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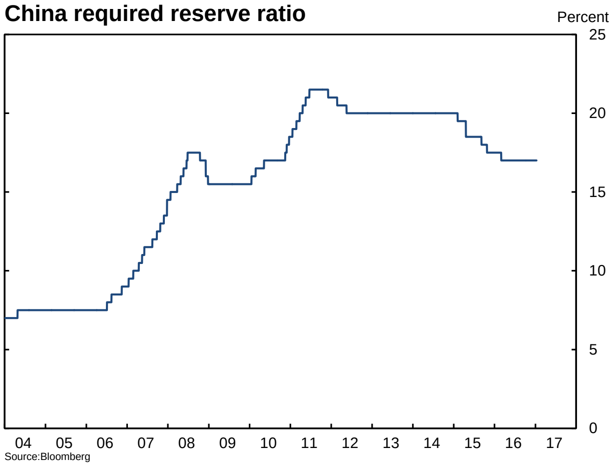
[1]The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco or the Federal Reserve System.

PBOC frequently adjusts reserve requirements (RR)



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

RR increases encouraged shadow banking activity

- Shadow bank lending increased over 30% per year between 2009 and 2013
  - Shadow banking facilitates financial intermediation but increases financial risks [Gorton and Metrick (2010)]
- Tightened regulations on formal banking contributed to shadow bank expansion (Elliott, et al (2015); Hachem and Song (2016); Chen, Ren, and Zha (2016))
  - binding loan/deposit caps (small/medium banks)
  - Interest rate controls
  - Increases in RR
- Large-scale fiscal stimulus in 2008-09 fueled demand for shadow bank financing

RR policy affects resource allocations

- RR acts as a tax on commercial banks
- Disproportionately affects state-owned enterprises (SOEs)
  - SOEs enjoy implicit government guarantees on loans
  - SOEs have superior access to bank loans despite low productivity
- Shadow banking not subject to RRs
  - Main source of financing for privately-owned enterprises (POEs) (Lu, et al. (2015))
- $\uparrow$ 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

Firm-level evidence of RR's reallocation effects

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

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

where $R^e_{j,t+h} = R_{j,t+h} - \hat{\beta}_j R_{m,t+h}$ denotes risk-adjusted excess return, ΔRR_{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

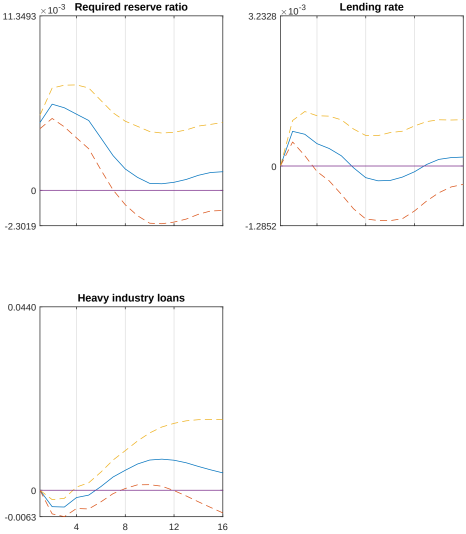
RR announcements effects on stock returns

Event window	1-day (H=0)	3-day (H=1)	5-day (H=2)
ΔRR_{t-1}	0.00206	0.00479	0.01057
	(7.20)	(9.21)	(15.74)
$\mathbf{SOE_{jt} \times \Delta RR_{t-1}}$	-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	4,119,971	4,079,847	4,0003,53
R^2	0.00071	0.00182	0.00288

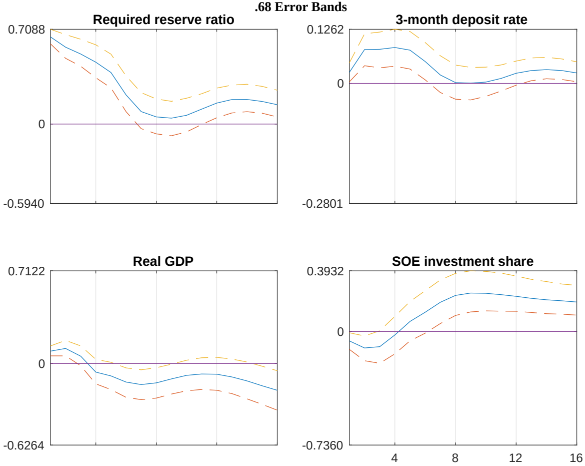
RR announcement effects mostly observed in post-stimulus period

