The Effects of Mortgage Credit Availability:
Evidence from Minimum Credit Score Lending Rules

Steven Laufer   Andrew Paciorek

Board of Governors of the Federal Reserve System

Urban Economics Association
November 9, 2017

Household Credit Access

- Credit access is important for household welfare: smooth consumption, borrow against illiquid assets, finance non-durable consumption
- Want to estimate effects of access on outcomes, but how do we measure access itself?
- Best measure is credit score, but credit score is also correlated with demand.
- Want to identify effects of credit access separately from other differences between people with high and low credits scores.

FHA Lending Pre-Crisis

Isolate effects of credit access from changes in FHA lending practices
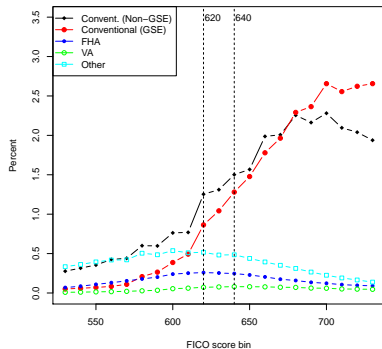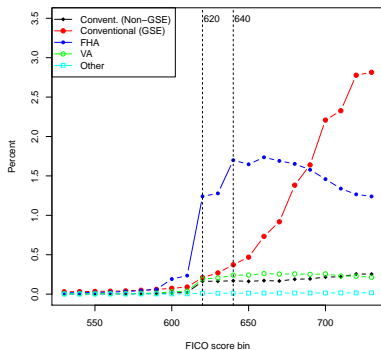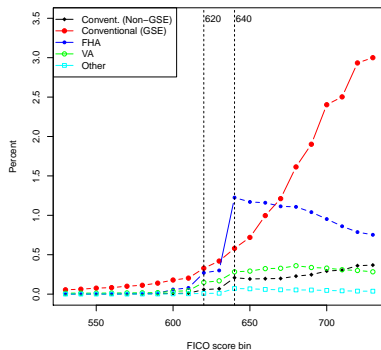

2005
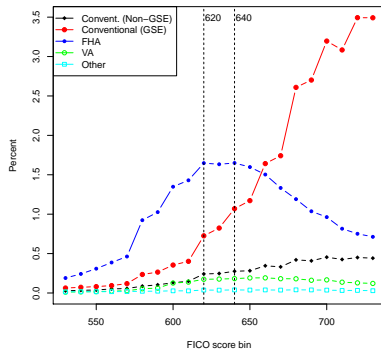
2008

FHA Lending Post-Crisis

After the crisis, mortgage lenders increasingly used minimum credit score thresholds in making lending decisions on FHA loans.


2010

2012

Our Paper

- Identify someone as having access to credit by whether she falls above or below these credit-score thresholds in periods where thresholds are important.
- Diff-in-Diff strategy:
  - First difference: Credit score is above or below the threshold
  - Second difference: Period where threshold more or less important.
- Controls for differences in demand that are correlated with credit score.
- Run our estimation on FRBNY/Equifax consumer credit panel (5 percent of US adult population), look at borrowing, delinquency, migration.

Related Literature

- Borrowing constraints and homeownership: Rosenthal (2002); Barakova, Bostic, Calem & Wachter (2003); Barakova, Calem & Wachter (2014); Acolin, Bricker, Calem & Wachter (2016); Chomsisengphet & Elul (2006)
    - We construct our measure for a large consumer panel. Control for demand. Look at more outcomes and longer-run effects.
- Credit availability since the crisis: Grop, Krainer & Laderman (2014); Bhutta (2016); Anenberg, Hizmo, Kung & Molloy (2016); Gete & Reher (2016)
    - Complimentary description of credit constraints at the *individual level*
- Housing and migration: Schulhofer-Wohl (2011); Ferreira, Gyourko, and Tracy (2011); Farber (2012)
    - Look at access to credit not negative equity
- Credit score thresholds: Keys, Mukherjee, Seru & Vig (2009, 2010, 2012); Bubb & Kaufman (2014)
    - Post crisis, thresholds clearly imposed by lenders, not securitizers/guarantors.

