Real Effects of Search Frictions in Consumer Credit Markets

Bronson Argyle
BYU

Taylor Nadauld
BYU

Christopher Palmer
MIT and NBER

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Credit-Market Imperfections

- How are credit markets special?
- Key household finance question: what credit-market imperfections prevent optimal consumption?
  - Zeldes (1989), Gross & Souleles (2002) – Borrowing constraints
  - Adams, Einav, Levin (2009) – Adverse selection and moral hazard
  - Scharfstein & Sunderam (2017) – Credit market concentration
- This paper: use auto-loan setting to document importance of search frictions in consumer finance

Relevance of costly search in credit markets

- SCF: Many people report doing "almost no searching" for loan.
- Bhutta et al. (2018): 96% of mortgagors think they got the best rate.
- Adams et al. (2019): UK depositors overestimate shopping time
- Our data: Average borrower 15 min drive from branch
  - contrast with U.S. average commute time 26 min

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- Frictions in credit markets affect durable consumption
- Importance of physical distance surprising in digital world,
- especially salient in an era of declining bank branches.

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2. Explain borrowers' propensity to shop around for a loan
3. Limit both extensive and intensive margin of borrowing
4. Distort intensive margin of consumption $\Rightarrow$ DWL

Welfare Consequences of Search Frictions

- Usual sequential search model: inelastic unit demand for a homogenous final good
- Firm j charges

$$p_j = MC + markup_j$$

- Given search cost distribution, markup distribution adjusts
- For each consumer having drawn price p

$$E(p_j) - p \leq k$$

- In equilibrium, buyers stay with first seller
- Costly search consequence: transfer from buyer to seller

Reality: Elastic Demand, Complements

Reality: DWL has two components.

1. If demand is elastic, $Q^{search} < Q^*$
   - $\rightarrow$ Could result in fewer and/or smaller transactions
2. For complements/intermediate goods, distorts final good consumption

$$Q_2(p_1^{search}, p_2) < Q_2(p_1^*, p_2)$$

   - $\rightarrow$ Credit market specialness

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search frictions $\Rightarrow$ credit markups $\Rightarrow$ smaller loans $\Rightarrow$ older, cheaper cars

Outline

1. **Auto loans setting and data**
2. Search model with elastic demand
3. Measuring interest rate dispersion
4. Discontinuous pricing policies
5. Direct evidence on search costs and search behavior
6. Consequences of search frictions on loans and consumption

Auto loans are ubiquitous, important

- $1.3 trillion outstanding (NY Fed, 2019)
- 3rd largest consumer debt category, more than credit cards
- 114m outstanding loans $\approx$ 0.9 per U.S. household
- 85% of car purchases are financed (Consumer Reports, 2013)
- Vehicles 50%+ of low-wealth HHs total assets (Campbell, 2006)

Data Source

- Data from a private software services company
- 2.4 million auto loans from 326 lending institutions in 50 states
- Majority originated by credit unions
- 70% of sample was originated between 2012 and 2015
- 1.3 million loan applications originating from 41 institutions
- Exclude indirect loans and refinances
- ▸ Representativeness

Variables

- Ex-ante borrower variables: FICO, DTI, gender, age, $\widehat{\text{ethnicity}}$
- Ex-ante loan variables: Interest rate, LTV, channel
- Collateral variables: make, model, year, purchase price
- Ex-post loan performance: delinquency, charge-off, ΔFICO

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Equilibrium Price Dispersion

- Price dispersion: same good sold for different prices
- Null hypothesis: Law of One Price holds
- Classic explanation: information/search frictions

- Theory: P.D. sustainable when some consumers only know one price
  - **I.** Stigler (1961), Diamond (1971), Rothschild (1973), Reinganum (1979)
  - **II.** Salop and Stiglitz (1982), Burdett and Judd (1983), Stahl (1989)

- Empirical challenge: ruling out product heterogeneity

Extensive empirical literature on price dispersion and search

- Prescription drugs: Sorensen (2000)
- Mortgages: Woodward & Hall (2012), Alexandrov & Koulayev (2017)
- Credit cards: Stango and Zinman (2016)
- Mutual funds: Hortacsu and Syverson (2004)
- Cars: Goldberg and Verboven (2001)
- Online shopping: De Los Santos, Hortacsu, Wildenbeest (2012), Ellison & Ellison (2009)
- Airfares, houses, auto insurance, electronics, books, fish...

→ Open Questions:

- All of these assume inelastic demand! How this matter?
- How are search frictions in *credit* markets special?
- Are the welfare consequences of credit-market search frictions?

Search Model with Elastic Demand

- Adapt Reinganum (1979) to credit market with elastic demand for loans and durables
- Demonstrate equilibrium price dispersion
- Characterize DWL (obscured by models with inelastic demand)
- Develop several comparative statics and testable predictions
- Results apply more broadly to the demand for any two complements.

Borrowers

- Continuum of borrowers ex-ante identical with quasi-linear indirect utility

$$U(r, p, W) = V(r, p) + W$$

  $V(\cdot, \cdot)$ indirect utility of facing prices r and p for loans and durables

- Assume that demand for loans and durables downward sloping
  $\Rightarrow$ $V(\cdot, \cdot)$ is strictly decreasing in both its arguments.

- Do not implicitly assume cross-price elasticities to be zero!
  - e.g., car loans and car services are strong complements.

Borrower Search

- Borrowers believe $r \sim F$ on $[\underline{r}, \bar{r}]$ but don't know price locations
- Pay search cost k for each interest-rate quote
- When current quote is r', expected utility gain from search is

$$\int_{\underline{r}}^{r'} [V(r,p) - V(r',p)]dF(r) - k$$

- Optimal search: reservation price $m(k)$ (De Groot, 1970; Lippman and McCall, 1976)
- Impt to use $V(\cdot,\cdot)$ instead of just markups r
  - Incorporates elastic demand + complements
  - Markups lead to smaller loans and less durable consumption

Lenders

- Lenders $j \in J$ have marginal costs $c_j \sim G$ on $[\underline{c}, \overline{c}]$ to lend \$1
- Lenders are perfectly informed of k and $F(\cdot)$
- Choose an interest rate r_j to max expected profits

$$E\pi_j = \begin{cases} (r_j - c_j)q(r_j, p)E(N_j) & \text{for } r_j \leq m(k) \\ 0 & \text{for } r_j > m(k) \end{cases}$$

- N_j is the number of borrowers that each take out $q(r_j)$

Equilibrium

- Pure-strategy Nash Equilibrium with price dispersion
- Given demand elasticity η_r, lender FOC satisfied when

$$r_j = \frac{c_j \eta_r}{\eta_r + 1}$$

- Borrower indifference over further search

$$\int_{\underline{r}}^{m(k)} [V(r,p) - V(m(k),p)] dF_{m(k)}(r) = k$$

$\Rightarrow$ $m(k)$ depends also in how interest rates paid affect the utility received from the corresponding loan sizes *and* durable consumption through $V(\cdot,\cdot)$.

