Search for Yield under Prolonged Monetary Easing and Aging

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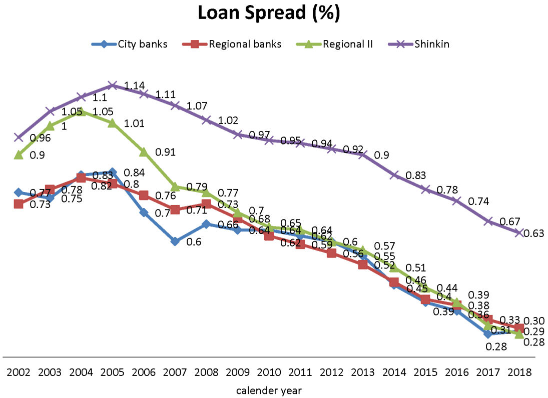
Motivation 1: Declining loan spread under QE and QQE



(Note) (Loan spread) = (loan yield) − (financing cost), where (loan yield) = (interests on loans and discounts)/(average outstanding loans and bills discounted), and (financing cost) = (interest expenses + overhead)/(average outstanding of financing accounts). Source: Japanese Bankers Association website (banks), and Shin'yo Kinko Gaikyo, Shinkin Central Bank (shinkin banks).

Motivation 2: Regional bank risk-taking under adversity

- Financial Service Agency (Jan. 25, 2014 in p.5, *The Nikkei*) *"Financial Service Agency sharpens the stance to promote consolidations among regional and regional II banks. The commissioner [. . .] made an unusual mention, "a consolidation is an important alternative." He also showed the market shrinkage in the next 10 years* $\cdots$ " (author's translation)
- Financial System Report (BoJ, April 2017), Box 3 (p.85). Intensified competition among regional financial institutions and its back ground. *"in both metropolitan and provincial areas, population decline and the increase in the number of competing branches, as well as the tightening of term spreads, contribute to pushing down markups."*
- Lax and relentless lending for retail real estate investment: Case of Suruga Bank (April 2018) and Seibu Shinkin Bank (May 2019).

Motivation 3: Existing theory.

1. **Search for yield (Penetration effect)** (Dell'ariccia et al 2014; Martinez-Miera et al 2017).
   - Monetary easing → if spread diminishes → Less monitor → More risk.
   - Empirical support: Jimenez et al (2014) and subsequent many studies.
2. **Competition fragility view (Risk-shifting)** (Keeley 1990)
   - More competition → high deposit interest → more risk taking by abusing limited liability.
   - If money easing does not penetrate to loan rate, risk-shifting reduces.
   - Empirics: Gan (2004), Beck et al (2013), Forssbæck et al (2015).
3. **Concentration fragility view** (Koskela et al 2000, Boyd et al 2005).
   - More comp. → low loan rate → improve borrower's incentive.
   - Empirics: Akins et al (2016).
4. Non-linear relation: Allen et al (2004), Martinez-Mirea et al (2010).
   - Empirics: Berger et al (2009), Bretschger et al (2012), Tabak et al (2012), Mirazei et al (2013), Kick et al (2015), Ojima (2018).

Empirical Question

1. How did monetary easing shift the loan supply function, and drive the lending competition?
2. How did demographic factor shift the loan demand function?
3. How did these shifts affect bank risk-taking?

Empirical Strategy

[Two steps]

1. IO-style structural estimation to measure demand elasticity and conducts of banks (conjectural variation) simultaneously.
2. Panel estimation of the correlation of these key parameters with risk-taking by banks.

Data: Prefecture-year panel 2003-2018

- Geographical proximity is important for SMEs, main users of bank loans. Median distance in Japan: 1.7 Km (Ono et al 2016).
- Smallest municipality unit, for which data is consistently available.
- Panel data of the financial statement of each city, trust (excl. subsidiary of other f.i.), regional, regional II, and Shinkin banks from March 2003 to March 2018 (banking account only).
    - Nikkei NEEDS Financial Quest, augmented by the database on Japanese Bankers Association.
    - Regular branch numbers in each prefecture of each bank from Nihon Kin'yu Meikan CDROM.
    - loans including mortgages from these institutions are substitutable.
- Aggregate them to prefecture level: Branch-share weighted average of bank financial indicators in each prefecture.
- Another version: Share of (# branches $\times$ avg. branch size).
- Prefecture economic data in 2003-2018 from various source (see the definition table).