Diff-in-Diff (1)

Difference #1: Whether someone has a FICO score above the threshold

- Mortgage lenders use FICO scores but consumer credit panel contains Equifax Risk Scores
- Data: CRISM - Merge of mortgage and credit bureau data. Contains both FICO score and Risk Score. Estimate joint distribution.
- Calculate **probability** that someone has FICO score over threshold given Risk Score.
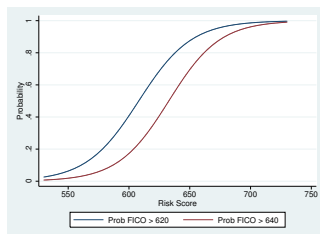
- Our empirical approach is a test of whether credit score in CCP captures access to credit.

Diff-in-Diff (2)

Difference #2: Period where threshold is more or less important for lending decisions.
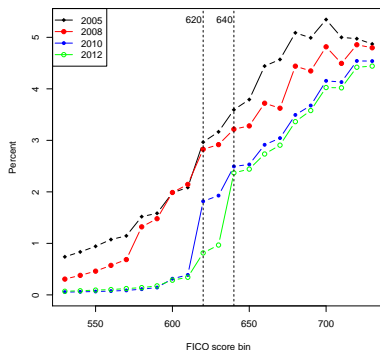
- Data: Black Knight (f.k.a. LPS, McDash) - mortgage originations
- Calculate ratio of number mortgages just below the threshold compared to just above $r_t^{620} = \frac{(\text{Loan Count}|FICO \geq 615, FICO < 620)_t}{(\text{Loan Count}|FICO \geq 620, FICO < 625)_t}$

Diff-in-Diff Specification

- Consider 620 threshold in isolation
- Probability of being over the threshold: $Pr(FICO \geq 620 | riskscore_{it})$
- Measure of the importance of the threshold:
  $r_t^{620} = \frac{(\text{Loan Count} | FICO \geq 615, FICO < 620)_t}{(\text{Loan Count} | FICO \geq 620, FICO < 625)_t}$
- Difference-in-difference approach:

$$y_{it} = \alpha Pr(FICO \geq 620 | riskscore_{it}) + \theta(1 - r_t^{620})$$
$$+ \beta Pr(FICO \geq 620 | riskscore_{it}) \times (1 - r_t^{620}) + \varepsilon_{it}$$
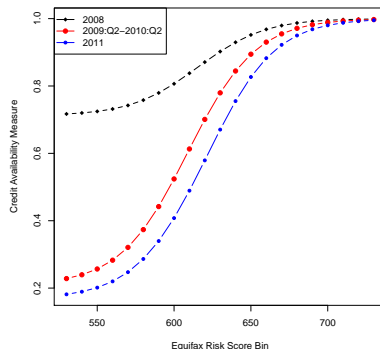
Two Thresholds

- Need to combine the effects of the 620 and 640 thresholds.
- Build a structural model where the interaction term can be interpreted as the probability that a borrower meets a lender willing to give her a mortgage.
  - r_t^{620} represents the fraction of lenders willing to make loans to borrowers with scores below 620 at time t.
- Extend the structural model to include two thresholds. Get combined credit availability measure:

$$credavail_{it} = Pr(FICO \geq 640|riskscore_{it})$$
$$+ Pr(640 > FICO \geq 620|riskscore_{it}) \times r_t^{640}$$
$$+ Pr(FICO < 620|riskscore_{it}) \times r_t^{640} \times r_t^{620}.$$

