

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

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Board of Governors of the Federal Reserve System

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# Mortgage Credit Since The Crisis

Mortgage credit is determined by the “3 C’s”

- Capacity – ability of the borrower to pay – DTI ratio
  
- Collateral – value of the house – LTV ratio
  
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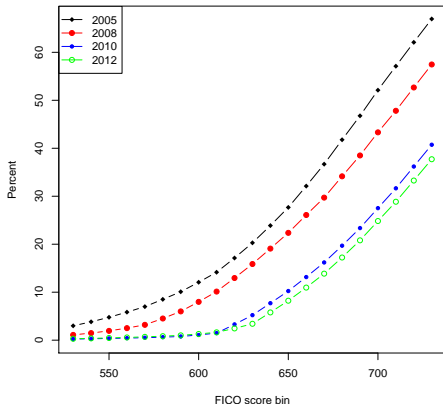
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- Credit – credit worthiness of the borrower – credit score
  - TIGHT. Difficult for low-FICO borrowers to get loans.

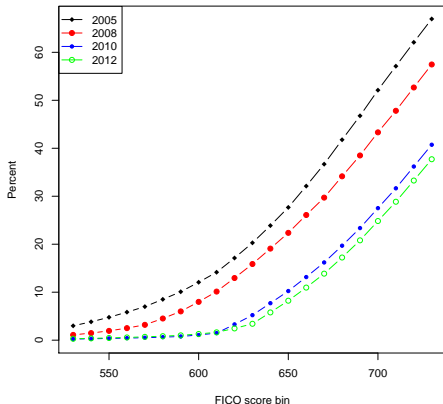
# Distribution of Credit Scores on Mortgages

Shift in distribution of mortgages away from borrowers with low credit scores.



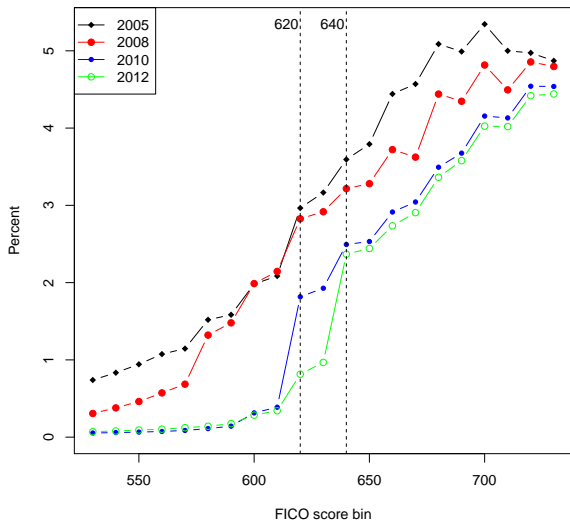
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Is this supply or demand?

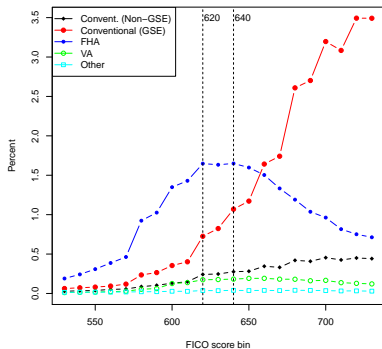
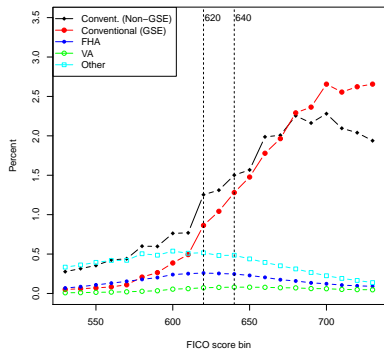
# Density of Credit Scores on Mortgages





