Bank Risk-Taking and Monetary Policy Transmission: Evidence from China[1]

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Links between monetary policy and bank risk-taking

- Monetary policy easing following global financial crisis and COVID-19 raised concerns about risk-taking and financial stability (Stein, 2013; Bernanke, 2020)
- Theory: ambiguous link b/n policy easing and bank risk-taking
  - Portfolio choice theory: low interest rates encourage risk-taking
  - Risk-shifting theory (Stiglitz and Weiss, 1981): low interest rates reduce bank funding costs, alleviating agency problem and reducing risk-taking
- In data, effects of both portfolio choice and risk shifting are present: hard to identify risk-taking channel

The goal

- Examine empirical link between bank risk-taking and monetary policy using micro-level Chinese data
  - Bank loans primary source of firm financing in China $\rightarrow$ changes in bank regulations important for monetary policy transmission
- Significant tightening of capital regulations in 2013 when China implemented Basel III
  - Raised minimum capital adequacy ratio (CAR) from 8% to 10.5%
  - New IRB approach raised sensitivity of risk-weighted assets to loan risks
- Use regulation change in 2013 to estimate effects of monetary policy shocks on bank risk taking
  - Guided by theory, use diff-in-diff identification
  - Exploit cross-sectional differences in lending behaviors b/n high-risk and low-risk bank branches before and after the new regulations

The findings

- New regulations significantly reduced bank risk-taking, both on average and conditional on monetary policy easing
  - To reduce asset risk, branches increased share of lending to SOEs, which are *de jure* safe borrowers
- Declines in risk-taking driven mainly by changes in risk weighting
- Risk-weighting mechanism implies tradeoff for monetary policy
  - Lessens financial-stability concerns associated with policy easing
  - But exacerbates capital misallocation, reducing TFP

A static model of bank risk-taking

- Representative bank has endowment e, takes deposit d at risk-free rate r, and lends k to finance risky project with stochastic return R
- Project return $R \in [\underline{R}(\sigma, \Delta), \bar{R}(\sigma, \Delta)]$ drawn from uniform distribution:

$$\mathbf{E}[R] = (\phi_1 - \phi_2 \sigma)\, \sigma, \quad \mathbf{Var}[R] = \frac{1}{12} (\sigma \Delta)^2 ,$$

where $\sigma > 1$ is aggregate risk and $\Delta \geq 1$ is bank-specific idiosyncratic risk (e.g., risks related to locations or customers)

Bank's optimizing decisions

- Under limited liabilities, a bank solves

$$V = \max_{\{\sigma,d\}} \int_{\underline{R}(\sigma,\Delta)}^{\bar{R}(\sigma,\Delta)} \max\left\{Rk - rd, 0\right\} d\mathbf{F}(R),$$

subject to flow-of-funds constraint

$$k = e + d$$

and CAR constraint

$$\frac{e}{\xi\left(\sigma\Delta\right)k} \geq \tilde{\psi}.$$

where $\xi(\sigma\Delta) = \mu\left(\sigma\Delta\right)^{\rho}$ is the risk-weighting function with $\rho \in (0,1)$

Model implications

1. Raising regulatory risk-weighting sensitivity (ρ) reduces bank risk-taking (σ)
2. Increasing ρ also reduces bank risk-taking in response to monetary policy easing
3. Banks facing higher idiosyncratic risks (Δ) respond more to changes in regulation (ρ), both on average and conditional on monetary policy shocks

These theoretical predictions help guide empirical identification

Data

- Confidential loan-level data from one of the "Big Five" commercial banks in China from 2008:Q1 to 2017:Q4
  - Data contain detailed information on each individual loan: quantity, price, credit rating, etc.
  - Focus on firm loans
- Merge loan data with firm-level data from ASIF to obtain controls for borrower characteristics
  - ASIF covers all above-scale manufacturing firms from 1998 to 2013, with about 4mn firm-year observations
  - Detailed information on individual firms: revenue, value-added, ownership type, employment, capital, balance sheets
- Merged data contain 400,000 unique firm-loan pairs, accounting for half of total loans issued to manufacturing firms by the bank