Main findings

1. Higher liquidity ratio intensifies competition (reduces CV).
   - Liquidity ratio of banks increase under QE and QQE.
   - Most regions moved from Cournot to Bertrand after 2009.
2. Loan demand is less elastic in more aging regions.
   - Loan does not increase despite of lower interest rate.
3. CV is positively correlated with the demand elasticity.
   - Competition is harsher under lower demand elasticity.
4. More risk-taking in more competitive market.

Model

Bank b's profit max (i: pref., t: year) by loan allocation across regions.

$$\max_{\{l_{bit}\}_{i,t}} \pi_{bt} \equiv \sum_{i \in N_{bt}} \{R_{it}(L_{it}) - D_{bit} - \rho_{bit}\} l_{bit} - c(L_{bt}, w_{bt}). \tag{1}$$

l_{bit}: loan outstanding by bank b in pref i in year t.
N_{bt}: set of pref. where bank b has branch in year t.
R_{it}: loan interest rate in pref i in year t.
D_{bit}: credit cost. Loan-loss provision / Loan.
ρ_{bit}: funding cost for a bank.
$c(\cdot)$: variable cost function, excl. funding and credit costs.
L_{it}: total outstanding loan in pref i in year t.
L_{bt}: total outstanding loan by bank b in year t.
w_{bt}: overhead cost per banker at bank b in year t.

FOC

Bank assumes it has a market power in the loan market, but not in the deposit and other input markets.

FOC w.r.t. l_{bit}:

$$R_{it}(L_{it}) - D_{bit} - \rho_{bit} - \frac{\theta_{bit}}{\beta_{it}} R_{it}(L_{it}) - \frac{\partial c}{\partial L_{bt}} = 0, \tag{2}$$

where

$$\theta_{bit} \equiv \frac{\partial L_{it}}{\partial l_{bit}} \frac{l_{bit}}{L_{it}}, \tag{3}$$

$$\beta_{it} \equiv -\frac{\partial L_{it}}{\partial R_{it}} \frac{R_{it}}{L_{it}}. \quad \text{(Demand Elasticity)} \tag{4}$$

Assume a quadratic MC

$$\frac{\partial c}{\partial L_{bt}} = \alpha_0 + \alpha_1 L_{bt} + \alpha_2 L_{bt}^2 + \alpha_3 w_{bt} + \alpha_4 w_{bt}^2 + \alpha_5 L_{bt} \cdot w_{bt}. \tag{5}$$

Estimation equation 1: Supply function

Aggregate in each pref after multiplying (2) by the share of branches of bank b in pref i, s_{bit}.

$$Spread_{it} = \frac{\Theta_{it}}{\beta_{it}} R_{it} + \alpha_0 + \alpha_1 L^s_{it} + \alpha_2 L^{s2}_{it} + \alpha_3 w_{it} + \alpha_4 w^2_{it} + \alpha_5 L^s_{it} \cdot w_{it} + \iota^s_t + \mu^s_i + \epsilon^s_{it}, \quad (6)$$

where

$$Spread_{it} \equiv \sum_{b \in B_{it}} s_{bit} \{R_{it}(L_{it}) - D_{bit} - \rho_{bit})\},$$

$$\Theta_{it} \equiv \sum_{b \in B_{it}} s_{bit} \theta_{bit}, \text{ (Conjectural Variation)}$$

$$L^s_{it} \equiv \sum_{b \in B_{it}} s_{bit} L_{bt}, \quad L^{s2}_{it} \equiv \sum_{b \in B_{it}} s_{bit} L^2_{bt}, \cdots$$

ι^s: year fe, μ^s: pref fe, ϵ_{it}: error term.

CV = Herfindahl index if Cournot, 1 if monopoly, 0 if Bertrand.