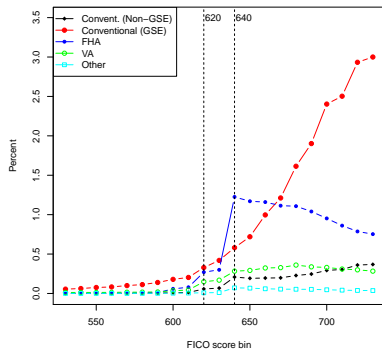
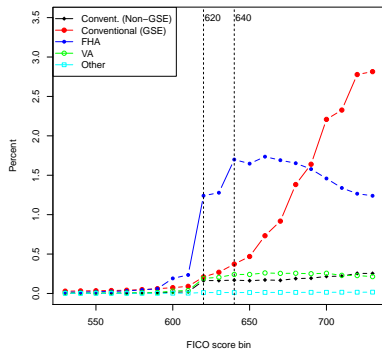
# Credit Score Density by Mortgage Type

Where did these thresholds come from?



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# Why Do We Care?

Tight credit to at least some borrowers could have played a role in:

- Decline in homeownership rate, shift towards rental demand
- Weak recovery in residential investment, particularly at the low end of the market
- Inability of some potential homeowners to take advantage of historically low interest rates

- We use discontinuities in the distribution of credit scores to construct a measure of mortgage credit availability that captures effect of minimum credit score lending rules
- Assign credit availability measure to everyone in FRBNY/Equifax consumer credit panel (5 percent of US adult population)
- In the spirit of RD and DiD, estimate consequences of tight mortgage supply while controlling for differences in demand that may be correlated with credit score

# Preview of Findings

- The effect of tight credit on mortgage borrowing is large and persistent, although it attenuates somewhat over time.
  - Effects concentrated among younger adults and middle-income or moderately black census tracts
  - In aggregate, we estimate that minimum credit scores reduced new mortgage originations by about 2 percent from 2011-2014, with much larger effects close to the thresholds.
- Among prior borrowers, access to credit reduced delinquency on mortgage and non-mortgage debt, increased auto loan borrowing
- But had little effect on cross-MSA migration

- 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.

# Credit Availability Measure

- Step 1: Estimate changes in relevance of 620 and 640 thresholds over time (Black Knight)
- Step 2: Link Equifax CCP to Black Knight data
- Step 3: Calculate credit availability measure, using interaction of thresholds and individual scores to identify credit supply effects

# Credit Availability Measure (Step 1)

- Measure impact of credit score thresholds each quarter from distribution of credit scores in new mortgages
- Calculate ratio of number mortgages just below the threshold compared to just above
- Data: Black Knight (f.k.a. LPS, McDash) - mortgage originations

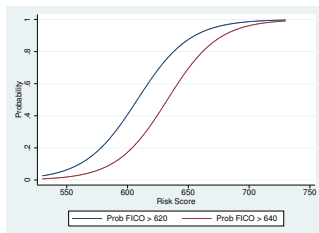


## Credit Availability Measure (Step 2)

- Two issues prevent us from implementing a straightforward RD design:
  - Black Knight data uses FICO scores but consumer credit panel contains Equifax Risk Scores
  - Timing issues: CCP is a snapshot on last day of quarter; Black Knight captures scores at originations

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  - Black Knight data uses FICO scores but consumer credit panel contains Equifax Risk Scores
  - Timing issues: CCP is a snapshot on last day of quarter; Black Knight captures scores at originations
- Calculate probability that someone has a FICO score above the threshold based on Risk Score
  - Data: CRISM - Merge of mortgage and credit bureau data. Contains both FICO score and Risk Score. Estimate joint distribution.



- Our empirical approach is a test of whether thresholds are relevant in CCP.