$$F_{m(k)}(r) = \begin{cases} G[r(1+\eta_r)/\eta_r] & \text{for } \underline{r} \leq r < m(k) \\ 1 & \text{for } r = m(k) \end{cases}$$

- For given k, $\left\{ m(k), F_{m(k)}(\cdot) \right\}$ constitute an equilibrium

Welfare

Deadweight loss has three components:

1. Lenders monopoly power $\Rightarrow$ lenders other than the lowest-cost lender survive
2. Each lender marks up cost c_j to charge monopoly prices
3. Elastic demand $\Rightarrow$ borrower demand less loans + goods

$$DWL = \int_{\underline{c}}^{\overline{c}} \int_{q(r^*(c),p)}^{q(\underline{c},p)} (r(q) - \underline{c})\, dq dG(c) + \int_{\underline{c}}^{\overline{c}} \int_{0}^{q(r^*(c),p)} (c - \underline{c})\, dq dG(c)$$

- $r(q)$ is inverse demand
- $q^m(c,p)$ is the quantity lent by a monopolistic lender with constant marginal cost c
- $q^*(\underline{c},p)$ is the perfect-competition q

n.b., under inelastic demand, $q^m = q^* \Rightarrow DWL = 0$!

Model Implications and Testable Predictions

1. Price dispersion and loan markups increasing in search costs
2. Loan sizes decreasing in search costs
3. Durables consumption decreasing in search costs
4. Welfare loss increasing in search costs and the elasticity of demand
5. Market shares invariant to markups when search costs are high

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Detecting Price Dispersion

- We put each borrower i into a cell ℓ matched by
  - Origination time (two-quarter window)
  - Loan maturity (in years)
  - FICO Score (5-point bins)
  - Car value (in $1,000 bins)
  - Debt-To-Income (10-point bins)
  - Commuting Zone
- Calculate the Difference from Lowest Available Rate

$$DLAR_{i\ell} \equiv r_i - \min_{j \in \ell} r_j$$

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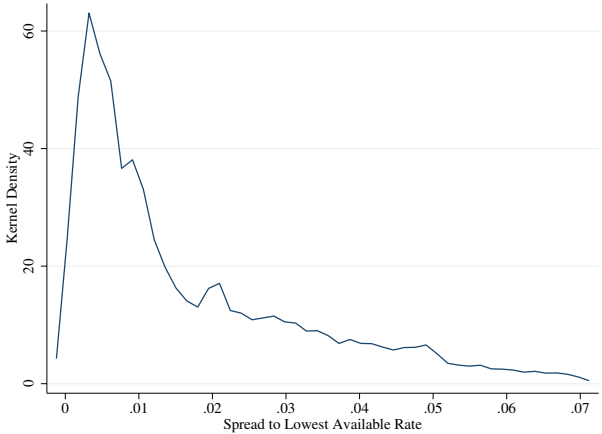
- Lower bound given data coverage (but multiple providers still big leap over existing lit)

Estimated Price Dispersion



- Mean: 234 bp, Median: 125 bp, 46% of borrowers get best rate
- Average markup 27 bp higher in high search-cost markets

Potential Reasons for Observed Price Dispersion

1. Costly price discovery
2. Measurement Error
3. Unobserved heterogeneity

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3. Unobserved heterogeneity

- Strategy: test for #1 in a setting where we can rule out #2 and #3
- Exploit quasi-experimental variation in *benefits* to search
- Measure search behavior and link to measures of search costs
- Estimate consequences of costly search by comparing people with high return to search in high vs. low search cost areas

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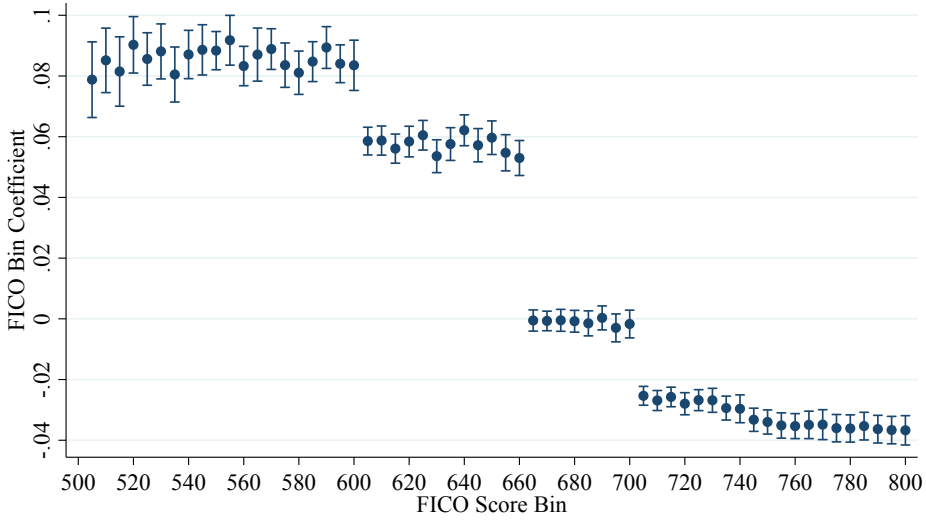
Example Credit Union with three discontinuities



Detecting Discontinuities

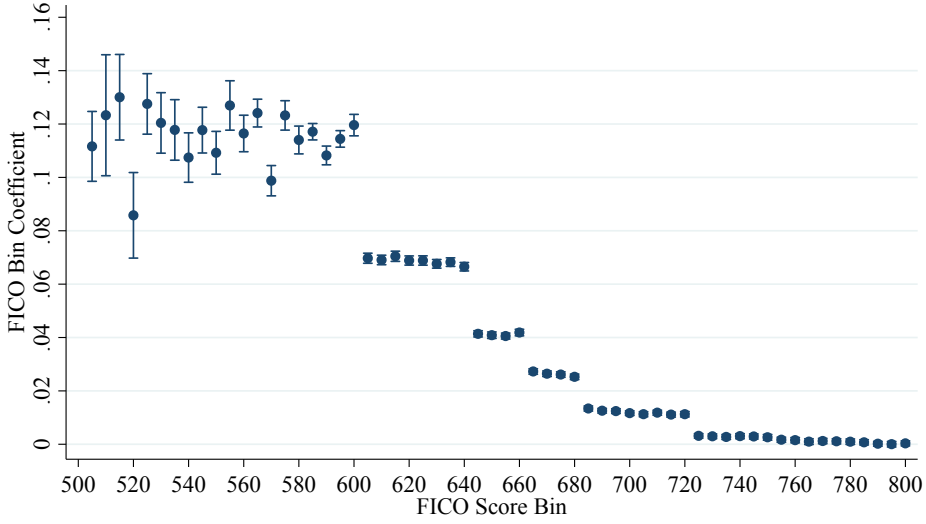
- Regress loan interest rates onto a series of dummies representing 5-point FICO bins, for a given institution c:

$$r_{il} = \alpha + \sum_b \delta_{bl} 1(FICO_i \in Bin_b) + \varepsilon_{il}$$

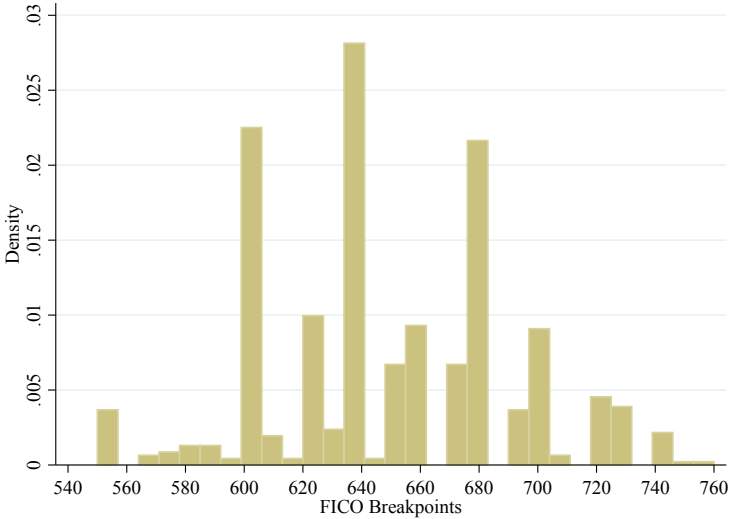
- Define a discontinuity as a FICO score cutoff with
  - a 50 bps difference in adjacent coefficients (economically significant)
  - p-value of difference less than .001 (statistically significant)
  - p-values between the leading and following bins $>.1$ (not just noise)

▸ whence

Example Credit Union with five discontinuities



Wide heterogeneity across institutions in policies



Empirical Strategy

- Regression Discontinuity around detected lending thresholds $\mathcal{D}$
- Form discontinuity sample using loans ± 19 FICO-point window around the threshold
- Normalize FICO scores to each cutoff and estimate

$$r_{iglt} = \sum_{d \in \mathcal{D}} 1(FICO_{il} \in \mathcal{D}_d) \left(\delta \cdot 1(\widetilde{FICO}_{id} \geq 0) + f(\widetilde{FICO}_{id}; \pi) + \psi_{dl} \right) + \alpha_g + \delta_t + \varepsilon_{iglt}$$

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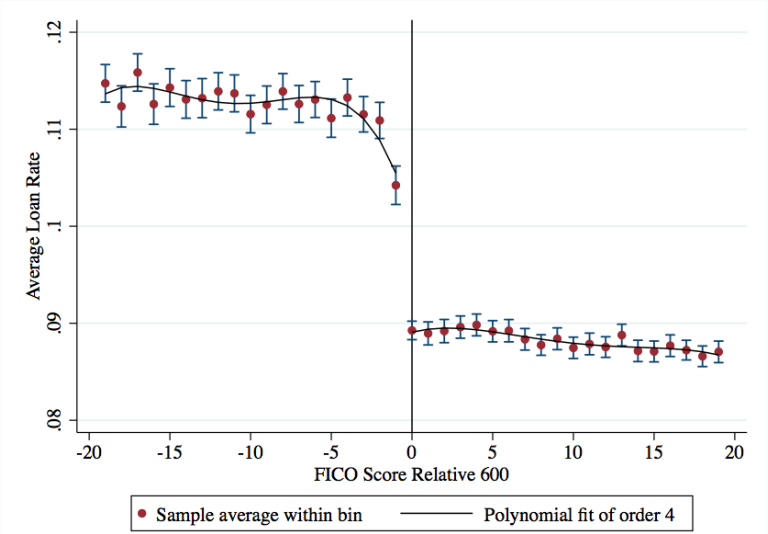
- Quadratic RD function of running variable

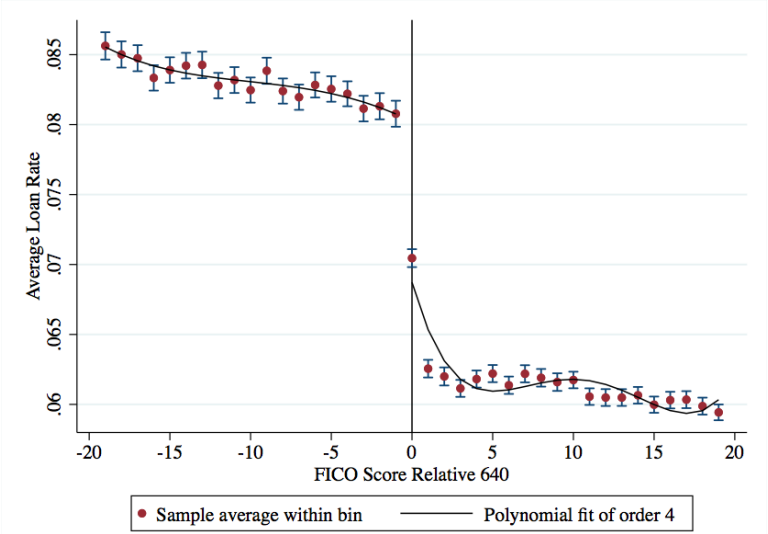
$$f(\widetilde{FICO}; \pi) = \pi_1 \widetilde{FICO} + \pi_2 \widetilde{FICO}^2 + 1(\widetilde{FICO} \geq 0) \left(\pi_3 \widetilde{FICO} + \pi_4 \widetilde{FICO}^2 \right)$$

- Uniform kernel: $1(FICO_{il} \in \mathcal{D}_d)$ indicates loan i within 20 points of discontinuity d at lender l
- Discontinuity $\times$ lender, Commuting Zone, and quarter fixed effects

