Macroprudential Policies and Market Competition in Mortgage Lending Markets: Evidence for Chile[1]

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1. This paper's results did not involve or compromise the Central Bank of Chile or the institutions that share their data with the Central Bank of Chile.

Motivation

- Macroprudential tools promote financial stability
  - Especially encouraged after the financial crisis
  - Leverage regulation (e.g., LTV caps), capital regulations on banks, etc.
- They are usually designed to control:
  - High leverage
  - Mortgage default
  - Credit growth and house-price booms
- However, they may have unexpected and secondary effects
  - E.g., market competition
- Still lack of evidence regarding how these policies can impact on competition

Mortgage loan-loss-provisioning Policy

- LLPs are reserves that banks create to cover expected losses from their loans
- Before 2016, banks had significant discretion in their mortgage provisioning
  - By group portfolios and IRB models; LTV had a secondary role
- A new LLP policy for mortgages started in January 2016
  - For each loan, every month
  - Standardized approach: days in arrears and LTV LLP Figure
  - This policy serves as a soft LTV cap: LLP can greatly rise with LTV $> 80\%$
  - Previous evidence: Calani and Paillacar (2022)
- The Chilean Banking Authority, pre-2016, expected that the new LLP policy:
  - Provisions reflect a correct risk in banks' portfolios
  - Minimal to no effects on prices

This Paper

1. How do banks adjust their originations in response to the LLP regulation?
   → Heterogeneous effects

2. How does the LLP policy alter borrowers' choice sets?
   → Estimation of borrowers' choice sets ⇒ Structural Model
   → Meaningful effects on choice sets

3. How do banks modify interest rates in response to the LLP policy?
   → Structural model ⇒ Mechanisms

Literature

MARKET FEATURES, DATA AND MOTIVATING FACTS

Market Features and Data

- **Chilean Mortgage Market**
  - In 2017, roughly 21% of households had at least one mortgage loan
  - The Chilean mortgage market is highly concentrated upstream
  - Mortgage contracts are simple and are set up in real terms (UF)
  - Interest rates are set up at borrower level

- **Data**
  - Banking loan registries for mortgages and other loans Data Used Stats
  - Unemployment insurance data, for all non-public formal workers, to obtain labor income and demographic characteristics
  - Census of real estate transactions (F2890) and Real Property Cadastre for LTV

LLP Policy's Motivating Facts

- For post policy period, high-LTV loans become less relevant General Share

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- Heterogeneous effects at bank level Composition Share
  - **Most-reactive banks:** The share in high-LTV loans (LTV>80%) plumped for three banks. *From around 60% to 15%*
  - **Least-reactive banks:** The share in high-LTV loans (LTV>80%) slightly decreased. *From around 70% to 60%*
  - Effects in choice sets?

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- After 2016, most-reactive banks target high-LTV loans to higher-income borrowers Borrowers

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  - Effects in choice sets?
- After 2016, most-reactive banks target high-LTV loans to higher-income borrowers Borrowers
- Gap in average interest rates between high- and low-LTV loans Interest rates
  - Before 2016, prices move in tandem ("parallel trends")
  - Most-reactive banks $\rightarrow$ gap favors high-LTV loans
  - Least-reactive banks $\rightarrow$ gap favors low-LTV loans

Summary

- **How does LLP policy explain the observed gaps in average interest rates?**
  $\rightarrow \Delta$ marginal costs on high-LTV loans
  $\rightarrow \Delta$ number of products in borrowers' choice sets
  $\rightarrow \Delta$ borrowers' attributes
  $\Rightarrow$ **The need of a structural model**

THE MODEL IN A NUTSHELL

The Model in a Nutshell

- **Method**: static partial-equilibrium model
  - Demand side
    - Four geographical markets
    - Product choice: 16 products (bank-LTV combination)
    - Loan amount
    - Default
  - Supply side
    - Nash-Bertrand competition on interest rates

Product Choice

- Borrower i's indirect utility from product j in market m for period t is

$$U_{ijmt} = \beta r_{ijmt} + Y'_{ijmt}\varphi + \delta_j^D + \epsilon_{ijmt},$$

where r_{ijmt} is the interest rate, δ_j^D are product fixed-effects j, Y_{ijmt} is a vector at borrower-product-market-period, and ϵ_{ijmt} is a T1EV shock

- The probability of having product j in choice set of borrower i (consideration probability) is:

$$\phi_{ijmt} = P(A_{ijmt} = 1) = P(\pi_0 + \delta_j^A + Y'_{ijmt}\pi_1 + Z'_{jt}\pi_2 + V'_{ijmt}\pi_3 + \tau_{ijmt} > 0)$$

where δ_j^A is a product fixed effect and τ_{ijmt} is a T1EV error. Also:

- $Z_{jt} \rightarrow$ 4 vars: Bank type $\times$ LTV type $\times$ Post Detail
- $V_{ijmt} \rightarrow$ 16 vars: Log Income (Log Risk Score) $\times$ Bank type $\times$ LTV type $\times$ Period

