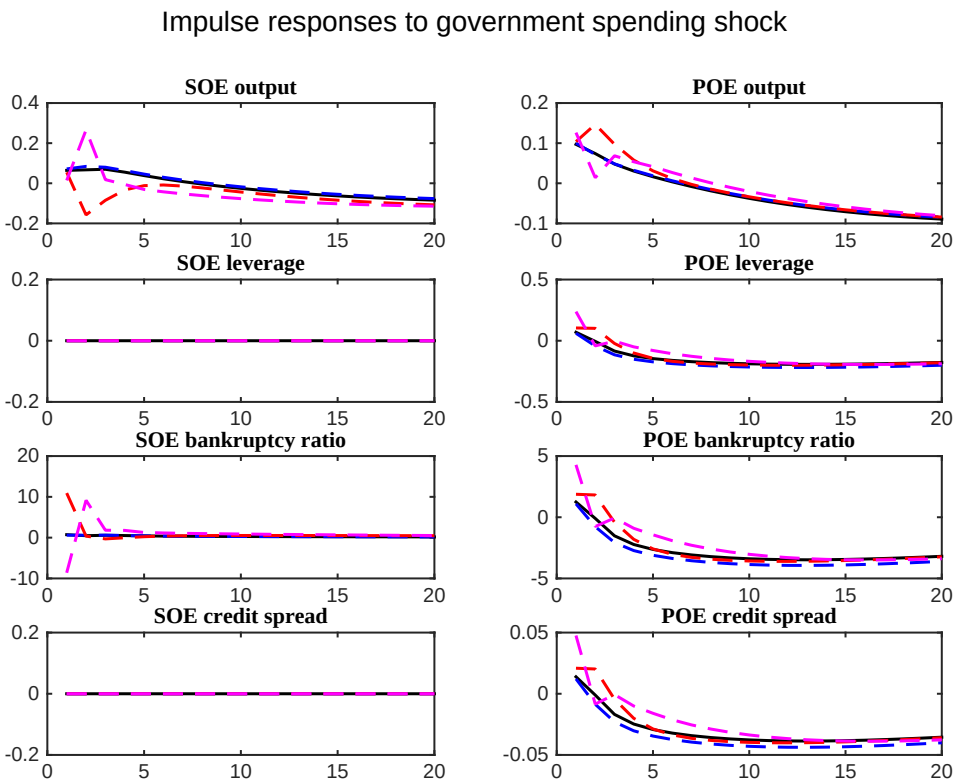
Sectoral responses to government spending shock: Benchmark vs optimal R



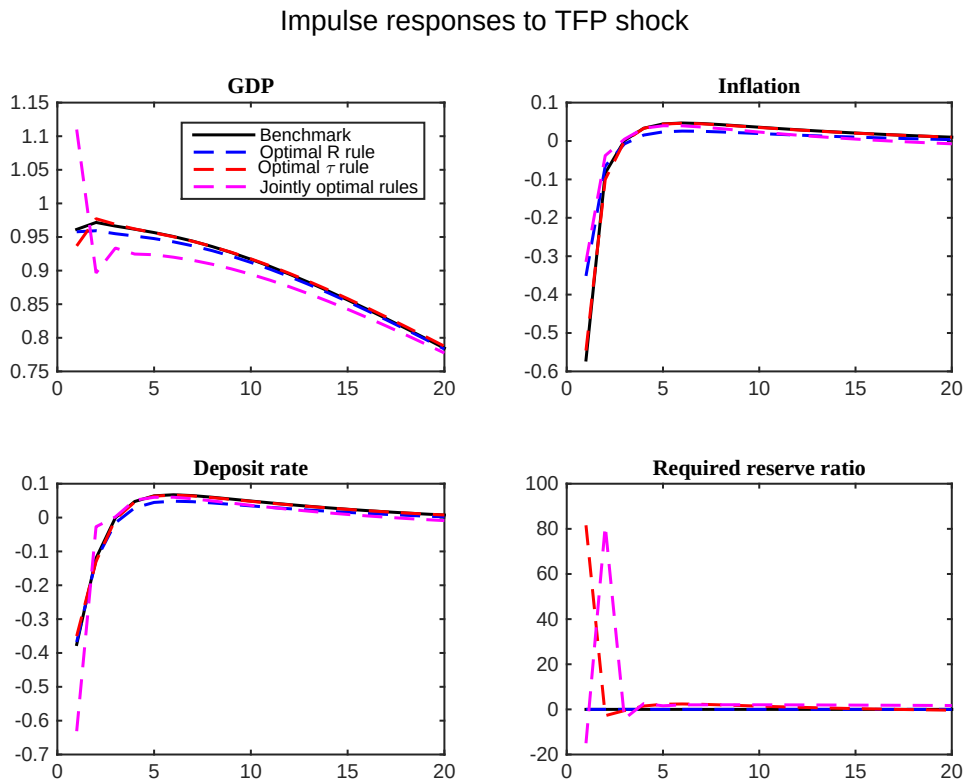
Aggregate responses to govt spending shock: Benchmark vs. alt policy rules



Sectoral responses to govt spending shock: Benchmark vs. alt policy rules



Aggregate Responses to TFP Shock: Benchmark vs. alternative policy rules



Sectoral responses to TFP shock: Benchmark vs. alternative policy rules