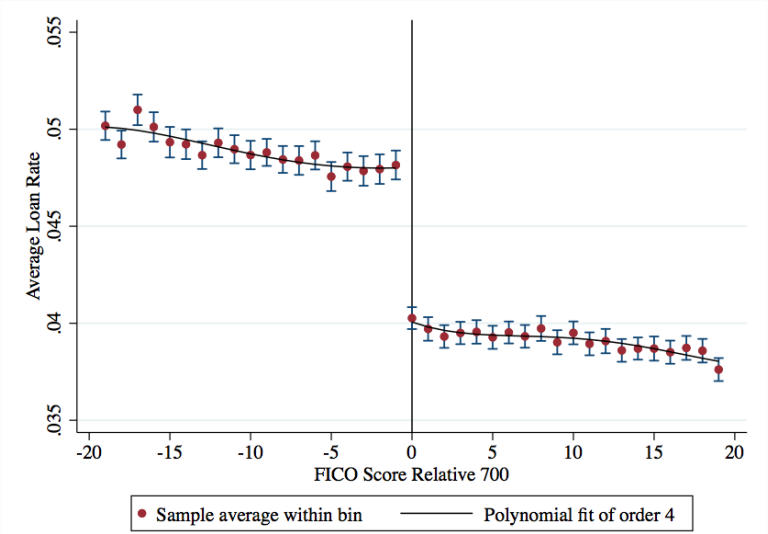
First stage for FICO = 600 cutoff



First stage for FICO = 640 cutoff



First stage for FICO = 700 cutoff

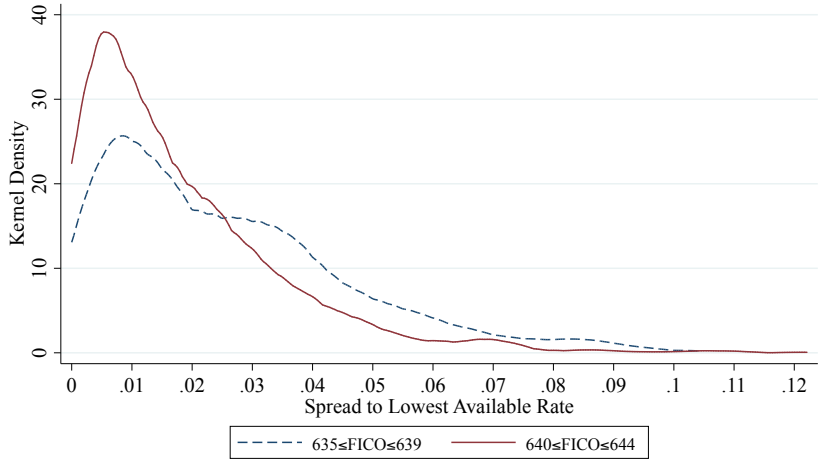


First stage: 130 bp difference in r

	(1) Loan Rate	(2) Loan Term
Discontinuity	-0.0127***	0.822***
Coefficient	(0.004)	(0.187)
Discontinuity x Lender FEs	✓	✓
Lender FEs	✓	✓
Quarter FE	✓	✓
N	514,834	514,834
R^2	0.169	0.083

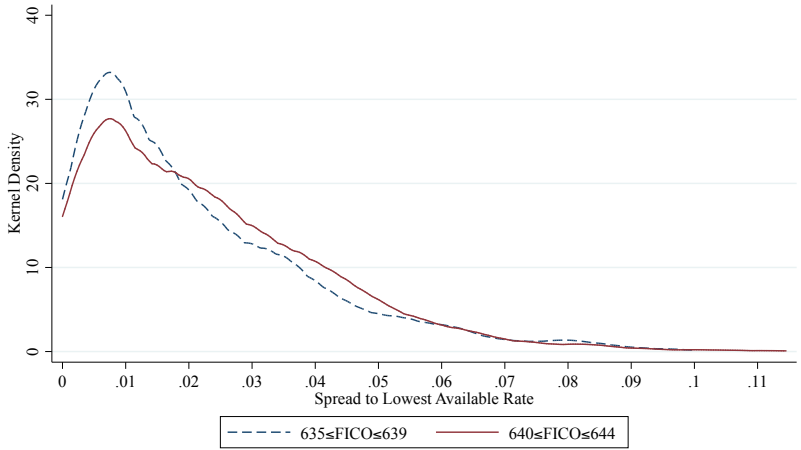
- -127 bp on average car loan is ΔPMT of \$13 and ΔPV of 440
- ▸ Heterogeneity by FICO

Discontinuities provide variation in benefits of searching

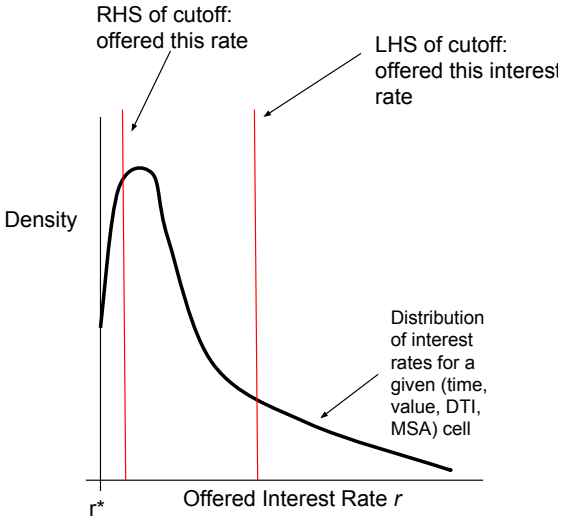


Difference in means: 70 bps

Placebo test: no difference w/o discontinuity



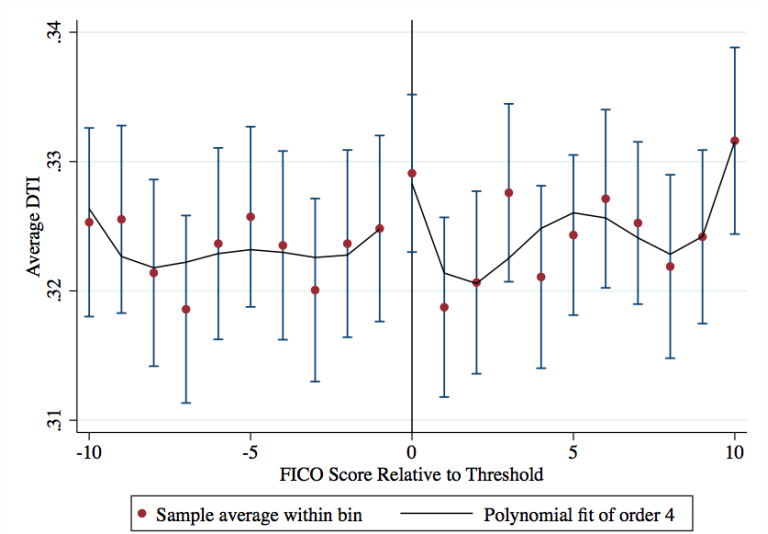
LHS borrowers face high returns to search across lenders