Supply Side

- Bank l maximizes the following expected net revenue from interest payments from a relation with borrower i

$$\max_{r_{i\mathbb{L}mt}, r_{i\mathbb{H}mt}} \Pi_{ilmt}(r_{ijmt}) = \sum_{j \in \{\mathbb{L}, \mathbb{H}\}} s_{ijmt} \times q_{ijmt} T_{imt} [r_{ijmt}(1 - F_{ijmt}) - MC_{ijmt}],$$

where s_{ijmt} is the probability that borrower i chooses product j (low or high-LTV), T_{imt} is the maturity, r_{ijmt} is the interest rate, q_{ijmt} is the loan amount, F_{ijmt} is the probability of default, and MC_{ijmt} is the unobserved marginal cost

Supply Model

- The FOC delivers the following pricing equation:

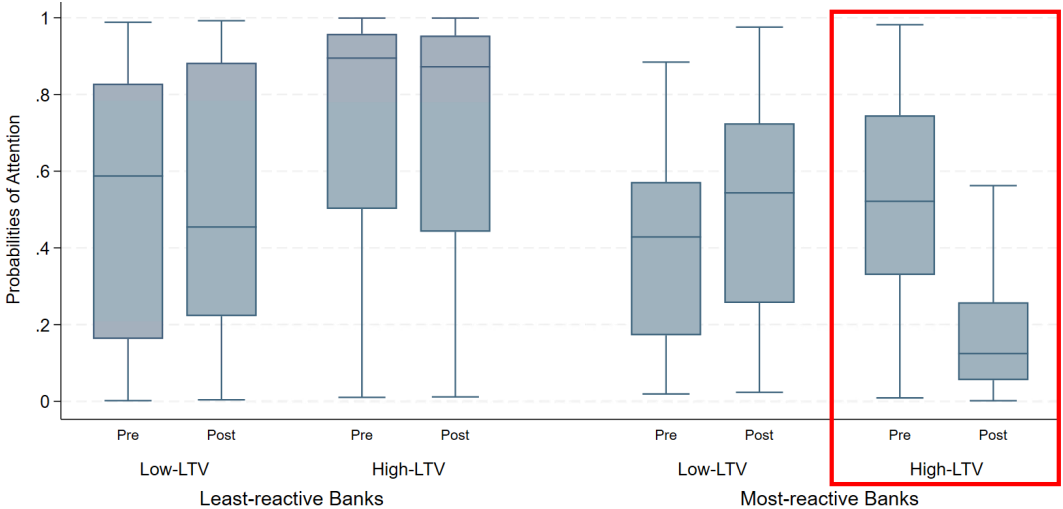
$$r_{ijmt} = \underbrace{\frac{MC_{ijmt}}{\left((1 - F_{ijmt}) + \frac{\frac{\partial(1-F_{ijmt})}{\partial r_{ijmt}}}{\frac{\partial q_{ijmt}}{\partial r_{ijmt}}\frac{1}{q_{ijmt}} + \frac{\partial s_{ijmt}}{\partial r_{ijmt}}\frac{1}{s_{ijmt}}}\right)}}_{\text{Effective marginal cost}} - \underbrace{\frac{1}{\left(\frac{\partial q_{ijmt}}{\partial r_{ijmt}}\frac{1}{q_{ijmt}} + \frac{\partial s_{ijmt}}{\partial r_{ijmt}}\frac{1}{s_{ijmt}} + \frac{\partial(1-F_{ijmt})}{\partial r_{ijmt}}\frac{1}{(1-F_{ijmt})}\right)}}_{\text{Full markup}}$$

$$- \underbrace{\frac{\frac{\partial s_{i-jmt}}{\partial r_{ijmt}} \times q_{i-jmt}[r_{i-jmt}(1 - F_{i-jmt}) - MC_{i-jmt}]}{\left(\frac{\partial q_{ijmt}}{\partial r_{ijmt}} s_{ijmt}(1 - F_{ijmt}) + \frac{\partial s_{ijmt}}{\partial r_{ijmt}} q_{ijmt}(1 - F_{ijmt}) + \frac{\partial(1-F_{ijmt})}{\partial r_{ijmt}} q_{ijmt} s_{ijmt}\right)}}_{\text{Other products effect}}$$