Estimation equation 2: Demand function

Assume the following demand function for each pref,

$$\ln L_{it} = \beta_0 - \beta_{it} \ln R_{it} + \beta_2' X_{it} + \iota_t^d + \mu_i^d + \epsilon_{it}^d. \tag{7}$$

To delete pref fe, we subtract the pref average from both sides.
Accordingly, we assume elasticity varies only cross-sectionally.
To allow time and/or cross-section variation in CV and elasticity and keep them positive, we assume

$$\Theta_{it} = \exp\left\{\delta_0 + \delta_1' Y_{it} + \sum_{k=2}^{47} \delta_k \mathbf{1}(i = k) + \sum_{k=2004}^{2018} \delta_k \mathbf{1}(t = k)\right\}, \tag{8}$$

$$\beta_{it} = \exp\left\{\zeta_0 + \zeta_1' Z_i\right\}. \tag{9}$$

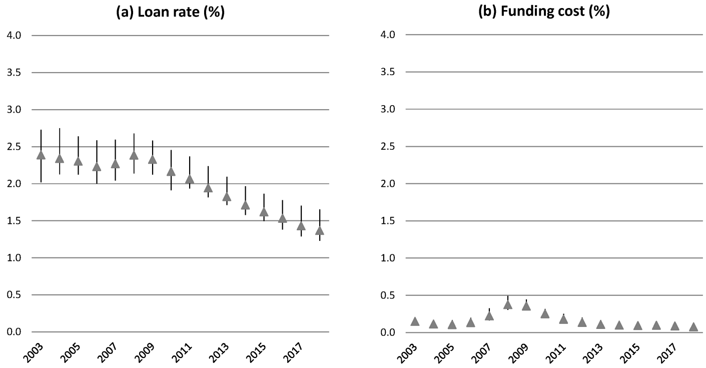
More specifics in estimation

- Control variables
  1. Demand shifter X_{it}: total construction, total taxbase, commercial land price (highest), difference from pref mean.
  2. Determinants of CV Y_{it}: liquidity ratio, Δpublic construction, Δprivate construction, Δtaxbase, Δworking-age population.
  3. Determinants of demand elasticity Z_i: time-series avg. of Δworking-age population, population density.
  4. Both prefecture and year dummies in (6).
- Proxy for R_{it}: Branch-share weighted-average of bank-level loan return. Use only the "banking account" information, which include domestic loans only.
- Alternative share s_{bit}: Share of the number of branches times the average size of branch of each bank, measured by (total loan)/(# branches).
- FIML with BHHH s.e. by assuming $(\epsilon^s, \epsilon^d)'$ is i.i.d. with $N(\mathbf{0}, \mathbf{\Sigma})$.

Difference from the existing studies

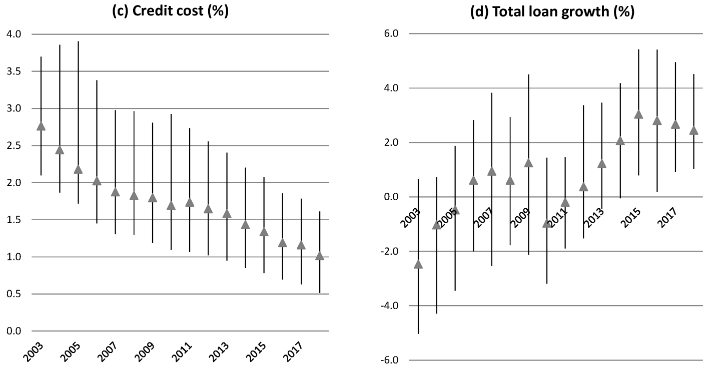
1. Explicitly introduce the credit cost, measured by the loan-loss provision rate, into the supply function.
    - Avoid aggressive risk-taking (higher credit spread) being interpreted as stronger market power.
    - Banks are required to accumulate a provision according to internal credit rating since March 1998. $\rightarrow$ reasonable proxy for expected default loss.
    - Note: Requirement for provisions reduced from December 2009 to March 2013 by the SME Financial Facilitation Law. Control by year-fixed effect.
    - Existing studies use Z-score or default-distance, but it captures risks of not only lending business but also others. We do not need stock prices.
2. Tell apart the demand elasticity, CV, and the determinants of each.
    - In literature, Lerner index ((p-MC)/p=CV/elasticity) is the standard.
    - Avoid directly using a notorious est MC (Kim et al 2006) in key tests.
    - Cross-sectional and time-series variation in CV.
3. Estimate the impact of QE (bank liquidity ratio) to CV.