	Pre-stimulus (2005-2008)		Post-stimulus (2009-2015)	
Event window	1-day (H=0)	3-day (H=1)	1-day (H=0)	3-day (H=1)
ΔRR_{t-1}	0.0010	0.0003	0.0029	0.0081
	(2.00)	(0.31)	(8.08)	(12.57)
$\mathbf{SOE_{jt} \times \Delta RR_{t-1}}$	0.0001	0.0012	-0.0024	-0.0046
	(0.11)	(1.03)	(-4.78)	-5.03
SOE_{jt}	0.00002	0.0005	-0.0002	-0.0005
	(2.90)	(4.09)	(-4.85)	(-8.86)
$Size_{jt}$	-0.0003	-0.0008	-0.0004	-0.0011
	(-9)	(-14)	(-26)	(-41)
BM_{jt}	0.0000	0.0001	0.0001	0.0004
	(-0.25)	(-0.56)	(2.91)	(4.50)
Sample size	1,018,628	1,003,518	3,101,343	3,076,329
R^2	0.0005	0.0011	0.0008	0.0022

Macro effects: RR $\uparrow \Rightarrow$ lending rate $\uparrow$ and banks' on-balance-sheet loans $\downarrow$



Macro effects: RR $\uparrow$ reallocates investment away from SOEs



What we do

- Build a two-sector 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 simple RR rule vs. interest rate rule

Two main findings

1. RR policy useful for improving steady state allocations
   - RR acts as tax on formal banking and SOE activity
   - Raising RR improves aggregate productivity by diverting capital to more productive POEs
   - But it also raises SOE bailout costs $\rightarrow$ interior optimal RR
2. RR policy complementary to conventional interest rate policy for macro stabilization
   - Interest rate easing stimulates *general* activity in both sectors
   - But RR easing stimulates *relative* activity of SOEs
   - RR particularly useful for stabilizing inefficient relative price fluctuations under gov't guarantees of SOE debt

Two sector DSGE model

- Representative household consumes, saves, and supplies labor
- Retail sector: use wholesale goods as inputs; monopolistic competition and sticky prices
- Wholesale sector: intermediate goods produced by SOEs and POEs imperfect substitutes
  - POEs have higher average productivity (Hsieh-Klenow, 2009)
  - External financing for working capital subject to costly state verification: financial accelerator (BGG, 1999)
- Banks provide working capital to firms in both sectors
  - Loans to SOEs are subject to RR, but debt guaranteed by government (on-balance-sheet)
  - Loans to POEs exempt from RR, but no government guarantees (off-balance-sheet)

Representative household

- Utility function

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

- Budget constraints

$$C_t + I_t + \frac{D_t}{P_t} = w_t H_t + r_t^k K_{t-1} + R_{t-1} \frac{D_{t-1}}{P_t} + T_t$$

- Capital accumulation with adjustment costs (CEE 2005)

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

Retail sector

- Final good CES composite of differentiated retail products

$$Y^f = \left[\int_0^1 Y_t(z)^{(\epsilon-1)/\epsilon} dz \right]^{\epsilon/(\epsilon-1)}$$

- Demand curve facing each retailer

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

- Monopolistic competition in retail markets, with quadratic price adjustment costs (Rotemberg, 1982)

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

- Optimal price decision → Phillips curve

Production technologies

- Wholesale good: CES composite of SOE and POE products (imperfect substitutes)

$$M_t = \left(\phi Y_{st}^{\frac{\sigma_m - 1}{\sigma_m}} + (1-\phi) Y_{pt}^{\frac{\sigma_m - 1}{\sigma_m}} \right)^{\frac{\sigma_m}{\sigma_m - 1}}$$

- Intermediate good production in sector $j \in \{s, p\}$

$$Y_{jt} = A_{jt} \omega_{jt} (K_{jt})^{1-\alpha} \left[(H_{jt}^e)^{1-\theta} H_{jt}^{\theta} \right]^{\alpha},$$

  - Idiosyncratic productivity shock ω_{jt} drawn from $F_{jt}(\cdot)$
  - Sector-specific TFP $A_{jt} = g^t A_{jt}^m$

$$\ln A_{jt}^m = (1-\rho_j) \ln \bar{A}_j + \rho_j \ln A_{j,t-1}^m + \epsilon_{jt},$$

  where $\bar{A}_s < \bar{A}_p$

Financial frictions and defaults

- Working capital constraint satisfies

$$\frac{N_{j,t-1} + B_{jt}}{P_t} = w_t H_{jt} + w_{jt}^e H_{jt}^e + r_t^k K_{jt}$$

  where w_{jt}^e is the real wage rate of managerial labor
- Firms default 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
- Defaulting firms liquidated, with fraction m_j output lost
- Government covers loan losses on SOE loans (but not POE loans) using lump sum taxes

Financial intermediaries

- Banks take deposits from household at rate R_t
- *On-balance-sheet* loans to SOEs subject to RR
  - RR drives wedge between loan and deposit rates $\rightarrow$ tax on SOE borrowing
  - Government guarantees imply risk-free loan rate R_{st} for SOEs