Credit Availability Measure
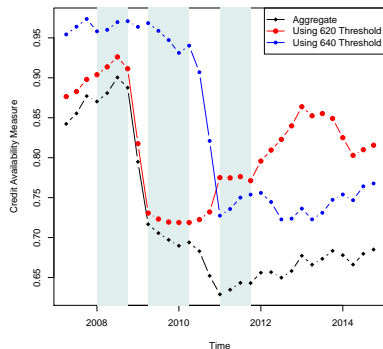
Time Series

Cross-Section Across Periods

Credit availability (interaction of thresholds with nonlinear function of credit score)

$$
\begin{aligned}
y_{it} =\ & \beta credavail_{it} \\
& + \alpha_{620} Pr(FICO \geq 620 | riskscore_{it}) \\
& + \alpha_{640} Pr(FICO \geq 640 | riskscore_{it}) \\
& + \delta_t riskscore_{it} \\
& + \eta_t \\
& + \gamma X_{it} \\
& + \varepsilon_{it}
\end{aligned}
$$

Final Empirical Specification

Control for main effect of credit score in two ways

$$
\begin{aligned}
y_{it} =\, & \beta \, credavail_{it} \\
& + \alpha_{620} Pr(FICO \geq 620 | riskscore_{it}) \\
& + \alpha_{640} Pr(FICO \geq 640 | riskscore_{it}) \\
& + \delta_t \, riskscore_{it} \\
& + \eta_t \\
& + \gamma X_{it} \\
& + \varepsilon_{it}
\end{aligned}
$$

Final Empirical Specification

Control for all time effects (including main effect of thresholds)

$$y_{it} = \beta credavail_{it}$$
$$+ \alpha_{620} Pr(FICO \geq 620 | riskscore_{it})$$
$$+ \alpha_{640} Pr(FICO \geq 640 | riskscore_{it})$$
$$+ \delta_t riskscore_{it}$$
$$+ \eta_t$$
$$+ \gamma X_{it}$$
$$+ \varepsilon_{it}$$

Final Empirical Specification

Other controls include first lag of all main variables

$$
\begin{aligned}
y_{it} =\ & \beta\, credavail_{it} \\
& + \alpha_{620} Pr(FICO \geq 620 | riskscore_{it}) \\
& + \alpha_{640} Pr(FICO \geq 640 | riskscore_{it}) \\
& + \delta_t\, riskscore_{it} \\
& + \eta_t \\
& + \gamma X_{it} \\
& + \varepsilon_{it}
\end{aligned}
$$

Final Empirical Specification

Other controls include first lag of all main variables

$$
\begin{aligned}
y_{it} =& \beta credavail_{it} \\
& + \alpha_{620} Pr(FICO \geq 620 | riskscore_{it}) \\
& + \alpha_{640} Pr(FICO \geq 640 | riskscore_{it}) \\
& + \delta_t riskscore_{it} \\
& + \eta_t \\
& + \gamma X_{it} \\
& + \varepsilon_{it}
\end{aligned}
$$

- Use linear, logit, or negative binomial models depending on outcome
- Estimate each model on full sample and separately on those who do and do not already have a mortgage

Identification

$$y_{it} = \beta credavail_{it}$$
$$+ \alpha_{620} Pr(FICO \geq 620 | riskscore_{it})$$
$$+ \alpha_{640} Pr(FICO \geq 640 | riskscore_{it})$$
$$+ \delta_t riskscore_{it}$$
$$+ \eta_t$$
$$+ \gamma X_{it}$$
$$+ \varepsilon_{it}$$

- Identification of β requires that credit availability is uncorrelated with confounding factors (esp. demand), conditional on controls.
- We are secure against confounders that
  - vary only in the time series
  - vary over time and are correlated with credit score in a linear fashion (within range of data)
  - are correlated with nonlinear threshold probabilities, but do not vary over time