Data description 1: Loan rate and funding cost



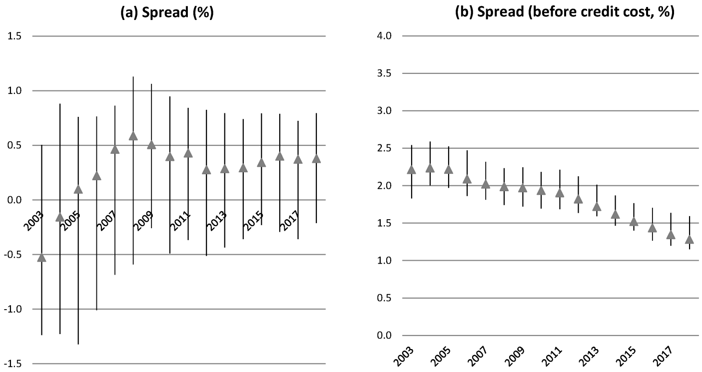
From the prefecture-year panel data.
top of segment: 90%, bottom: 10%. triangle: median.

Data description 2: Credit cost



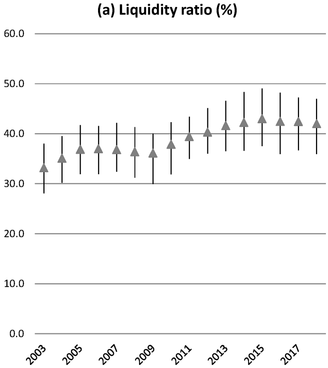
From the prefecture-year panel data.
top of segment: 90%, bottom: 10%. triangle: median.

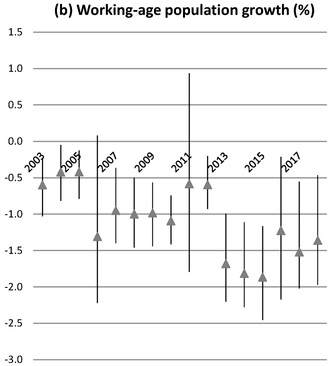
Data description 3: Spread



From the prefecture-year panel data.
top of segment: 90%, bottom: 10%. triangle: median.

Data description 4: Liquidity ratio, ΔPopulation





From the prefecture-year panel data.
top of segment: 90%, bottom: 10%. triangle: median.

Result of structural estimation

(1)(2): branch-share weighted, (3): branch-size adjusted branch-share.

	(1)			(2)			(3)		
(Supply function)	Coef.	S.E.		Coef.	S.E.		Coef.	S.E.	
δ(liquidity ratio)	-0.020	0.007	***	-0.020	0.008	**	-0.026	0.014	*
δ(Δpublic constr.)	0.000	0.000		0.000	0.000		-0.001	0.000	
δ(Δprivate constr.)	0.000	0.000		0.000	0.000		0.000	0.000	
δ(Δtax base)	0.012	0.006	*	0.012	0.007		0.020	0.011	*
δ(Δpopulation)	0.009	0.017		0.009	0.018		0.037	0.026	
δ(merger)				0.000	0.001				
$\alpha(L_{it})$	-0.174	0.072	**	-0.176	0.073	**	-0.074	0.026	***
$\alpha(L_{it}^2)$	0.001	0.001	*	0.001	0.001	*	0.001	0.000	***
$\alpha(w)$	-0.108	0.030	***	-0.106	0.031	***	-0.064	0.021	***
$\alpha(w^2)$	0.006	0.002	***	0.005	0.002	***	0.003	0.001	***
$\alpha(w \cdot L_{it})$	0.000	0.002		0.000	0.002		0.000	0.001	
α(merger)	-0.001	0.001					0.001	0.001	

(Note) *** $p<0.01$, ** $p<0.05$, * $p<0.1$. S.E. is the pref-clustered standard error. Est. const., coef. of pref dummies and year dummies are omitted.

CV is decreasing in liquidity ratio.: QQE increased lending capacity.
MC is decreasing in scale: Economy of scale.