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

- *Off-balance-sheet* loans to POEs not subject to RR
  - Funding cost $R_{pt} = R_t$
  - No government guarantees on POE debt $\Rightarrow$ default premium (credit spread) over funding cost

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:

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

where $l_s = 1$ and $l_p = 0$ are guarantee ratios on SOE and POE lending respectively

Monetary policy

- Two instruments for monetary policy: deposit rate and RR
- Interest rate rule

$$\ln\left(\frac{R_t}{R}\right) = \psi_{rp}\ln\left(\frac{\pi_t}{\bar{\pi}}\right) + \psi_{ry}\ln\left(\frac{\tilde{GDP}_t}{\tilde{GDP}}\right)$$

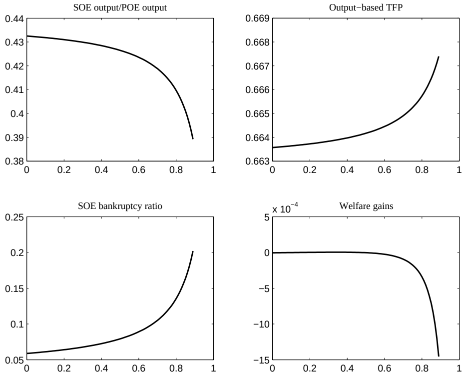
- Reserve requirement rule

$$\ln\left(\frac{\tau_t}{\bar{\tau}}\right) = \psi_{\tau p}\ln\left(\frac{\pi_t}{\bar{\pi}}\right) + \psi_{\tau y}\ln\left(\frac{\tilde{GDP}_t}{\tilde{GDP}}\right)$$

- Benchmark model: Taylor rule and constant RR

$$\tau_t = \bar{\tau}$$

Steady state impact of RR increase



- Reallocation from SOE to POE improves TFP
- Higher funding costs increase SOE bankruptcies
- Tradeoff $\Rightarrow$ interior optimum $\tau^* = 0.34$ under our calibration

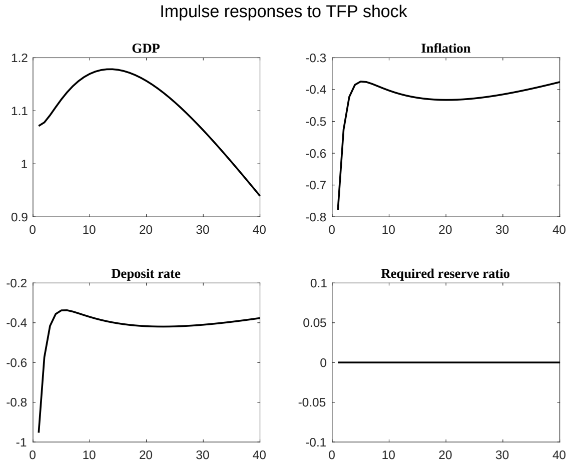
Volatilities and welfare: Aggregate TFP shock

Variables	Benchmark	Optimal τ rule	Optimal R rule	Jointly optimal rule
		Policy rule coefficients		
ψ_{rp}	1.50	1.50	7.42	5.18
ψ_{ry}	0.20	0.20	0.07	-0.12
$\psi_{\tau p}$	0.00	-13.14	0.00	11.67
$\psi_{\tau y}$	0.00	4.81	0.00	15.96
		Volatility		
GDP	8.618%	8.155%	5.279%	4.952%
π	3.409%	3.231%	0.084%	0.136%
C	6.118%	5.950%	4.388%	4.306%
H	2.103%	1.835%	0.599%	0.416%
R	3.412%	3.236%	0.398%	0.349%
Y_s	9.091%	6.999%	5.362%	3.415%
Y_p	8.132%	8.455%	5.552%	5.982%
		Welfare		
Welfare gains	—	0.2423%	1.1799%	1.1801%

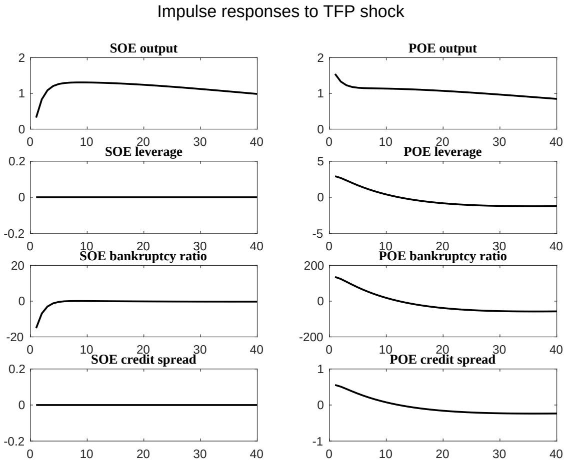
Volatilities and welfare: SOE-specific TFP shock