Estimation

RESULTS

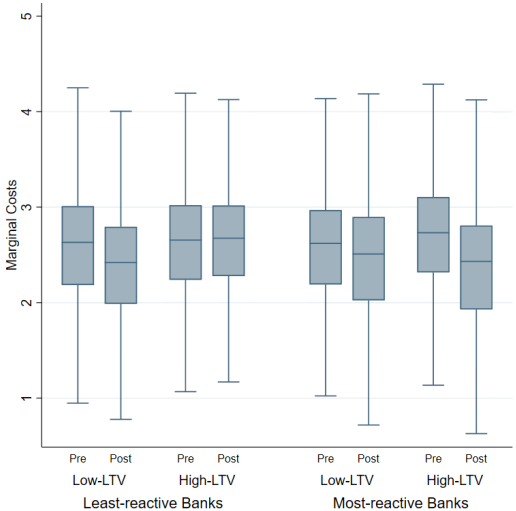
Probabilities of Consideration

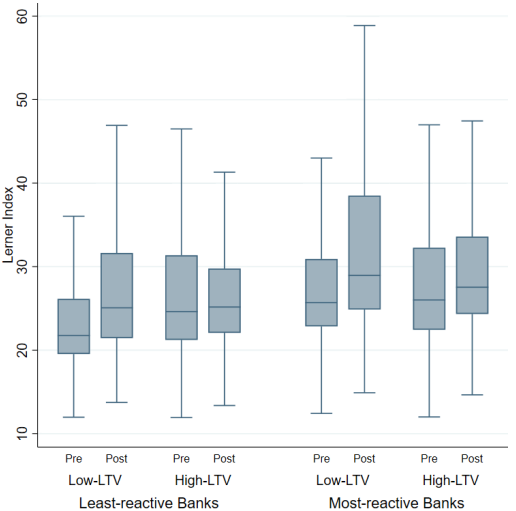


Note. Weighted values are used, where the weights are the product choice probabilities from the baseline scenario. The box designates the interquartile range (IQR), and the whiskers represent the most extreme observations still within 1.5×IQR of the upper / lower quartiles.

Parameters PChet PC Detailed

Marginal Costs and Lerner Indexes





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Pass-through of LLP Policy on Marginal Costs

- I model the recovered marginal cost using a DID design

$$MC_{ijmt}(\theta) = c_l + c_t + c_m + N'_{ijmt}\zeta_1 + M'_{imt}\zeta_2 + \zeta_3 \mathbb{1}[LTV_{ijmt} > 80\%] + \phi \mathbb{1}[LTV_{ijmt} > 80\%] \times Post_t + \varepsilon_{ijmt},$$

  where c_l, c_t, and c_m are fixed effects, N_{ijmt} is a vector at product-borrower level, while M_{imt} is a vector at borrower level
  - ϕ: differential change in MgCs for high-LTV loans relative to low-LTV loans following the implementation of LLP policy (Benetton et al. 2021)

- Parallel trends assumption is credible MgCs

Pass-through of LLP Policy on Marginal Costs

	Least-reactive Banks		Most-reactive Banks	
	(1)	(2)	(3)	(4)
LTV $>$ 80% $\times$ Post	0.205***	0.175***	-0.160***	0.033***
	(0.005)	(0.005)	(0.005)	(0.004)
Controls		X		X
Controls - Post		X		X
Controls - LTV$>$80%		X		X
Marginal Cost (mean)	2.409	2.409	2.307	2.307
R-squared	0.182	0.520	0.120	0.679
Number of Observations	200,000	200,000	120,000	120,000

Note. Controls include maturity, logarithm of loan amount, borrower's previous relationship with the bank, and predicted default. All regressions include market FEs, quarter FEs, bank FEs, and a *LTV* $>$ 80% dummy. Observations are weighted by the product choice probabilities from the baseline scenario. Standard errors are reported in parentheses and clustered at the borrower level. Significance levels 10%, 5%, and 1% are denoted by *, **, and ***, respectively.

SUMMARY OF THE COUNTERFACTUALS

Summary of Counterfactuals for the Post Policy period

- **Main objective**: Explain the observed gap in average interest rates between high- and low-LTV loans since the policy implementation

- **Counterfactuals: Δ Pbbs of Consideration (PCs) + Δ MgCs**
  1. Make post-policy PCs resemble the values observed during the pre-policy period
  2. Counterfactual 1 + ruling out the rise in MgCs associated to the LLP regulation

- **Results**:
  - Under "no other products effect" assumption, both counterfactuals explain the rate gap Plot

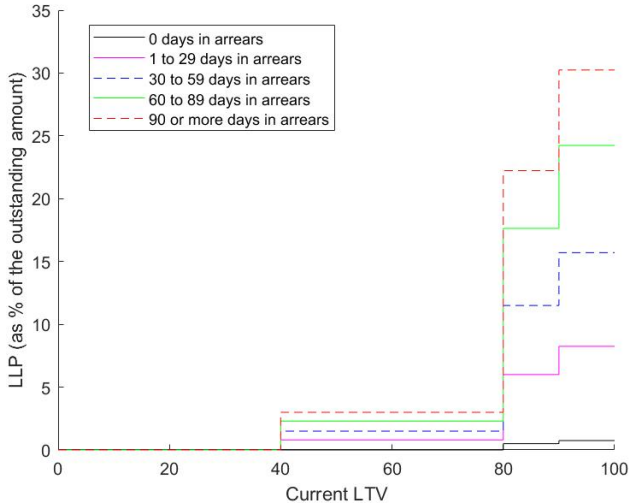
Final Thought

Final Thought

- When implementing and evaluating macroprudential policies, it is crucial to consider the trade-offs between competition and policy targets

APPENDIX

LLP Requirements Under the New Regulation



Note: Current LTV is in percentage. Sources: Calani and Paillacar (2022) and López et al. (2014).