Probability of Taking Out Mortgage
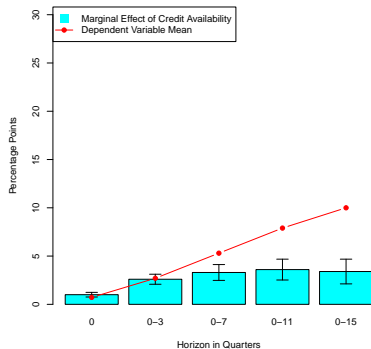
No Initial Mortgage Balance
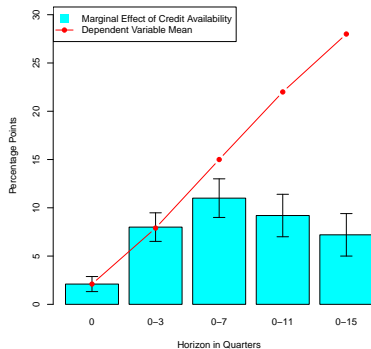
Positive Initial Mortgage Balance
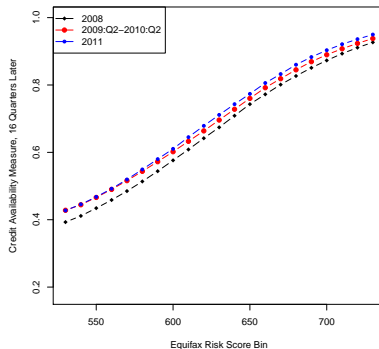
Why are Effects So Persistent? (1)
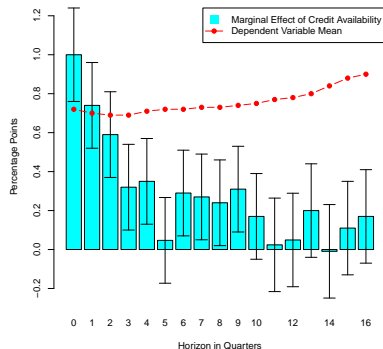
No Initial Mortgage Balance
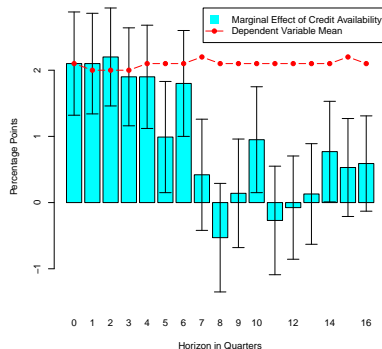
Positive Initial Mortgage Balance

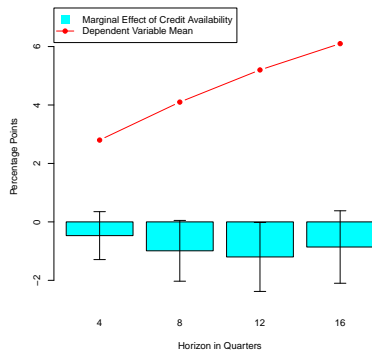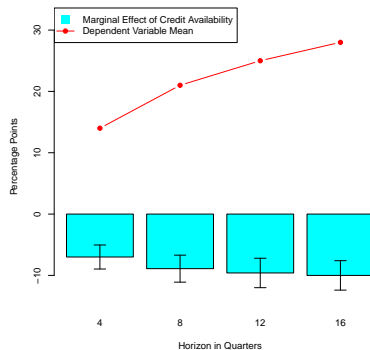# Why are Effects So Persistent? (2)
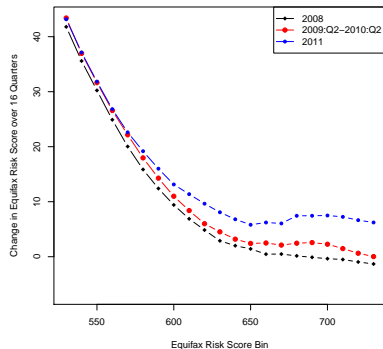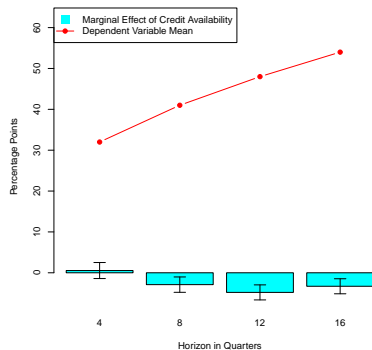