Variables	Benchmark	Optimal τ rule	Optimal R rule	Jointly optimal rule
		Policy rule coefficients		
ψ_{rp}	1.50	1.50	7.72	5.78
ψ_{ry}	0.20	0.20	0.32	-0.59
$\psi_{\tau p}$	0.00	-31.81	0.00	71.72
$\psi_{\tau y}$	0.00	-3.99	0.00	-52.78
		Volatility		
GDP	2.296%	2.192%	1.471%	1.412%
π	0.908%	0.867%	0.075%	0.170%
C	1.572%	1.532%	1.116%	1.027%
H	0.664%	0.604%	0.293%	0.311%
R	0.911%	0.871%	0.168%	0.203%
Y_s	7.993%	7.606%	7.314%	8.407%
Y_p	1.479%	1.435%	1.326%	1.785%
		Welfare		
Welfare gains	—	0.0126%	0.0648%	0.0734%

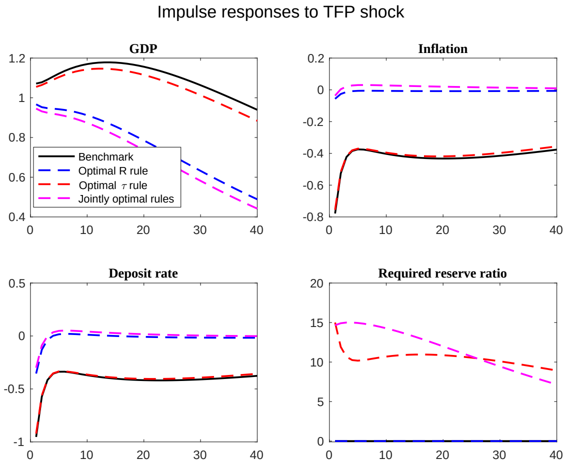
Aggregate Responses to TFP Shock: Benchmark



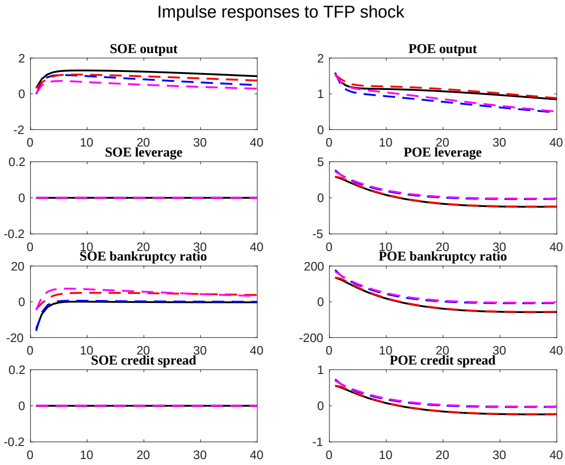
Sectoral responses to TFP shock: Benchmark



Aggregate Responses to TFP Shock: Benchmark vs alternative policies



Sectoral responses to TFP shock: Benchmark vs alternative policies



Extension with money growth rule (Chen, et al. 2017)

POE-specific TFP shocks

Variables	Benchmark	Optimal τ rule	Optimal money rule	Jointly optimal rule
		Policy rule coefficients		
ψ_{mp}	-0.65	-0.65	-45.42	-89.88
ψ_{my}	0.30	0.30	4.42	19.05
$\psi_{\tau p}$	0.00	-10.38	0.00	-38.79
$\psi_{\tau y}$	0.00	0.09	0.00	13.23
		Volatility		
GDP	3.828%	3.808%	3.809%	3.694%
π	0.180%	0.119%	0.046%	0.050%
C	3.284%	3.275%	3.273%	3.267%
H	0.377%	0.385%	0.353%	0.312%
R	0.084%	0.203%	0.206%	0.237%
Y_s	2.848%	2.822%	2.817%	3.459%
Y_p	6.549%	6.550%	6.529%	6.861%
		Welfare		
Welfare gains	—	0.0032%	0.0032%	0.0039%

- Moving from optimal money growth rule to jointly optimal rules lead to greater welfare gains under sector-specific shocks than under aggregate TFP shocks (not shown)
- Again, optimal RR rules useful for reallocation

Conclusion

- Examine RR policy in DSGE model with Chinese characteristics
- Steady-state implications of RR: tradeoff between allocation efficiency and SOE bailout costs
- Macro-stabilization role of RR: complementary to conventional monetary policy
  - Conventional policy instruments (interest rate or money growth) effective for stabilizing aggregate fluctuations
  - RR more useful for stabilizing inefficient relative-price fluctuations under sector-specific shocks
- Caveats:
  - Results are "second-best"
  - Open-economy features not in model: RR policy may stem from sterilized intervention in FX market