Baseline empirical specification

$$SOE_{ijt} = \alpha \times RiskH_j \times Post_y + \beta \times RiskH_j \times Post_y \times MP_t + \gamma \times RiskH_j \times MP_t + \theta \times X_i \times \mu_y + \eta_j + \mu_t + \epsilon_{ijt}.$$

- Dependent variable: dummy $SOE_{ijt} = 1$ if loan i is extended to SOE by branch j in quarter t
  - All else equal, SOE loans receive high credit ratings: SOE credit rating
- $Post_y$: post-Basel III dummy, equal to 1 iff year $\geq$ 2013
- MP_t: monetary policy shock estimated by Chen, Ren, and Zha (2018)
- $RiskH_j$: risk history of branch j, equals 1 iff pre-2013 average NPL ratio above median
- X_i: initial controls of firm i: size, age, leverage, and ROA
- Fixed effects: year (μ_y), quarter (μ_t), and branch/location (η_j)

The empirical specification

$$SOE_{ijt} = \alpha \times RiskH_j \times Post_y + \beta \times RiskH_j \times Post_y \times MP_t + \gamma \times RiskH_j \times MP_t + \theta \times X_i \times \mu_y + \eta_j + \mu_t + \epsilon_{ijt}$$

- Theory implies $\alpha > 0$
  - New regulations increased risk-weighting sensitivity, reducing risk-taking Prop 1
  - High-risk branches more responsive to regulation changes Prop 4

The empirical specification

$$SOE_{ijt} = \alpha \times RiskH_j \times Post_y + \beta \times RiskH_j \times Post_y \times MP_t + \gamma \times RiskH_j \times MP_t + \theta \times X_i \times \mu_y + \eta_j + \mu_t + \epsilon_{ijt}$$

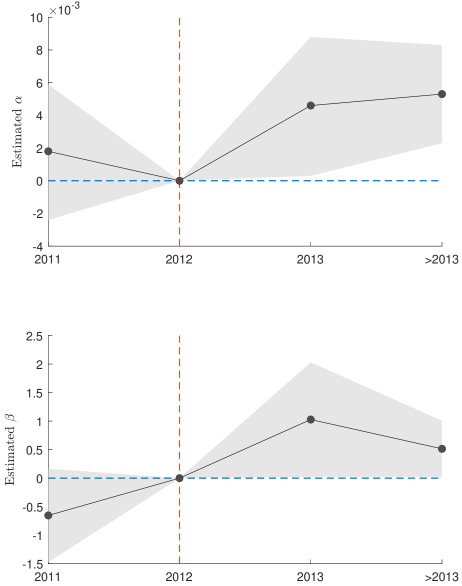
- Theory implies $\alpha > 0$
  - New regulations increased risk-weighting sensitivity, reducing risk-taking Prop 1
  - High-risk branches more responsive to regulation changes Prop 4
- Theory also implies $\beta > 0$
  - Monetary policy expansion boosts bank leverage; under binding CAR, bank reduces loan risks Prop 2
  - By raising sensitivity to risk weighting, new regulations amplify reductions in risk-taking Prop 3
  - Amplification effects are stronger for high-risk branches Prop 4

Effects of regulations on bank risk-taking

$SOE_{i,j,t}$	(1) OLS	(2) Probit	(3) OLS	(4) Probit
$RiskH_j \times MP_t \times Post_y$	0.535**	0.452**	1.221***	0.929***
	(0.215)	(0.184)	(0.354)	(0.293)
$RiskH_j \times Post_y$	0.00712***	0.0058***	0.00411*	0.0025
	(0.00149)	(0.0014)	(0.00213)	(0.0021)
$RiskH_j \times MP_t$	-0.0185	-0.0598	6.137**	4.245*
	(0.172)	(0.125)	(2.415)	(2.287)
$RiskH_j \times MP_t \times CAR_{y-1}$			-0.487**	-0.339*
			(0.192)	(0.179)
$RiskH_j \times CAR_{y-1}$			0.00192*	0.0021**
			(0.00108)	(0.0011)
Branch FE	yes	yes	yes	yes
Year-quarter FE	yes	yes	yes	yes
Initial controls × year FE	yes	yes	yes	yes
R^2	0.353		0.353	
Observations	333,500	315,382	333,500	315,382