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Related Literature

1. **Evaluating leverage regulation for mortgages using microdata**
   - Kinghan et al. (2019), DeFusco et al. (2020), Benetton (2021), Acharya et al. (2022), Van Bekkum et al. (2019), and Peydró et al. (2024)
     → Less explored way regulation impacts competition: choice set formation

2. **Estimate demand models with consideration sets**
   - Auxiliary data: Cuesta and Sepúlveda (2019). No auxiliary data: Abaluck and Adams-Prassl (2021), Goeree (2008), and Yu (2023)
     → Novelty by studying a policy change that influences choice sets

3. **Estimation of IO structural model in credit markets**
   - Allen et al. (2019), Benetton et al. (2018), Robles-Garcia (2019), Buchak et al. (2018), Einav et al. (2012), and Crawford et al. (2018)
     → Focus on the choice set formation under the differentiated product approach

4. **Literature on mortgage markets in Chile**
   - Avanzini et al. (2020), Madeira (2021), and Calani and Paillacar (2022)
     → Banks' heterogeneity and change in mean prices using a structural model

Data used

Main Sample (131k observations)

- For 2014-2017: Bank Registries ∩ Unemployment Ins. ∩ Census of RE Trans.
- Only First-time buyers
- Standard mortgages for the Chilean setting
  - Maturities of 15, 20, 25, and 30 years
  - LTVs between 70% and 90%
- Rule out mortgages associated with housing subsidies

Prediction sample (356k observations)

- Main sample + 2013, 2018, and 2019, and second buyers and refinancing

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Data

	Mean	SD	P1	P99
Panel A: Loan Attributes				
Interest Rate (%)	4.01	0.50	2.93	5.30
LTV (%)	82.63	10.27	43.26	98.41
Loan Amount (UF)	2324.44	1760.43	694.00	9600.00
Maturity (Years)	24.26	4.70	15.00	31.00
Panel B: Borrower Attributes				
Borrower is Male (%)	61.80	48.59	0.00	100.00
Age (Years)	35.07	8.07	23.00	58.00
Labor Income (UF)	84.99	81.09	11.46	284.06
Panel C: Borrower Credit History				
Previous Relation with the Bank (%)	20.85	40.62	0.00	100.00
Credit risk Score (%)	8.98	7.52	1.45	37.65
Mortgage Default (%)	9.65	29.52	0.00	100.00
Panel D: Market Features				
Branches (Number)	8.13	12.30	0.00	66.00
Metropolitan Region (%)	59.44	49.10	0.00	100.00

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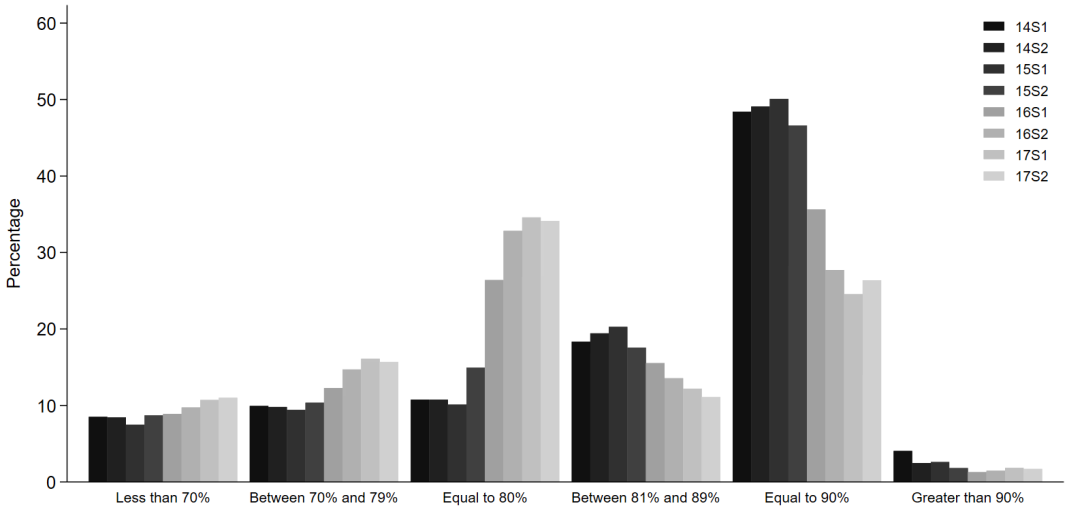
LTV Distribution at Origination