Score Evolution

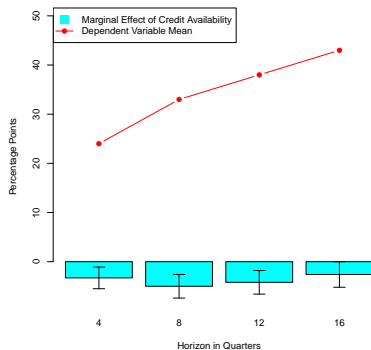Availability Evolution

No Initial Mortgage Balance

Positive Initial Mortgage Balance
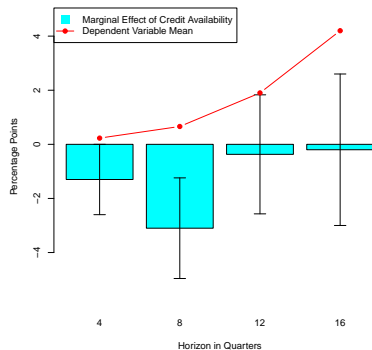
Non-Mortgage Delinquency
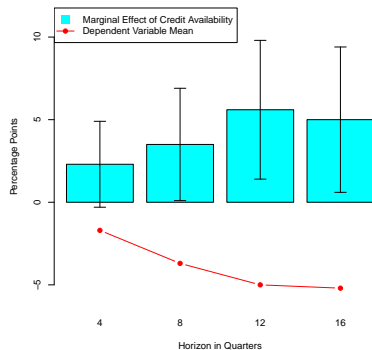

No Initial Mortgage Balance

Positive Initial Mortgage Balance
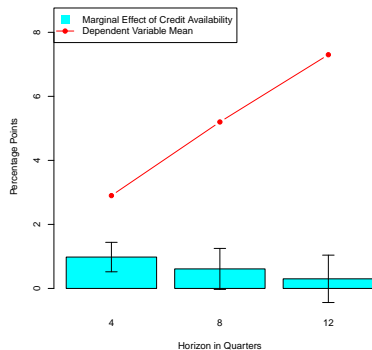
Auto Borrowing
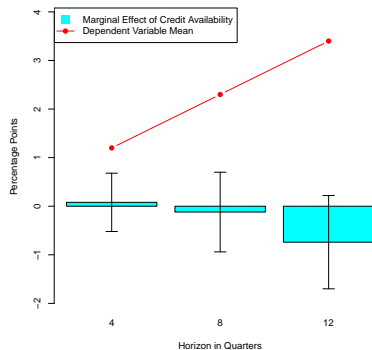

No Initial Mortgage Balance

Positive Initial Mortgage Balance

Migration

No Initial Mortgage Balance

Positive Initial Mortgage Balance

Summary of Main Results

- Credit score thresholds have very large effects on mortgage borrowing at short horizons (as measured – a non-trivial result!)
- Effects attenuate only slightly over 20 quarters, although they shrink more substantially relative to average probabilities of mortgage attainment
- Access to credit substantially lowers probability of mortgage delinquency among prior borrowers
- Access to credit substantially lowers probability of non-mortgage delinquency among all borrowers
- Prior borrowers buy more cars when they have access (refinancing), while prior non-borrowers buy fewer cars (substitution)
- Prior borrowers do not seem to be "locked in": No evidence that lack of credit lowers cross-MSA migration
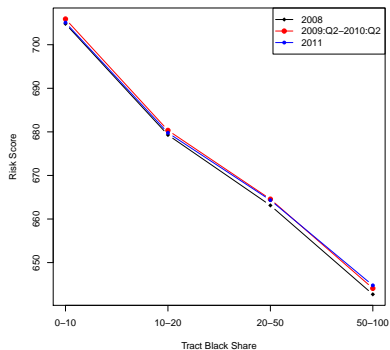
Heterogeneity

Does mortgage credit access have different effects on different parts of the population?

- Estimate separately on different subgroups (age, income, race).
- Look across geography.