- One-std MP shock increases prob of SOE lending by up to 14%

Parallel trends



Changes in risk-taking reflect loan supply decisions, not demand factors

	(1) $LoanRate_{i,j,t}$	(2) $RateGap_{i,j,t}$	(3) $LoanRate_{i,j,t}$	(4) $RateGap_{i,j,t}$
$RiskH_j \times SOE_{i,t} \times MP_t \times Post_y$	-18.86**	-2.779**	-19.31**	-2.878**
	(9.169)	(1.407)	(9.233)	(1.435)
$RiskH_j \times MP_t \times Post_y$	15.58**	2.239*	15.70**	2.336*
	(6.309)	(1.174)	(6.467)	(1.208)
$RiskH_j \times SOE_{i,t} \times MP_t$	7.960*	1.597**	8.407*	1.609**
	(4.750)	(0.673)	(4.724)	(0.674)
$RiskH_j \times MP_t$	-15.34***	-2.186***	-15.33***	-2.180***
	(2.699)	(0.414)	(2.684)	(0.414)
$RiskH_j \times SOE_{i,t} \times Post_y$	-0.0115	0.00867	-0.0169	0.00806
	(0.0885)	(0.0142)	(0.0881)	(0.0143)
$RiskH_j \times SOE_{i,t}$	-0.281***	-0.0387***	-0.273***	-0.0381***
	(0.0541)	(0.00839)	(0.0538)	(0.00836)
$RiskH_j \times Post_y$	0.124	0.0235*	0.123	0.0238*
	(0.0781)	(0.0133)	(0.0780)	(0.0133)
$\ln(LoanAmount_{i,j,t})$			0.0102***	0.001***
			(0.0025)	(0.0003)
Observations	15,552	15,552	15,470	15,470
R-squared	0.966	0.937	0.966	0.937
Branch FE	yes	yes	yes	yes
Firm-Year-Quater FE	yes	yes	yes	yes

Empirical results are robust

- Control for impact of interest rate liberalization
- Control for effects of anti-corruption campaign
- Placebo test: deleveraging policy
- Including more controls
- A battery of other variations:
    - Clustering standard errors
    - Alternative classifications of SOE
    - Alternative measures of CAR
    - Using total social financing in place of M2
    - Using direct measures of IRB coverage instead of post-2013 dummy

see the Appendix

MP easing increases SOE lending and reduces TFP

	(1) TFP Growth	(2) TFP Growth	(3) TFP Growth	(4) TFP Growth
$MP_t \times Post_y$	-9.688***	-8.760***	-8.169***	
	(1.197)	(1.191)	(1.352)	
$MP_t \times Post_y \times RiskH_p$			-4.550**	-4.077*
			(1.850)	(2.055)
$Post_y$	-0.0298***	-0.0351***	-0.0387***	
	(0.00589)	(0.00631)	(0.00679)	
MP_t	2.847***	3.350***	2.254**	
	(0.988)	(0.975)	(0.930)	
$Post_y \times RiskH_p$			0.0274**	0.0292**
			(0.0129)	(0.0107)
$MP_t \times RiskH_p$			8.189***	8.297***
			(1.792)	(1.638)
Year FE	no	no	no	yes
Controls	no	yes	yes	yes
Province FE	yes	yes	yes	yes
Observations	300	287	287	287
R^2	0.288	0.375	0.391	0.557

- SOEs less productive than private firms (Hsieh-Klenow, 2009) → increasing SOE lending reduces TFP
- Under new Basel regulations after 2013, monetary policy easing reduced TFP growth, esp. for provinces with high-risk bank branches

Conclusion

- We present robust evidence that Basel III regulations in China reduced bank risk-taking, both on average and conditional on monetary policy expansions.
  - Diff-in-diff identification guided by theory: banks of different risk types respond to regulations differently
- Under new regulations, banks reduced risk-taking by shifting lending to SOEs, leading to capital misallocation that reduces TFP
  - Reduction in risk-taking quantitatively important: one std positive shock to monetary policy increased prob of SOE lending by up to 14%
- Broader implications: under industrial policy that favors inefficient firms (e.g., SOEs), capital regulations can lead to tradeoff between financial stability and credit misallocation