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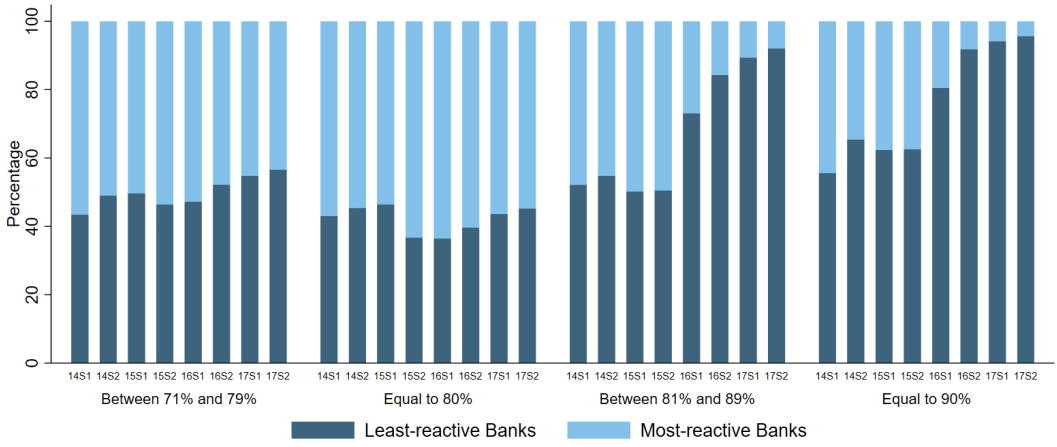
Market Share



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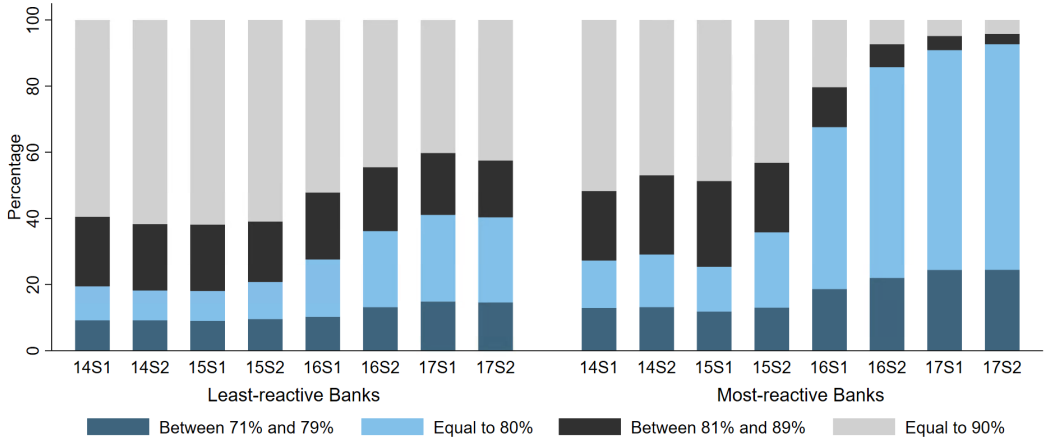
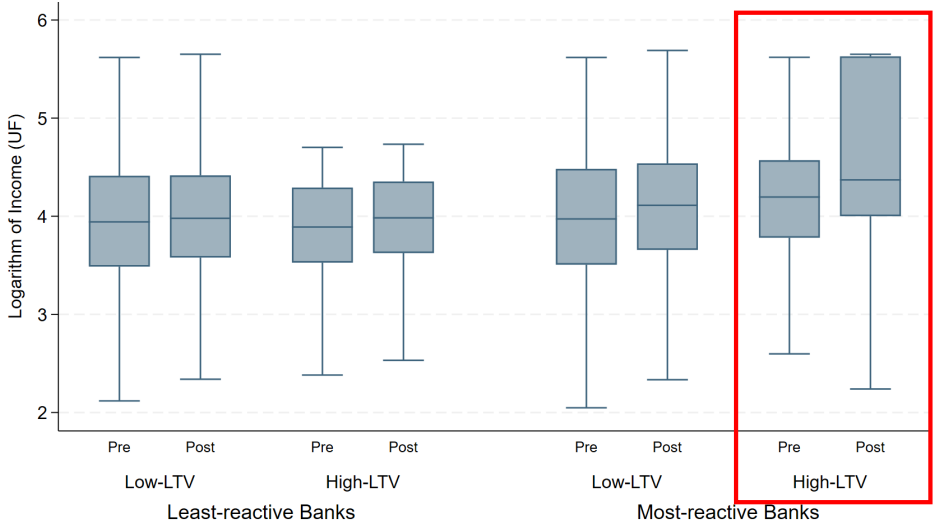
Product Composition