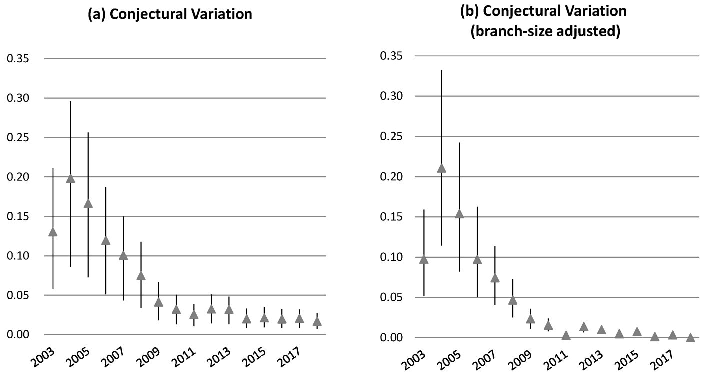
(cont.)

(Demand function)	(1) Coef.	S.E.		(2) Coef.	S.E.		(3) Coef.	S.E.	
ζ(mean Δpopulation)	1.310	0.226	***	1.311	0.226	***	1.088	0.196	***
ζ(mean density)	-0.562	0.205	***	-0.559	0.206	***	-0.369	0.158	**
β(ln construction)	0.019	0.014		0.019	0.014		0.018	0.014	
β(ln taxbase)	0.560	0.115	***	0.559	0.115	***	0.570	0.119	***
β(ln land price)	-0.012	0.013		-0.012	0.013		-0.010	0.014	
σ_1	0.216	0.012	***	0.216	0.012	***	0.196	0.014	***
σ_2	0.048	0.002	***	0.048	0.002	***	0.048	0.002	***
σ_{12}	0.002	0.001	**	0.002	0.001	**	0.001	0.001	
N	752			752			752		
log likelihood	1334.5			1321.8			1384.5		

(Note) *** $p<0.01$, ** $p<0.05$, * $p<0.1$. S.E. is the pref-clustered standard error. Est. const. and coef of year dummies are omitted. pref dummies are not included.

Elasticity increasing in Δpop.: working-age respond more to lower rate. Elasticity is decreasing in density.

Estimated Conjectural Variation

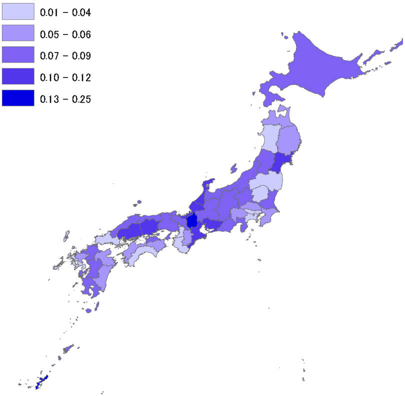


From the prefecture-year panel data.
top of segment: 90%, bottom: 10%. triangle: median.

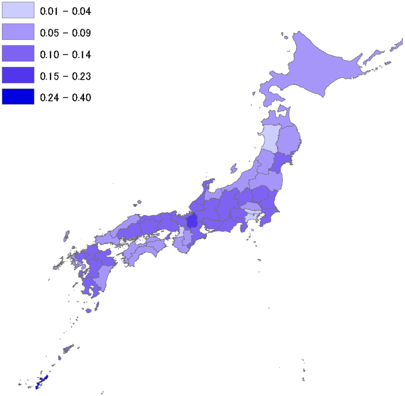
Positive correlation between CV and elasticity

$Corr(\hat{\Theta}_{it}, \hat{\beta}_{it}) = 0.48$ ($p < 0.01$).

(c) Esri Japan



(a) conjectural variation



(b) elasticity

Mean of 2003-2018.

(Note) The author produced from the digital map (geospatial information) by Geospatial Information Authority of Japan, and the National Municipality Border data by ESRI Japan.

Competition increased risk-taking?