Appendix

Regulation changes and risk-taking

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Proposition 1

Given regulations, optimal project risk σ increases with idiosyncratic risk Δ:

$$\frac{\partial \sigma}{\partial \Delta} > 0$$

Given Δ, optimal project risk σ decreases with both required capitalization (ψ) and the sensitivity of risk-weighting (ρ):

$$\frac{\partial \sigma}{\partial \psi} < 0, \quad \frac{\partial \sigma}{\partial \rho} < 0$$

Monetary policy easing raises leverage and reduces risk-taking

Go back

Proposition 2

Given CAR constraints, banks response to a decline in the risk-free rate r by raising leverage ($\lambda = \frac{k}{e}$) and reducing project risk (σ):

$$\frac{\partial \lambda}{\partial r} < 0, \quad \frac{\partial \sigma}{\partial r} > 0.$$

CAR regulations affect how bank risk-taking responds to monetary policy shock

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Proposition 3

In special case with homogeneous banks (identical Δ), sensitivity of risk-taking to monetary policy shock ($\frac{\partial\sigma}{\partial r}$) decreases with ψ but increases with ρ:

$$\frac{\partial^2\sigma}{\partial r\partial\psi} < 0, \quad \frac{\partial^2\sigma}{\partial r\partial\rho} > 0.$$

- Raising $\psi \rightarrow$ better capitalization $\rightarrow$ policy easing still raises bank leverage and reduces risk-taking, but to lesser extent
- Raising $\rho \rightarrow$ CAR more sensitive to risks $\rightarrow$ policy easing leads to larger reduction in risk-taking

Heterogeneous risk-taking responses to CAR regulations (idiosyncratic risks important)

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Proposition 4

Following an increase in ρ, high-risk banks (high Δ) reduces risk-taking more aggressively, both on average...

$$\frac{\partial^2 \sigma}{\partial \rho \partial \Delta} < 0$$

...and conditional on monetary policy easing

$$\frac{\partial}{\partial \Delta}\left[\frac{\partial \sigma}{\partial r}|_{\rho=1} - \frac{\partial \sigma}{\partial r}|_{\rho=0}\right] > 0$$

All else equal, SOE loans receive high credit ratings

Go back

- SOEs enjoy preferential credit access and government guarantees
- SOE loans, both in numbers and amounts, account for bulk of high-quality (AA or higher) loans

Credit Rating	(1) OLS	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Probit
SOE loan	1.361***	0.884***	0.374***	0.509***
	(0.028)	(0.008)	(0.011)	(0.012)
Branch FE	yes	no	no	yes
Year-quarter FE	yes	no	yes	yes
Initial Controls × year FE	yes	no	yes	yes
R^2	0.262	–	–	–
Observations	241,688	264,213	241,688	241,688

Treatment vs. control groups: parellel trend test

Variables	(1) Low-risk group	(2) High-risk group	(3) Mean difference	(4) t-statistic	(5) p-value
SOE loan share	0.316	0.349	-0.033	-0.9256	0.355
AAA&AA+ loan share	0.097	0.068	0.028	1.3638	0.174
Small firm loan share	0.236	0.209	0.028	1.212	0.226
Averaged loan rate (%)	6.357	6.403	-0.046	-1.1523	0.250
log(Interest Income)	17.299	17.308	-0.009	-0.0589	0.953
log(loan amount)	20.057	20.049	0.008	0.0533	0.958
Loan-to-firm asset ratio	0.142	0.130	0.012	0.5455	0.586

Controlling for interest-rate liberalization

Go back

$SOE_{i,j,t}$	(1) OLS	(2) Probit
$RiskH_j \times MP_t \times Post_y$	0.708***	0.551***
	(0.223)	(0.190)
$RiskH_j \times Post_y$	0.00737***	0.0060***
	(0.00152)	(0.0014)
$RiskH_j \times MP_t$	0.213	0.1602
	(0.340)	(0.325)
$RiskH_j \times MP_t \times LoanRateGap_{t-1}$	-3.518	-2.857
	(3.121)	(3.148)
$RiskH_j \times LoanRateGap_{t-1}$	0.0624***	0.0424***
	(0.0185)	(0.0186)
Branch FE	yes	yes
Year-quarter FE	yes	yes
Initial controls × year FE	yes	yes
R^2	0.350	0.510
Observations	330,473	312,053