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- Have access to mortgage credit relative to 620 threshold if (i) score is above the threshold or (ii) the threshold is unimportant
- Probability of being over the threshold:  $Pr(FICO \geq 620 | riskscore_{it})$
- Measure of the importance of the threshold:

$$r_t^{620} = \frac{(\text{Loan Count} | FICO \geq 615, FICO < 620)_t}{(\text{Loan Count} | FICO \geq 620, FICO < 625)_t}$$

- Structural interpretation:  $r_t^{620}$  reflects fraction of lenders willing to lend below threshold, the size of those lenders, and the cost to borrowers of seeking them out

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  - Structural interpretation:  $r_t^{620}$  reflects fraction of lenders willing to lend below threshold, the size of those lenders, and the cost to borrowers of seeking them out
- Difference-in-difference approach:

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

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- $r_t^{640} = \frac{(\text{Loan Count} | FICO \geq 635, FICO < 640)_t}{(\text{Loan Count} | FICO \geq 640, FICO < 645)_t}$

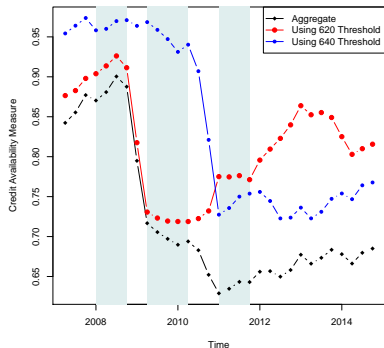
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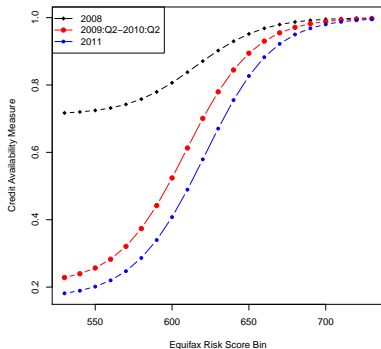
$$\begin{aligned} credavail_{it} &= Pr(FICO \geq 640 | riskscore_{it}) \\ &\quad + Pr(640 > FICO \geq 620 | riskscore_{it}) \times r_t^{640} \\ &\quad + Pr(FICO < 620 | riskscore_{it}) \times r_t^{640} \times r_t^{620}, \end{aligned}$$



# Credit Availability Measure



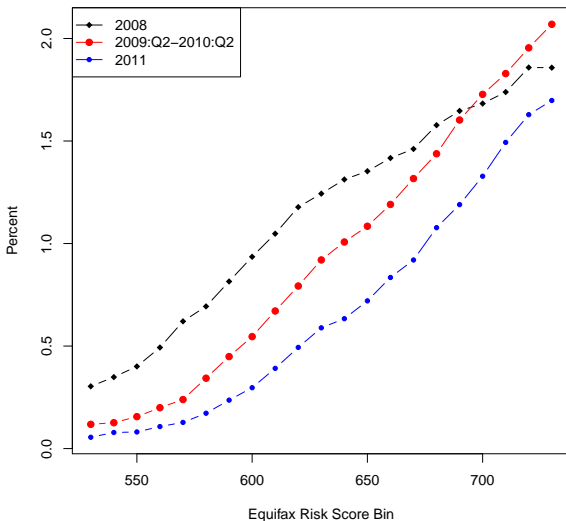
Time Series



Cross-Section Across Periods

# Credit Availability & Mortgage Originations

Contemporaneous probability of taking out a mortgage, by Equifax Risk Score



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

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

Control for main effect of credit score in two ways

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

# Empirical Specification

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

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

Other controls include first lag of all main variables

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- 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

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

- Identification of  $\beta$  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

**Table:** Effects on Probability of Taking Out a First Mortgage

Horizon in Quarters:	(1) 0	(2) 0-3	(3) 0-7	(4) 0-11	(5) 0-15
<i>Panel A: Entire Sample</i>					
Credit Availability	0.010 (0.001)	0.028 (0.003)	0.035 (0.004)	0.034 (0.006)	0.028 (0.007)
Dep. Var. Mean Observations	0.009 32,521,878	0.035 31,978,664	0.068 31,397,303	0.100 30,895,003	0.130 30,392,255
<i>Panel B: No Initial Mortgage Balance</i>					
Credit Availability	0.010 (0.001)	0.026 (0.003)	0.033 (0.004)	0.036 (0.005)	0.034 (0.006)
Dep. Var. Mean Observations	0.007 27,692,800	0.027 27,203,296	0.053 26,676,170	0.079 26,217,051	0.100 25,754,177
<i>Panel C: Positive Initial Mortgage Balance</i>					
Credit Availability	0.021 (0.004)	0.080 (0.007)	0.110 (0.010)	0.092 (0.011)	0.072 (0.011)
Dep. Var. Mean Observations	0.021 4,829,078	0.079 4,775,368	0.150 4,721,133	0.220 4,677,952	0.280 4,638,078