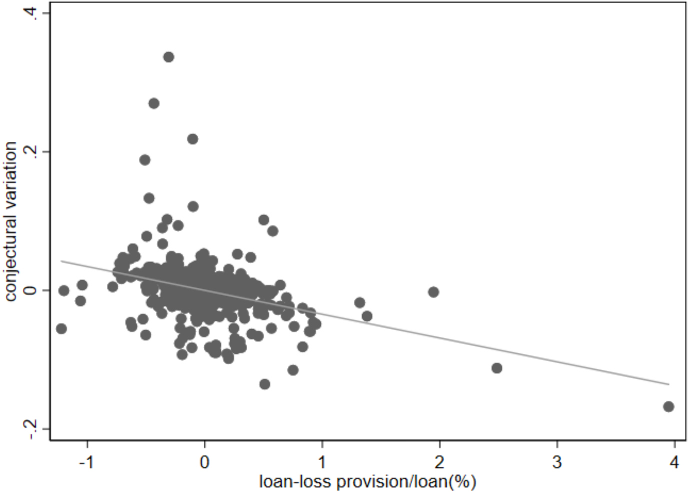
- Measure of risk taking in each prefecture: Branch-share weighted average of provision / total loan.
- Regress CV onto provision with pref and year fe to avoid the complication due to estimated regressor.

$$\hat{\Theta}_{it} = \gamma_0 + \gamma_1 D_{it} + \iota_t + \mu_i + \epsilon_{it}. \tag{10}$$

- Regress after two-way demeaning.

Scatter plot: CV and risk-taking

(note) Both values are two-way (pref, year) demeaned.



Result of fixed effect regression

Dependent var: $\hat{\Theta}_{it}$ (CV).
Col 1-2: branch-share weighted. Drop bottom and top 1% in col 2.
Col 3-4: branch-size-adj. branch-share weighted. Outliers excl. in col 4.

	(1)	(2)	(3)	(4)
D_{it}	-0.022***	-0.025***	-0.036***	-0.029***
	(0.007)	(0.006)	(0.007)	(0.008)
Observations	752	712	752	714
Number of pref_id	47	47	47	47
Adjusted R-squared	0.737	0.850	0.818	0.895
prefecture fe	yes	yes	yes	yes
year dummy	yes	yes	yes	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Competition drives risk-taking.

Robustness: IV to deal with unobservable common factors

- IV: Capital ratio = gross capital / total asset (%).
- Check no correlation with the error term in the first stage.
  (1) branch-share weight, (2) branch-size adj. branch-share weight.

Dependent var: $\hat{\Theta}_{it}$.

	(1)			(2)		
	Coef.	S.E.		Coef.	S.E.	
D_{it}	-0.017	0.010	*	-0.030	0.010	***
Capital ratio	0.009	0.010		0.007	0.007	
N	752			752		
Adj. R^2	0.054			0.143		

S.E.: pref-clustered standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Non-correlation assumption is OK.

(cont.)

- IV(capital ratio) is relevant enough. Risk-shifting, or the accumulation of credit costs damages capital.
- Negative correlation is fairly robust.

	(1) Coef.	S.E.		(2) Coef.	S.E.	
(1st stage, dep.var: D)						
Capital ratio	-0.382	0.098	***	-0.378	0.059	***
F for excluded IV	15.24			41.54		
(p-value)	(0.000)			(0.000)		
(2nd stage, dep.var: $\hat{\Theta}$)						
D_{it}	-0.042	0.022	*	-0.049	0.014	***
N	752			752		
Adj. R^2	0.007			0.116		

SE: pref-clustered standard errors. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Summary of our findings

1. Prolonged monetary easing, which increases lending capacity of banks, drove them to compete more aggressively.
   - Lending competition shifted from Cournot to Bertrand in many prefectures.
2. Competition is harsher under less elastic demand.
3. Demand is less elastic in regions where working-age population is decreasing more.
4. Banks take more credit risks in more competitive loan market.

Consistent with the Search for Yield.

(Supple) Literature: IO structural estimation

- Traditional structural estimation in IO with the demand function and the supply function: Iwata (1974), Bresnahan (1982), Lau (1982), Porter (1983).
  $\rightarrow$ CONJECTURAL VARIATION (CV)
  = 0 if perfect comp.,
  1 if monopoly,
  Herfindahl if Cournot.
- Application to loan market : Uchida et al (2005), Coccorese (2005, 2009), Delis et al (2009), Ishikawa et al (2013), and Crawford et al (2018). Some estimate three equation model with cost function.
- Application to deposit market : Ho and Ishii (2011), Aguirregabiria et al (2016), Egan et al (2017), Kumar (2018). Consider discrete choice of banks by depositors and see bank-run risk.
- Entry-exit: Sanches et al (2018).
- Merger: Akkus et al (2015).