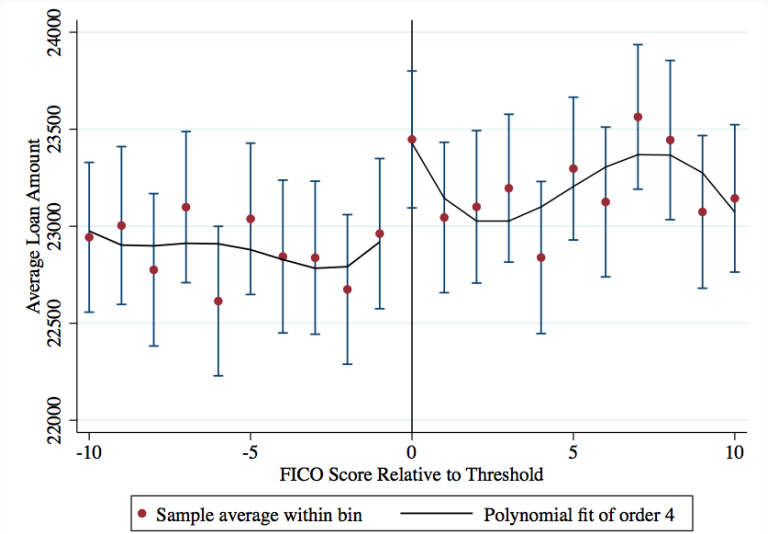
Is there selection around interest-rate discontinuities?

- Are LHS and RHS borrowers different along any observable dimension?
  - e.g., (un)awareness of pricing policies correlated with quality
- Rule out selection via smoothness of observables at discontinuity:
  - ✓ Application loan size
  - ✓ Application Debt-to-Income
  - ✓ Borrower age
  - ✓ Borrower gender
  - ✓ Borrower ethnicity

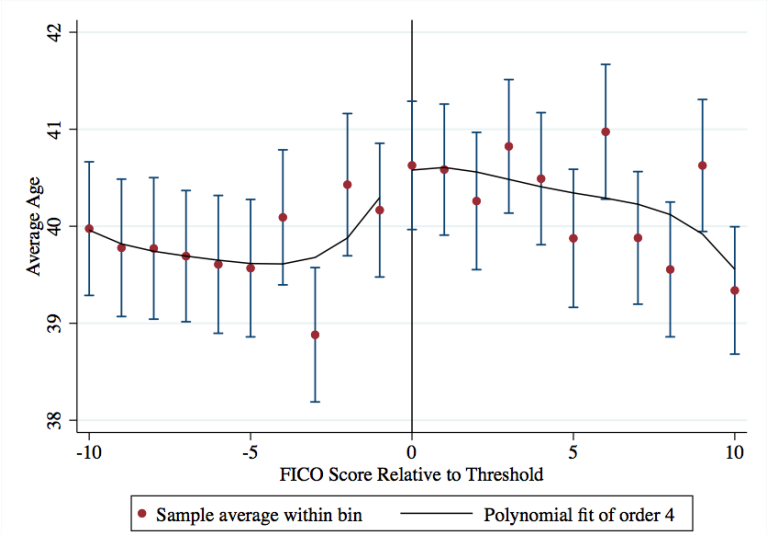
Balance checks: Application Debt-to-Income Ratio