# Mortgage Delinquency

Table: Effects on Probability of Having a Delinquent Mortgage

Horizon in Quarters:	(1) 0-3	(2) 0-7	(3) 0-11	(4) 0-15
<i>Panel A: Entire Sample</i>				
Credit Availability	-0.022 (0.006)	-0.031 (0.008)	-0.036 (0.009)	-0.034 (0.009)
Dep. Var. Mean Observations	0.045 30,558,656	0.068 29,138,671	0.085 27,932,190	0.098 26,860,384
<i>Panel B: No Initial Mortgage Balance</i>				
Credit Availability	-0.005 (0.004)	-0.010 (0.005)	-0.012 (0.006)	-0.009 (0.006)
Dep. Var. Mean Observations	0.028 25,790,250	0.041 24,431,303	0.052 23,282,082	0.061 22,267,892
<i>Panel C: Positive Initial Mortgage Balance</i>				
Credit Availability	-0.070 (0.010)	-0.089 (0.011)	-0.096 (0.012)	-0.100 (0.012)
Dep. Var. Mean Observations	0.140 4,768,406	0.210 4,707,368	0.250 4,650,108	0.280 4,592,492

# Non-Mortgage Delinquency

**Table:** Effects on Probability of Having a Delinquent Non-Mortgage Loan

Horizon in Quarters:	(1) 0-3	(2) 0-7	(3) 0-11	(4) 0-15
<i>Panel A: Entire Sample</i>				
Credit Availability	0.000 (0.009)	-0.034 (0.008)	-0.050 (0.008)	-0.035 (0.008)
Dep. Var. Mean Observations	0.31 31,978,664	0.40 31,397,303	0.47 30,895,003	0.52 30,392,255
<i>Panel B: No Initial Mortgage Balance</i>				
Credit Availability	0.006 (0.010)	-0.029 (0.009)	-0.048 (0.009)	-0.033 (0.009)
Dep. Var. Mean Observations	0.32 27,203,296	0.41 26,676,170	0.48 26,217,051	0.54 25,754,177
<i>Panel C: Positive Initial Mortgage Balance</i>				
Credit Availability	-0.033 (0.011)	-0.050 (0.012)	-0.042 (0.012)	-0.026 (0.013)
Observations	4,775,368	4,721,133	4,677,952	4,638,078

**Table:** Effects on Moving to Different Census Block

Horizon in Quarters:	(1) 4	(2) 8	(3) 12
<i>Panel A: Entire Sample</i>			
Credit Availability	0.013 (0.005)	-0.001 (0.006)	0.004 (0.007)
Dep. Var. Mean Observations	0.100 20,414,501	0.190 20,379,761	0.250 20,257,793
<i>Panel B: No Init. Mort. Bal.</i>			
Credit Availability	0.018 (0.006)	0.003 (0.007)	0.011 (0.008)
Dep. Var. Mean Observations	0.110 17,003,743	0.200 16,962,731	0.270 16,842,345
<i>Panel C: Pos. Init. Mort. Bal.</i>			
Credit Availability	-0.003 (0.007)	-0.016 (0.009)	-0.034 (0.010)
Dep. Var. Mean Observations	0.053 3,410,758	0.100 3,417,030	0.140 3,415,448