Share

Borrowers' Attributes



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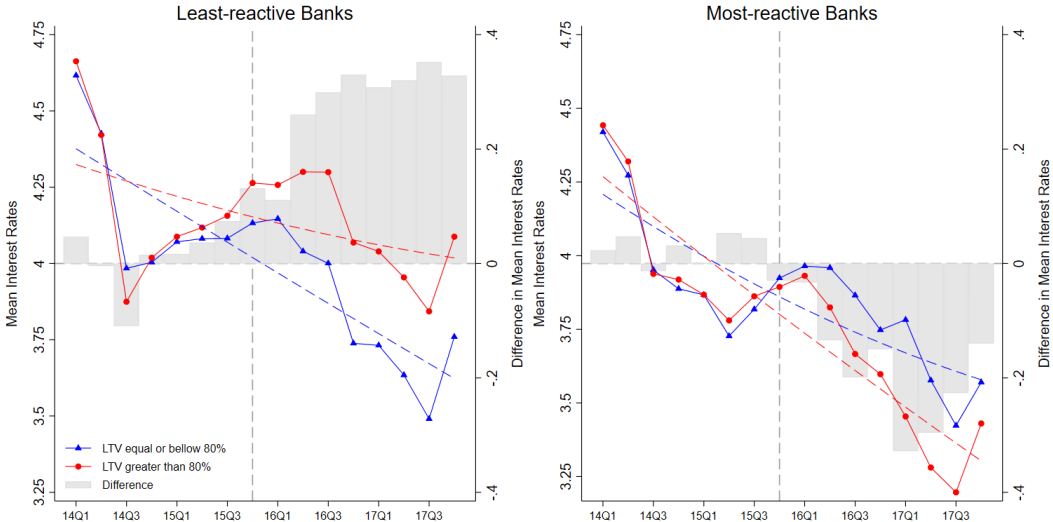
Average Interest Rates



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LLP Variables on PA

Z_{jt}:
$\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post
$\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post
$\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post
$\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post
V_{jt}:
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Pre
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Pre
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Log Risk Score $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post
Log Income $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Pre
Log Income $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post
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Estimation and Identification

- **Demand:**
  - Random sample of 20,000 borrowers
  - Prediction model for prices from unchosen products
  - Product choice estimation via Maximum Likelihood Product Choice Estimation
  - Loan Amount and default estimation via OLS OLS Estimation
  - Endogeneity in prices
    - Control function approach
    - IVs Stats

      → Cost shifters: expenses on mortgage LLP over mortgage debt and mortgage non-performing loans ratio. Bank-time level

      → A novel Hausman type IV: Average personal loans' interest rates in other markets. Bank-time-market level

- **Supply:**
  - Recover borrower-product marginal costs
  - Measure the possible effects of the LLP regulation on marginal costs

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Estimation of the Product Choice Model

- Let a borrower i chooses the product from a consideration set c that maximizes her utility
  - In this setting there are 2^{16} $(65,536)$ potential consideration sets

- The conditional probability that i picks j from c before the realization of the shock ϵ_{ijmt} is

$$P^{*}_{ijmt}(c) = \frac{exp(\beta r_{ijmt} + Y'_{ijmt}\varphi + \delta^{D}_{j})}{\sum_{j' \in c} exp(\beta r_{ij'mt} + Y'_{ij'mt}\varphi + \delta^{D}_{j'})}$$

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- Probability that borrower i considers product j (PA)

$$\phi_{ijmt} = \frac{exp(\pi_0 + \delta^{A}_{j} + Y'_{ijmt}\pi_1 + Z'_{jt}\pi_2 + V'_{ijmt}\pi_3)}{1 + exp(\pi_0 + \delta^{A}_{j} + Y'_{ijmt}\pi_1 + Z'_{jt}\pi_2 + V'_{ijmt}\pi_3)}$$

Estimation of the Product Choice Model

- The probability that borrower i considers choice set c in m and t is defined as

$$\omega_{icmt} = \prod_{j \in c} \phi_{ijmt} \prod_{j' \notin c} (1 - \phi_{ij'mt})$$

- The unconditional probability that borrower i chooses j is

$$P_{ijmt} = \sum_{c \in \mathbb{P}(j)} \omega_{icmt} P^*_{ijmt}(c)$$

  where $\mathbb{P}(j)$ is the set that includes all consideration sets that contain j

- To estimate the parameters, Θ, via ML, I use the log-likelihood function:

$$\mathcal{L}(\Theta) = \sum_i \sum_j \mathbb{1}_{ijmt} ln(P_{ijmt})$$

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OLS Estimation for the Loan Amount and Default

- For the loan amount:

$$log(q_{ijmt}) = \alpha_0^q + \alpha_1^q r_{ijmt} + Y_{ijmt}^{q'} \alpha_2^q + \lambda_{jmt(Post)}^q + v_{ijmt}^q,$$

where q_{ijmt} is the loan amount, Y_{ijmt}^q is a vector of borrower- product- market-period determinants of the loan amount, and $\lambda_{jmt(Post)}^q$ corresponds to product- market- time fixed effects