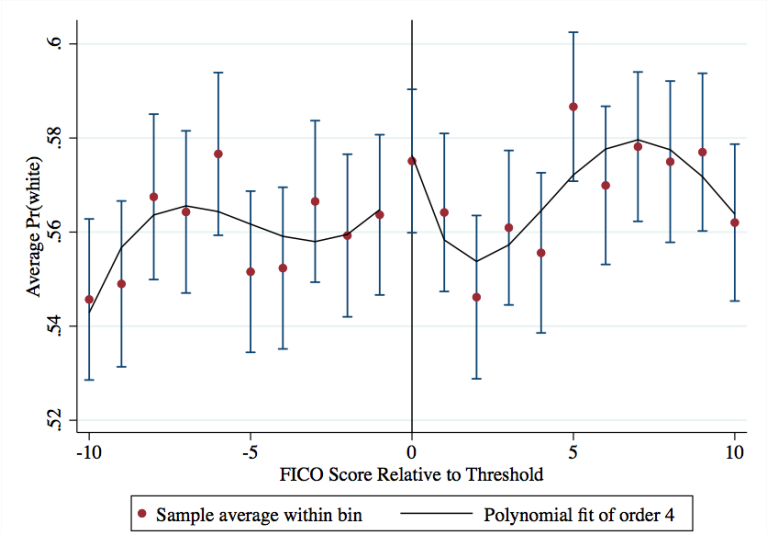
Balance checks: Application Loan Amount



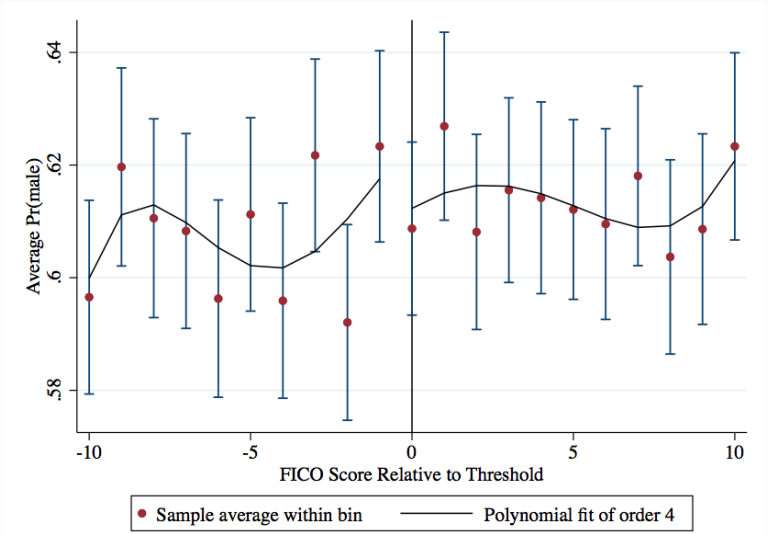
Balance checks: Applicant Age



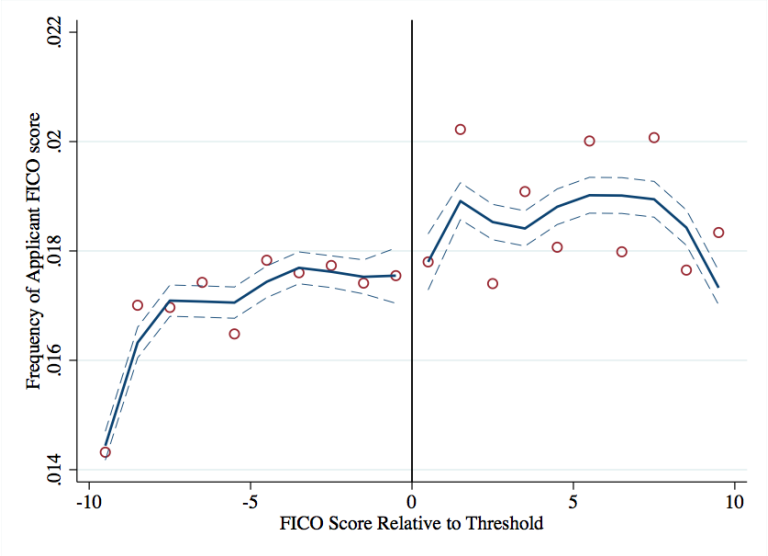
Balance checks: Applicant Ethnicity



Balance checks: Applicant Gender



No bunching in running variable: Application Counts



Ex-ante Smoothness

	(1) Application Loan Amount	(2) Application Debt-to-Income	(3) Number of Loan Applications
Discontinuity	128.43	-0.084	-270.18
Coefficient	(187.75)	(0.447)	(760.48)
Discon. × Lender FE	✓	✓	✓
Institution FE	✓	✓	✓
Quarter FE	✓	✓	✓
N	117,985	91,923	39
R^2	0.058	0.009	0.466

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Why don't borrowers on LHS find better available rates?

- Dimensions of search costs
  - Temporal specificity (given car/price may expire)
  - Cost of attention to stressful/overwhelming financial paperwork
  - Concerned with impact of FICO pulls (Liberman et al., 2017)
  - Beliefs about price dispersion or time to search
- Our focus: physical search plays important role
  - Average commute: 26 min, average borrower: 15 min drive to lender
- Why would physical distance matter?
  - Paperwork, brand awareness, individual-level pricing, tight timing
  - Can matter in lending (Degryse and Ongena, 2005 and Nguyen, 2016)

Bringing costly search to the data

To ask whether costly search inhibits price discovery, we need

1. A measure of borrower search

2. Variation in search costs

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   - Total number of applications per borrower
   - Accepting/Rejecting approved loans from application data
   - Takeup $\equiv$ 1(Offered loan is accepted)
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   - Takeup $\equiv 1$(Offered loan is accepted)
2. Variation in search costs
   - Geocode FDIC+NCUA branch data to calculate driving times
   - For each borrower: # of institutions within a 20-minute drive
   - High search costs $\equiv 1(\leq 10$ lenders within 20 minute drive)

Direct measure of search varies with search costs

	High Search Costs (1)	Low Search Costs (2)	Difference (1) - (2)
Mean	1.342	1.409	-0.067***
S.D.	(0.009)	(0.004)	(0.011)
N	6,042	44,655	

- Data coverage makes this a lower bound
- * n.b., in Stahl equilibrium, all shoppers buy from first seller they query.

Indirect measure of search varies with search costs

$$takeup_{iglt} = \sum_{d \in \mathcal{D}} 1(FICO_{il} \in \mathcal{D}_d) \left(\delta \cdot 1(\widetilde{FICO}_{id} \geq 0) + f(\widetilde{FICO}_{id}; \pi) + \psi_{dl} \right) + \alpha_g + \delta_t + \varepsilon_{iglt}$$

- Estimate for high/low search cost areas
- Investigate if markups more consequential in low search-cost areas
- Verify markups comparable across high/low search-cost areas
- Check robustness to possible endogeneity of search-cost measure

Indirect measure of search varies with search costs

Search Costs	Full	High	Low	Difference
	(1)	(2)	(3)	(2) - (3)
	Dependent Variable = 1(Loan Offer Accepted)			
Discontinuity	0.121***	0.020***	0.137***	-0.116***
Coefficient	(0.015)	(0.005)	(0.016)	(0.006)
Discon. × Lender FE	✓	✓	✓	
Quarter FE	✓	✓	✓	
Commuting Zone FE	✓	✓	✓	
N	30,743	4,436	26,307	
R^2	0.27	0.45	0.25	

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→ Low–search-cost borrowers relatively less likely to accept markups

- Robust to varying definition of high search cost area ▸ Results

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1. Auto loans setting and data
2. Search model with elastic demand
3. Measuring interest rate dispersion
4. Discontinuous pricing policies
5. Direct evidence on search costs and search behavior
6. **Consequences of search frictions on loans and consumption**

Selection into take-up?

- Want to show real effects of costly search *given* take-up
- But *accepting* a dominated loan offer is an endogenous choice...
- Check for selection: Do LHS borrowers have worse ex-post outcomes?
  - ✓ # days delinquent
  - ✓ default (90+ days past due)
  - ✓ charge-off (was loan written off by lender)
  - ✓ ΔFICO score since origination

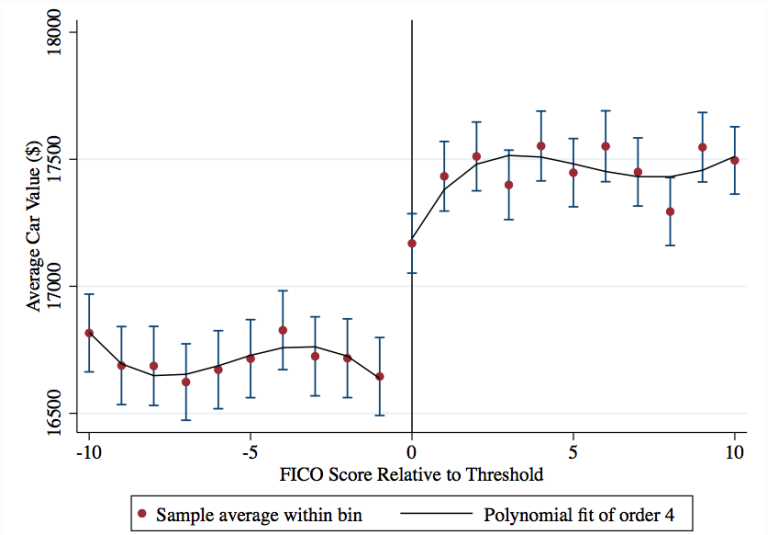
Validating conditional on take-up results

	(1) Days Delinq.	(2) Charge-off	(3) Default	(4) ΔFICO
Discontinuity	4.185	0.004	0.002	0.001
Coefficient	(3.101)	(0.003)	(0.003)	(0.003)
Discon. × Lender FE	✓	✓	✓	✓
Commuting Zone FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
N	331,590	514,834	514,834	405,236
R^2	0.162	0.073	0.091	0.015