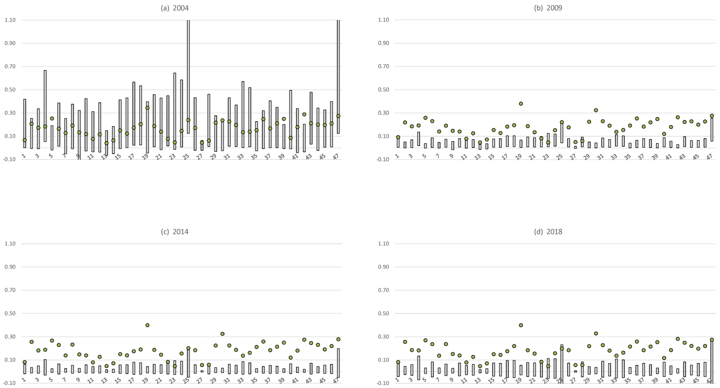
Variable definition

Variable	Definition
L_{it}: total loan	Total loan outstanding by domestic banks including shinkin banks in each pref. as of March, tril. JPY. Loan by domestic banks is collected from the long-term time-series database in the Bank of Japan website. For shinkin banks, the sum of loans by those with headquarters in each prefecture, which is collected from Nikkei NEEDS Financial Quest.
R: loan rate	Weighted avg. of the ratio of interest on loans and discounts over loans and bills discounted in the accounting period ending in March in each year (%). Weight is the branch share of each bank including shinkin banks, which is calculated from the database in the Nihon Kin'yu Meikan CDROM (Nihon Kin'yu Tsushin Sha). Augmented for Jonan Shinkin and Kakegawa Shinkin in 2005 by Zenkoku Shinyo Kinko Zaimu Shohyo (Kin'yu Tosho Konsarutanto Sha), and for Saitama Risona Bank (2005,06), Gifu Bank (2011), Nagasaki Bank (2015-16), Kinki Osaka Bank (2012-16), and Ashikaga Bank (2005-2012) by the database on the Japanese Bankers Association Bankers Library Website https://www.zenginkyo.or.jp/en/statistics/.
ρ: funding cost	Weighted avg. of the ratio of interest expenses over total funding in each prefecture (%). Weight is the branch share of each domestic bank including shinkin banks. Total funding is the sum of deposits, negotiable certificates of deposit, debentures, call money, payables under repurchase agreements, payables under securities lending transactions, bills sold, commercial papers, borrowed money, foreign exchanges, bonds payable, bonds with subscription rights to shares, borrowed money from trust account in the liability (English translation by Japanese Bankers Association).
D: Credit cost	Ratio of provision for loans over total loans (%). Weighted average by the branch number share of each bank in each prefecture. Augmented for Towada Shinkin and Ninohe Shinkin in March 2008 in the same way as R.
Liquidity ratio	Ratio of the liquid asset over over total asset (%). Liquid asset is the sum of cash and due from banks, call loans, receivables under resale agreement, receivables under securities borrowing transactions, bills bought, money held in trust, and securities in the asset side (English translation by Japanese Bankers Association).

(cont.)

Spread	$R-\rho-$Credit cost (%).
L^s_{it}: average bank size	Weighted avg. of bank asset size located in each prefecture, tril. JPY. Weight: #branch share.
w: banker's wage	Overhead cost per staff at each bank, mil. JPY. Weighted avg. by the #branch share in each prefecture. Augmented for Yamaguchi Shinkin in March 2003-2008.
Capital ratio	Gross capital / total asset (%). Weighted average by the branch number share of each bank in each prefecture.
Construction	Total building construction started in each prefecture, fiscal year, tril. JPY. Construction General Statistics, Ministry of Land Infrastructure, Transport and Tourism (MILT), Japan.
ΔPrivate construction	Annual % growth rate of the building construction started by the private sector in each prefecture, fiscal year, tril. JPY. Construction General Statistics, MLIT, Japan.
ΔPublic construction	Annual % growth building construction started in each prefecture, fiscal year, tril. JPY. Construction General Statistics, MLIT, Japan.
Tax base	Total tax base of the municipality tax, i.e., household income in the previous calender year, in each prefecture. Survey on the Taxation Status of the Municipality Tax, Ministry of Internal Affairs and Communications (MIAC).
ΔTax base	Annual growth rate of tax base (%).
ΔPopulation	Annual growth rate of the production age, 15-64 years old, % as of October 1 in each year. From Population Projections, Statistics Bureau, MIAC, Japan.
Density	Population density, 1000 persons per km^2.
Land price	Highest official land price in commercial districts in each prefecture, 100 thousand JPY per m^2. MILT, Japan.
Bank merger	Branch share of banks who had merged in the last 3 years including the current year, %. Merger information was collected from Nikkin Shirho Nenpo (Nihon Kin'yu Tsushin Sha).