- Similarly, for the the default rate:

$$F_{ijmt} = \alpha_0^F + \alpha_1^F r_{ijmt} + Y_{ijmt}^{F'} \alpha_2^F + \lambda_{jmt(Post)}^F + v_{ijmt}^F,$$

where F_{ijmt} is a dummy that indicates default. The other variables are defined similarly to the previous regression

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IV Statistics

	Mean	SD	P1	P99
Panel E: Bank Level				
Personal Loans' Interest Rate in other Markets (%)	20.82	4.21	12.92	31.67
Expenses on Mortgage LLP over Mortgages (%)	0.30	0.28	-0.06	1.18
Mortgage Non-performing Loans Ratio (%)	0.76	0.39	0.15	1.48

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Demand Results

	Product Choice		Log Loan Amount	Default
	Utility	Attention		
Interest Rate	-1.254^{***}		-0.106^{***}	0.043^{**}
	(0.137)		(0.019)	(0.020)
Previous Relation with the Bank	1.984^{***}	0.774^{***}	-0.035^{***}	0.013^{**}
	(0.077)	(0.086)	(0.007)	(0.006)
Number of Branches	0.002	0.007^{**}	0.002^{***}	-0.000
	(0.003)	(0.003)	(0.000)	(0.000)
Controls			X	X
Product FEs	X			X
LTV Type-Bank Type-Post		X		
Log Risk Score-LTV Type-Bank Type-Period		X		
Log Income-LTV Type-Bank Type-Period		X		
Product-Year-Market FEs			X	X
Interest Rate Residual	X		X	X
R-Squared			0.523	0.085
Number of Observations	320,000	320,000	20,000	20,000

Note. Product choice standard errors are calculated by the inverse of the Information Matrix. Log Loan Amount and Default are robust standard errors. Significance levels 10%, 5%, and 1% are denoted by *, **, and ***, respectively.

First-stage Back

Demand Results: First-stage regressions

	Product Choice	Log Loan Amount and Default
Personal Loans' Interest Rate in other Markets	0.069***	0.067***
	(0.005)	(0.002)
Expenses on Mortgage LLP over Mortgages	0.198***	0.170***
	(0.010)	(0.015)
Mortgage Non-performing Loans Ratio	0.258***	0.196***
	(0.014)	(0.037)
Controls		X
Product FEs	X	
Product - Period - Market FEs		X
First-stage F stat	455.200	552.290
R-squared	0.173	0.427
Number of Observations	320,000	20,000

Note. Robusts standard errors are reported in parentheses. Significance levels 10%, 5%, and 1% are denoted by *, **, and ***, respectively.

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Demand Results: Product Choice Parameters

	Coefficient	Standard Errors
Utility		
Interest Rate	-1.254***	(0.137)
Previous Relation with the Bank	1.984***	(0.077)
Number of Branches	0.002	(0.003)
Attention		
Previous Relation with the Bank	0.774***	(0.086)
Number of Branches	0.007**	(0.003)
$\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post	1.783***	(0.662)
$\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post	0.972	(0.864)
$\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post	-0.049	(0.576)
$\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post	-0.067	(0.755)
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Pre	-0.340***	(0.106)
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post	-0.460***	(0.090)
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Pre	-0.159	(0.098)
Log Risk Score $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post	-0.394***	(0.101)
Log Risk Score $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Pre	-0.415***	(0.089)
Log Risk Score $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post	-0.550***	(0.081)
Log Risk Score $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Pre	-0.252***	(0.083)
Log Risk Score $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post	-0.475***	(0.114)
Log Income $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Pre	0.881***	(0.117)
Log Income $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post	0.649***	(0.104)
Log Income $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Pre	1.697***	(0.174)
Log Income $\times$ $\mathbb{1}$[Least-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post	1.552***	(0.205)
Log Income $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Pre	0.419***	(0.101)
Log Income $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $\leq$ 80] $\times$ Post	0.714***	(0.098)
Log Income $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Pre	1.608***	(0.137)
Log Income $\times$ $\mathbb{1}$[Most-reactive bank] $\times$ $\mathbb{1}$[LTV $>$ 80] $\times$ Post	1.115***	(0.115)
Constant	-5.716***	(0.601)
Number of Observations	320,000	

Note. Estimation includes product FEs on the utility and attention sides, as well as the interest rate residual, which is located on the utility side. Significance levels 10%, 5%, and 1% are denoted by *, **, and ***, respectively.