Real Effects: Loan Choice Impacts Real Consumption

	(1) Price	(2) Loan Amount	(3) LTV	(4) Payment
Discontinuity	376.58**	566.21***	0.0130**	0.17
Coefficient	(175.72)	(167.93)	(0.005)	(1.02)
Discon. × Lender FE	✓	✓	✓	✓
Commuting Zone FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
N	514,834	514,834	514,834	514,834
R^2	0.052	0.059	0.029	0.056

Second stage plot: Purchase prices



Evidence on Substitution Patterns

Mileage

	(1) Car Value	(2) Car Value	(3) Car Age
Discontinuity	344.69***	79.71	-1.76***
Coefficient	(123.78)	(49.25)	(0.043)
Discon. × Lender FE	✓	✓	✓
Commuting Zone FE	✓	✓	✓
Quarter FE	✓	✓	✓
Make-Model FE	✓		✓
Year-Make-Model FE		✓	
N	468,800	468,800	468,800
R^2	0.353	0.767	0.352

- Costly search ⇒ market power ⇒ each lender faces downward sloping demand ⇒ consumption response to price dispersion ⇒ DWL: fewer and lower quality goods

Addressing endogeneity of search-cost measure

- Number of proximate financial institutions possibly correlated with
  1. time-varying differences (local economic shocks, etc.) and/or
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  2. time-invariant differences (financial sophistication, etc.)
- Address (1) with Bartik instrument using 1990 branch network ▸ Results
- Address (2) with
  - **(a)** zip8 FEs and
  - **(b)** diff-in-diffs around branch closings ▸ Results

Ruling out alternative explanations

1. Selection into takeup
2. Exclusivity of credit unions
3. Measurement error in interest rates
4. Digital search
5. Risk-based pricing on other dimensions
6. Lender price discrimination
7. Steering by car dealers to lenders

Conclusion

- Auto loans market full of price dispersion, search frictions
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- Auto loans market full of price dispersion, search frictions
- Used rich data to isolate exogenous variation in the benefits of search
- Provided direct evidence that search costs influence search behavior
- Transmission of interest rates to durables inhibited by search frictions
- Search costs $\Rightarrow$ finance less, buy older, \$400 less car
- In the real world, elastic demand + costly search $\Rightarrow$ DWL
- Costly-search fueled markups affect consumer welfare through both extensive and intensive margins

search frictions $\Rightarrow$ credit markups $\Rightarrow$ smaller loans $\Rightarrow$ lower consumption

Representativeness

- Top 5 states by number of loans:
  - Washington (770,334 loans)
  - California (476,791 loans)
  - Texas (420,090 loans)
  - Florida (314,718 loans)
  - Utah (292,523 loans)
- Our data are less diverse (73% estimated to be white vs. 64.5% in census data).
- Median FICO at origination is 711 (vs. 695 for US borrowers)
- Back

Aside: why would lenders price this way?

- Hard coded from pre-Big Data era (Hutto & Lederman, 2003)
- Persistence of rate-sheet pricing
- Particular processing cost structure (Bubb & Kauffman 2014; Livshitz et al. 2016)
- Worry about overfitting (Al-Najjar and Pai 2014; Rajan et al. 2015)

* n.b., costly search makes it hard to gain market share by undercutting

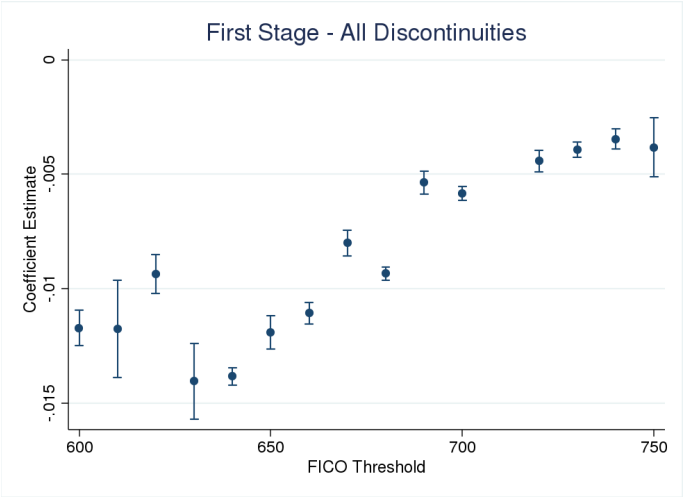
Example rate sheet

Unitus COMMUNITY CREDIT UNION

Consumer Loan Rate Sheet
Effective March 1, 2017

New Auto Loans: Model Years 2015 and Newer													
Repayment Period	**Minimum Loan Amount**	**Credit Score 740 +**		**Credit Score 739 to 700**		**Credit Score 699 to 660**		**Credit Score 659 to 610**		**Credit Score 609 to 560**		**Credit Score 559 or below**	
		APR^	**DPR**	**APR^**	**DPR**	**APR^**	**DPR**	**APR^**	**DPR**	**APR^**	**DPR**	**APR^**	**DPR**
Up to 36 Months[1]	$500	**2.24%**	0.0061%	**2.74%**	0.0075%	**3.99%**	0.0075%	**8.24%**	0.0226%	**13.49%**	0.0370%	**14.49%**	0.0397%
37 - 60 Months	$5,000	**2.74%**	0.0075%	**3.24%**	0.0089%	**4.49%**	0.0116%	**8.74%**	0.0239%	**13.99%**	0.0383%	**14.99%**	0.0411%
61 - 66 Months	$6,000	**2.99%**	0.0082%	**3.49%**	0.0096%	**4.74%**	0.0116%	**8.99%**	0.0246%	**14.24%**	0.0390%	**15.24%**	0.0418%
67 - 75 Months	$10,000	**3.24%**	0.0089%	**3.74%**	0.0102%	**4.99%**	0.0130%	**9.24%**	0.0253%	**14.49%**	0.0397%	**15.49%**	0.0424%
76 - 84 Months[2]	$15,000	**3.49%**	0.0096%	**3.99%**	0.0109%	**5.24%**	0.0158%	**9.49%**	0.0260%	**N/A**		**N/A**	
2015 and newer hybrid vehicles qualify for an additional 0.25% rate reduction.													
We may finance up to 100% Retail NADA or KBB unless the vehicle has over 100,000 miles in which case we may lend up to 100% of NADA or KBB for Tier 1 borrowers and up to 80% of NADA or KBB for Tier 2-6 borrowers. Maximum term for vehicles with over 100,000 miles is 66 months.													