Controlling for effects of anti-corruption campaign

$SOE_{i,j,t}$	(1) OLS	(2) OLS
$RiskH_j \times MP_t \times Post_y$	0.550**	1.237***
	(0.215)	(0.353)
$RiskH_j \times Post_y$	0.00677***	0.00376*
	(0.00149)	(0.00213)
$RiskH_j \times MP_t$	-0.0295	6.136**
	(0.172)	(2.415)
$RiskH_j \times MP_t \times CAR_{y-1}$		-0.487**
		(0.192)
$RiskH_j \times CAR_{y-1}$		0.00192*
		(0.00108)
$AntiCorrup_j \times Post_y$	0.00673***	0.00672***
	(0.00154)	(0.00154)
$AntiCorrup_j \times MP_t$	0.207	0.204
	(0.174)	(0.174)
$AntiCorrup_j \times MP_t \times Post_y$	-0.319	-0.317
	(0.218)	(0.218)
Branch FE	yes	yes
Year-quarter FE	yes	yes
Initial controls × year FE	yes	yes
R^2	0.354	0.354
Observations	333,500	333,500

Deleveraging: a placebo test

$SOE_{i,j,t}$	(1) OLS	(2) OLS	(3) Probit	(4) Probit
$RiskH_j \times Delev_y$	0.001	0.001	0.002	0.016
	(0.002	(0.002)	(0.002)	(0.036)
$RiskH_j \times MP_t \times Delev_y$		0.150		-0.504
		(0.563)		(0.531)
$RiskH_j \times MP_t$		0.072		0.036
		(0.098)		(0.087)
Branch FE	yes	yes	yes	yes
Year-quarter FE	yes	yes	yes	yes
Initial control $\times$ year FE	yes	yes	yes	yes
R^2	0.353	0.353	–	–
Observations	333,500	333,500	315,382	315,382

Including additional controls

$SOE_{i,j,t}$	(1) OLS	(2) OLS	(3) OLS	(4) Probit	(5) Probit	(6) Probit
$RiskH_j \times Post_y$	0.007***	0.006***	0.002	0.006***	0.005***	0.006***
	(0.0015)	(0.0015)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
$RiskH_j \times MP_t \times Post_y$	0.541**	0.522**	0.688***	0.475***	0.453**	0.594***
	(0.215)	(0.214)	(0.203)	(0.184)	(0.184)	(0.188)
$RiskH_j \times MP_t$	-0.0178	-0.0268	-0.136	-0.0675	-0.066	-0.140
	(0.172)	(0.170)	(0.160)	(0.126)	(0.128)	(0.123)
$InitProfit_j$ × year FE	yes	yes	yes	yes	yes	yes
$InitSOE_j$ × year FE	no	yes	yes	no	yes	yes
Industry FE	no	no	yes	no	no	yes
Branch FE	yes	yes	yes	yes	yes	yes
Year-quarter FE	yes	yes	yes	yes	yes	yes
Initial controls × year FE	yes	yes	yes	yes	yes	yes
R^2	0.355	0.359	0.448	–	–	–
Observations	333,500	333,500	303,404	315,382	315,382	276,893

SOE loans more likely to be non-performing ex post

	(1) NPL OLS	(2) NPL Probit	(3) Overdue OLS	(4) Overdue Probit
SOE Loan	0.0286***	0.0197***	0.0121***	0.0290***
	(0.0021)	(0.0012)	(0.0019)	(0.0022)
Credit Rating	-0.0051***	-0.0056***	-0.0160***	-0.0149***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Branch FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Initial controls × year FE	yes	yes	yes	yes
R^2	0.075	–	0.111	–
Observations	241,688	225,845	241,086	236,923

- SOE loans receive high credit ratings, reflecting government guarantees
- But ex post, controlling for credit ratings, new SOE loans have higher NPL