Age

Black Share

Age
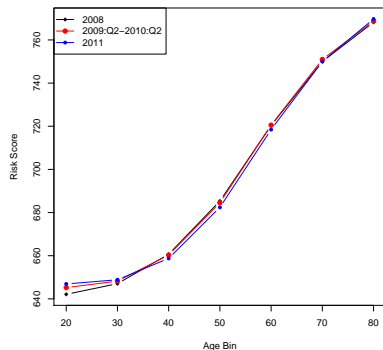
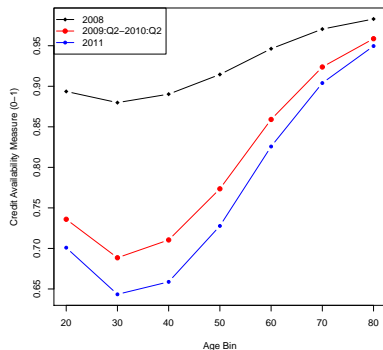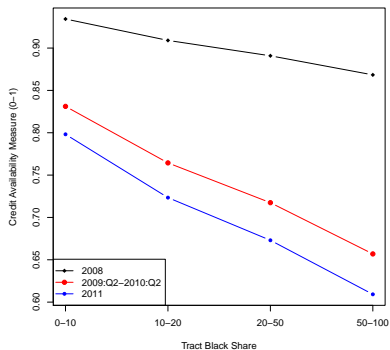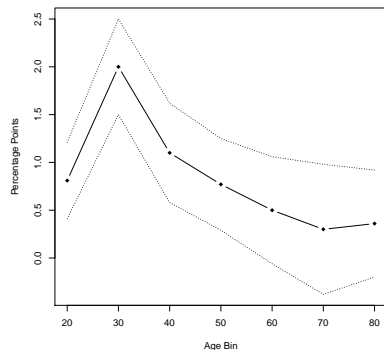Black Share
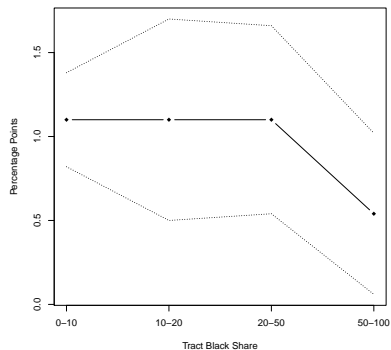
Heterogeneity – Marginal Effects

Age

Black Share

Heterogeneity – Net Implied Effects

Age

Black Share

Geography (1)
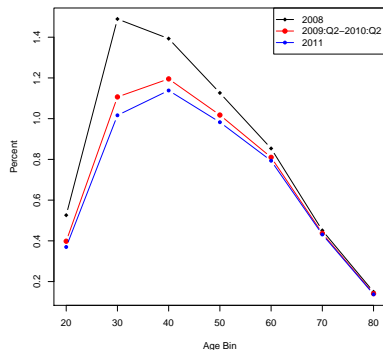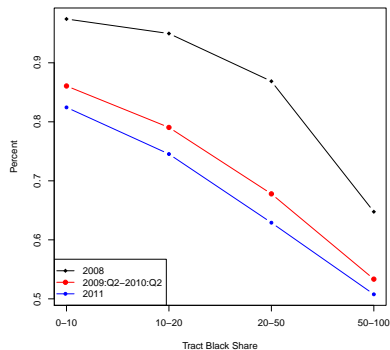
Average Credit Score, 2008

Legend:
- ☐ (665,676]
- (676,686]
- (686,697]
- (697,707]
- ■ (707,718]

Geography (2)

Credit Availability, 2008

☐	(0.89,0.9]
▨	(0.9,0.91]
▨	(0.91,0.93]
▨	(0.93,0.94]
■	(0.94,0.95]