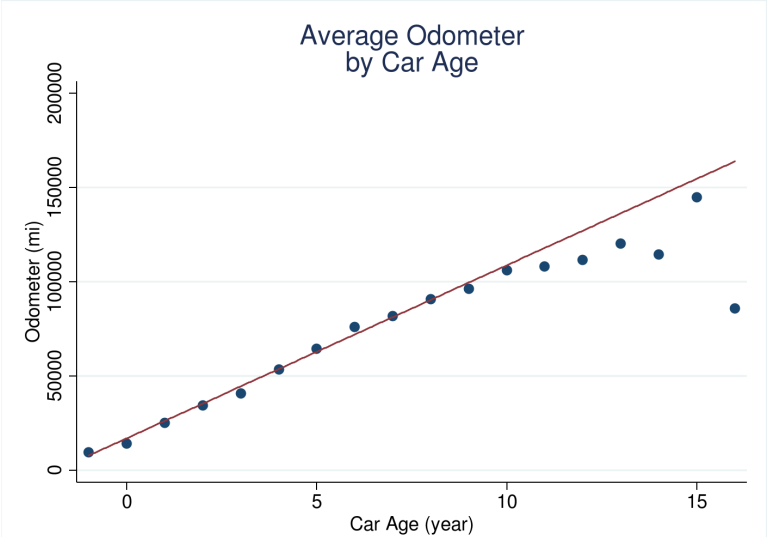
Pricing Discontinuities Largest for low FICOs



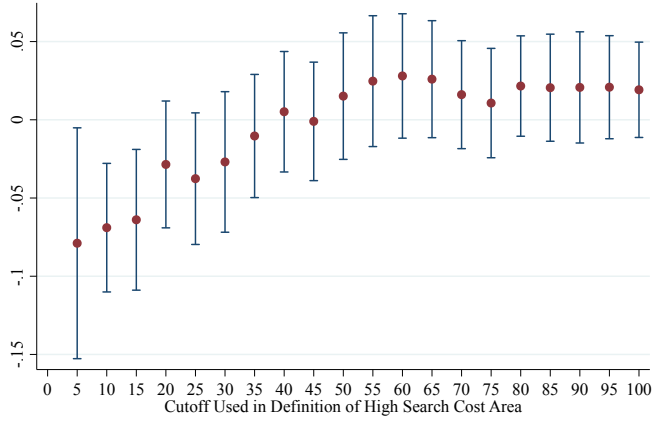
Back

Older cars generally have higher mileage

Back



Robustness to varying definition of high search cost



Time-varying endogeneity of search costs

- Easy to think of time-varying joint endogeneity between takeup and search costs, e.g. endogenous branch closings
- Abstract away from *time-varying* endogeneity of search costs with shift-shares instrument for number of proximate financial institutions
- Use NETS, FDIC, and NCUA data

$$\#PFIs_{ct}^{Bartik} = \#PFIs_{c,1990} \times \frac{\overline{\#PFIs}_{-c,t}}{\overline{\#PFIs}_{-c,1990}}$$

- Define High Search Costs if $\#PFIs_{ct}^{Bartik} \leq 10$

Results with Bartik Instrument

$$takeup_{ict} = \eta_{cz(i)} + \delta_t + \gamma \cdot \widetilde{FICO}_{ict} + \delta \cdot 1(\widetilde{FICO}_{ict} \geq 0) + \beta \cdot \widetilde{FICO}_{ict} \cdot 1(\widetilde{FICO}_{ict} \geq 0) + \varepsilon_{ict}$$

$Takeup_{ict}$= 1(Loan Offer Accepted)			
Bartik Search Costs	High	Low	Diff
	(1)	(2)	(1)-(2)
Discontinuity Coefficient	0.050	0.135***	-0.085***
	(0.045)	(0.037)	(0.006)
Discontinuity×Lender FE	✓	✓	
CZ×Quarter FE	✓	✓	
N	5,591	25,152	

Back

Time-invariant endogeneity

- Remaining problem is whether branch proximity is correlated with other things *that determine effect of discontinuity*
- Time-invariant characteristics may determine branch network and takeup, e.g., financial sophistication
- Usual problem with Bartik instruments: possibility of endogenous initial conditions
- Looking within CZ may not be enough—CZs large

Addressing time-invariant endogeneity

- Two solutions given Bartik robustness:

1. Zip8 fixed effects in RD, identify off how RD differs for places that changed their

$$takeup_{igt} = \eta_g + \delta_t + \gamma \cdot \widetilde{FICO}_{ict} + \delta \cdot 1(\widetilde{FICO}_{ict} \geq 0) + \beta \cdot \widetilde{FICO}_{ict} \cdot 1(\widetilde{FICO}_{ict} \geq 0) + \varepsilon_{ict}$$

Addressing time-invariant endogeneity

- Two solutions given Bartik robustness:

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2. Difference-in-differences design that focuses on *changes* to search cost status

$$takeup_{igt} = \eta_g + \delta_t + \gamma High\ Search\ Cost_{gt} + \beta FICO_{igt} + \varepsilon_{igt}$$

$$\Delta takeup_{gt} = \eta_{cz(g)} + \delta_{t,\Delta t} + \gamma \Delta High\ Search\ Cost_{gt} + \beta \Delta FICO_{gt} + \varepsilon_{gt}$$

Zip8 FEs in RD Design

$$takeup_{igt} = \eta_g + \delta_t + \gamma \cdot \widetilde{FICO}_{ict} + \delta \cdot 1(\widetilde{FICO}_{ict} \geq 0) + \beta \cdot \widetilde{FICO}_{ict} \cdot 1(\widetilde{FICO}_{ict} \geq 0) + \varepsilon_{ict}$$

Search Costs Sample	High	Low	Difference
Discontinuity Coefficient	0.066	0.190***	-0.125
	(0.057)	(0.035)	(0.009)
8-digit Zip-code FE	✓	✓	
Quarter FE	✓	✓	
Number of Observations	4,436	26,307	

Takeup difference-in-differences

$$takeup_{igt} = \eta_g + \delta_t + \gamma High\ Search\ Cost_{gt} + \beta FICO_{igt} + \varepsilon_{igt}$$

$$\Delta takeup_{gt} = \eta_{cz(g)} + \delta_{t,\Delta t} + \gamma \Delta High\ Search\ Cost_{gt} + \beta \Delta FICO_{gt} + \varepsilon_{gt}$$

	Levels	Differences
High Search Cost Area	0.11**	0.03*
	(0.04)	(0.017)
FICO	-0.00004	-0.0002***
	(0.0003)	(0.00003)
Geographic Fixed Effects	Zip9	CZ
Time Fixed Effects	Quarter	Quarter Pair
Number of Observations	608	29,321
R-squared	0.60	0.05

Robust standard errors clustered by quarter

→ Borrowers in areas that became high search cost more likely to accept

Back

Are search costs just a catch all for imperfect competition?

Search Costs	Competition: LOW	Competition: HIGH
LOW	0.12 [3.49]	0.11 [3.38]
HIGH	-0.03 [-0.24]	-0.02 [-0.23]