(Supple) From Cournot to Bertrand



Horizontal: prefecture ID.
Dot: Branch Herfindahl index, Bar: 95%CI of CV (from baseline est).

(Guess) QE → more liquidity → capacity constraint disappear
(Kreps and Sheinkman 1980).

(Supple) Elasticity in subsample periods

Prefecture-year panel data of est. elasticity.

Sample period	mean	s.d.	p10	med	p90
2003-18	0.095	0.058	0.048	0.092	0.132
2003-12	0.079	0.089	0.000	0.048	0.213
2013-18	0.030	0.070	0.003	0.014	0.055

- Elasticity is positively correlated with CV
  (corr. coef: 0.48, $p < 0.01$).
- Competition is harsher in the region where demand does not increase in response to QQE.

(Supple) Cross-sectional Heterogeneity: CV

Mean of estimated CV, $\hat{\Theta}_{it}$, in 2003-2018.

Hokkaido	0.071	Ishikawa	0.097	Okayama	0.100
Aomori	0.041	Fukui	0.094	Hiroshima	0.090
Iwate	0.056	Yamanashi	0.058	Yamaguchi	0.033
Miyagi	0.120	Nagano	0.079	Tokushima	0.054
Akita	0.028	Gifu	0.072	Kagawa	0.067
Yamagata	0.071	Shizuoka	0.082	Ehime	0.058
Fukushima	0.035	Aichi	0.109	Kouchi	0.031
Ibaragi	0.063	Mie	0.101	Fukuoka	0.078
Tochigi	0.034	Shiga	0.215	Saga	0.049
Gunma	0.069	Kyoto	0.072	Nagasaki	0.027
Saitama	0.049	Osaka	0.007	Kumamoto	0.085
Chiba	0.060	Hyogo	0.081	Oita	0.055
Tokyo	0.014	Nara	0.042	Miyazaki	0.057
Kanagawa	0.023	Wakayama	0.036	Kagoshima	0.069
Niigata	0.067	Tottori	0.076	Okinawa	0.249
Toyama	0.070	Shimane	0.064		

(Supple) Cross-sectional Heterogeneity: Elasticity

Estimated elasticity , $\hat{\beta}_i$, in 2003-2018.

Hokkaido	0.082	Ishikawa	0.118	Okayama	0.132
Aomori	0.048	Fukui	0.108	Hiroshima	0.121
Iwate	0.071	Yamanashi	0.095	Yamaguchi	0.058
Miyagi	0.142	Nagano	0.097	Tokushima	0.069
Akita	0.037	Gifu	0.095	Kagawa	0.078
Yamagata	0.073	Shizuoka	0.092	Ehime	0.069
Fukushima	0.079	Aichi	0.134	Kouchi	0.052
Ibaragi	0.093	Mie	0.117	Fukuoka	0.109
Tochigi	0.128	Shiga	0.232	Saga	0.108
Gunma	0.110	Kyoto	0.099	Nagasaki	0.060
Saitama	0.069	Osaka	0.011	Kumamoto	0.111
Chiba	0.098	Hyogo	0.098	Oita	0.094
Tokyo	0.021	Nara	0.056	Miyazaki	0.086
Kanagawa	0.036	Wakayama	0.055	Kagoshima	0.091
Niigata	0.085	Tottori	0.096	Okinawa	0.403
Toyama	0.077	Shimane	0.079		