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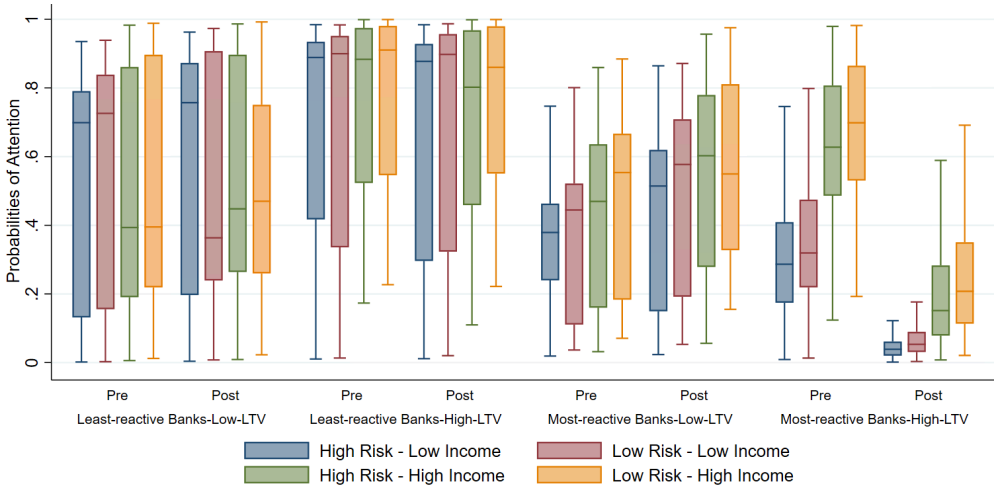
Probabilities of Attention by Income and Risk



Note. Weighted values are used, where the weights are the product choice probabilities from the baseline scenario. “High Risk” (“Low Risk”) refers to borrowers in the upper (lower) half of the credit score distribution in a given quarter; “High Income” (“Low Income”) categorizes borrowers in the upper (lower) half of the income distribution, in a given quarter. The box designates the interquartile range (IQR), and the whiskers represent the most extreme observations still within 1.5×IQR of the upper / lower quartiles.

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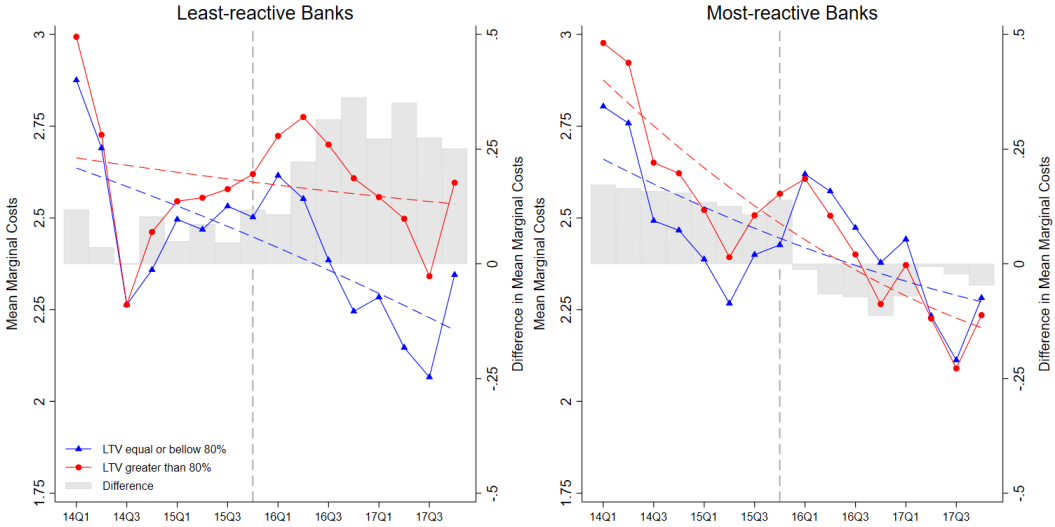
Marginal Costs



Note. Weighted averages are used, where the weights are the product choice probabilities from the baseline scenario.

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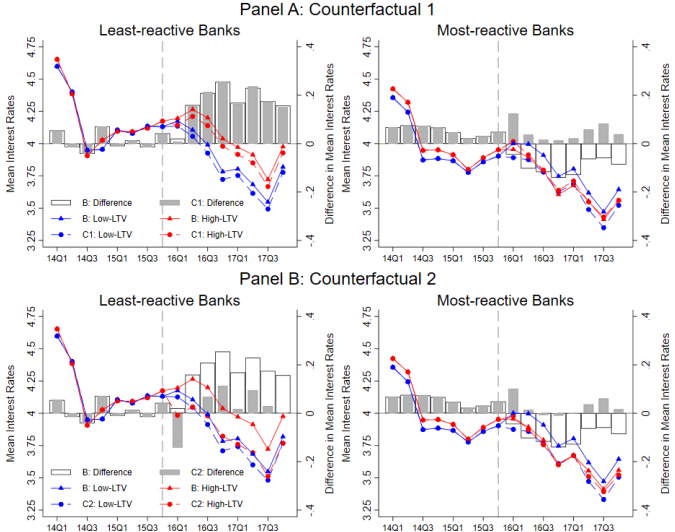
Counterfactuals



Note. Weighted averages are used, where the weights are the product choice probabilities from the baseline and counterfactual scenarios.

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