Geography (3)
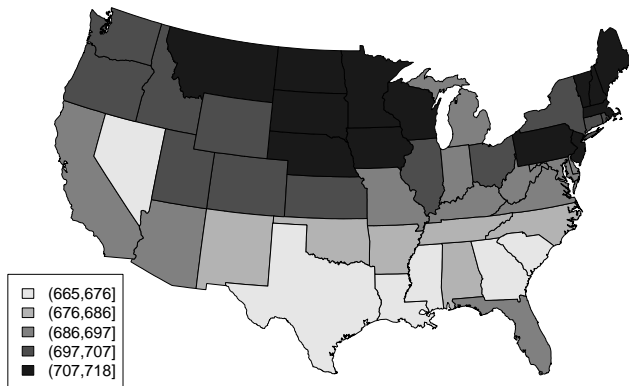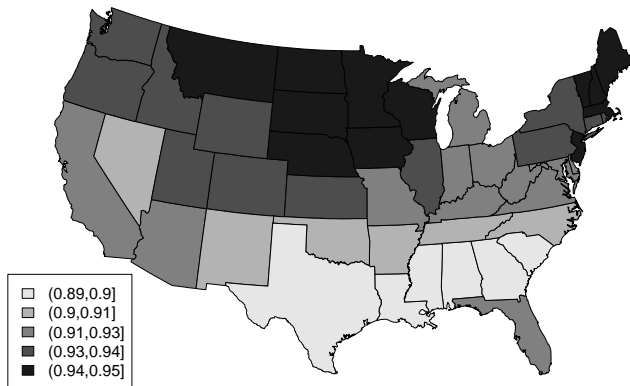
Change in Credit Availability, 2008-2011

Legend:
- (−0.22,−0.2]
- (−0.2,−0.17]
- (−0.17,−0.15]
- (−0.15,−0.13]
- (−0.13,−0.1]

Heterogeneity
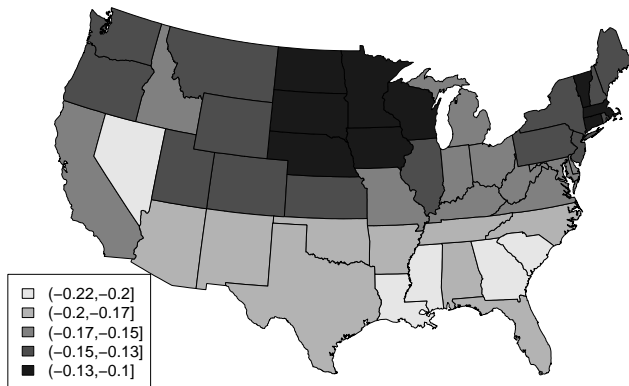
Does mortgage credit access have different effects on different parts of the population?

- People in census tracts with lower income or higher minority share
  - are more likely to be affected by thresholds.
  - are less responsive to thresholds (lower demand)
- Credit availability restrictions have largest effects in middle-income or moderately black census tracts.
- Younger borrowers are both more likely to be affected and are more responsive so effects are largest on younger adults.
- Largest declines in credit availability in southern states.

Counterfactual

- What are the aggregate effects of credit score thresholds?
    - Predict number of mortgages that would have been originated if use of thresholds had remained at 2008 levels, holding all else constant

Counterfactual

- What are the aggregate effects of credit score thresholds?
  - Predict number of mortgages that would have been originated if use of thresholds had remained at 2008 levels, holding all else constant
- From 2011-2014, thresholds lowered originations by about 580,000
  - 7 percent of actual originations in our sample (530-730 credit scores)
  - 2 percent of actual originations to all individuals (HMDA)
- These calculations reflect only the direct effects of the thresholds!

Conclusion

- Measure effects of mortgage credit availability from use of minimum credit score lending rules
  - Based on credit score but allows us to isolate the supply channel by controlling for demand factors correlated with credit scores
- Effects on mortgage attainment attenuate over time but remain for years afterward.
  - Persistence suggests large costs to constrained borrowers
  - Effects concentrated among younger adults and in middle-income or moderately black census tracts
- Mortgage credit access reduces delinquencies on both mortgage and non-mortgage debt.
- Document spillovers to auto borrowing
- Policy makers need to balance effects of credit constraints on individual households against macroeconomic effects and financial stability concerns.