**Table:** Effects on Moving to Different CBSA

Horizon in Quarters:	(1) 4	(2) 8	(3) 12
<i>Panel A: Entire Sample</i>			
Credit Availability	0.009 (0.002)	0.006 (0.003)	0.003 (0.003)
Dep. Var. Mean Observations	0.026 24,467,862	0.048 24,175,627	0.067 23,901,752
<i>Panel B: No Init. Mort. Bal.</i>			
Credit Availability	0.010 (0.002)	0.006 (0.003)	0.003 (0.004)
Dep. Var. Mean Observations	0.029 20,601,775	0.052 20,333,093	0.073 20,076,915
<i>Panel C: Pos. Init. Mort. Bal.</i>			
Credit Availability	0.001 (0.003)	-0.001 (0.004)	-0.007 (0.005)
Dep. Var. Mean Observations	0.012 3,866,087	0.023 3,842,534	0.034 3,824,837

**Table:** Effects on Change in Number of Auto Loans

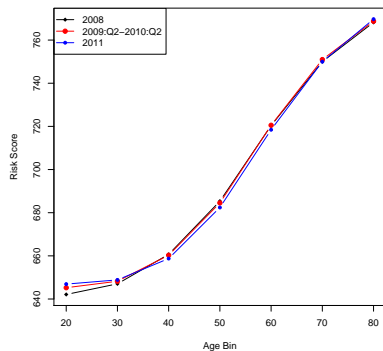
Horizon in Quarters:	(1) 4	(2) 8	(3) 12	(4) 16
<i>Panel A: Entire Sample</i>				
Credit Availability	-0.009 (0.006)	-0.021 (0.009)	0.008 (0.011)	0.010 (0.013)
Dep. Var. Mean Observations	-0.001 30,664,032	0.000 29,587,609	0.008 28,787,215	0.026 28,143,066
<i>Panel B: No Initial Mortgage Balance</i>				
Credit Availability	-0.013 (0.007)	-0.031 (0.009)	-0.004 (0.011)	-0.002 (0.014)
Dep. Var. Mean Observations	0.002 25,886,884	0.007 24,852,642	0.019 24,089,800	0.042 23,481,558
<i>Panel C: Positive Initial Mortgage Balance</i>				
Credit Availability	0.023 (0.013)	0.035 (0.017)	0.056 (0.021)	0.050 (0.022)
Dep. Var. Mean Observations	-0.017 4,777,148	-0.037 4,734,967	-0.050 4,697,415	-0.052 4,661,508

# Summary of Main Results

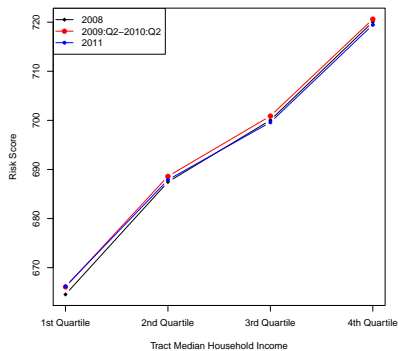
- Credit score thresholds have very large effects on mortgage borrowing at short horizons (a non-trivial result!)
- Effects attenuate only slightly over 20 quarters, although they shrink more substantially relative to average probabilities of mortgage attainment
- Access to credit substantially lowers probability of mortgage default among prior borrowers
- Prior borrowers do not seem to be “locked in”: Lack of credit *increases* moving and has no effect on cross-MSA migration
- Prior borrowers buy more cars when they have access (refinancing), while prior non-borrowers buy fewer cars (substitution)

# Heterogeneity (1)

## Credit Score



Age

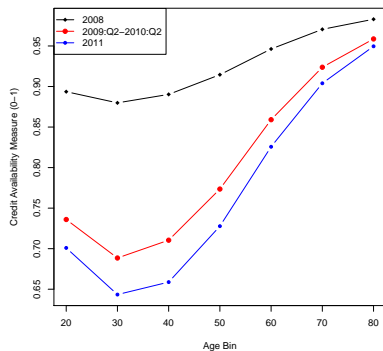


Income

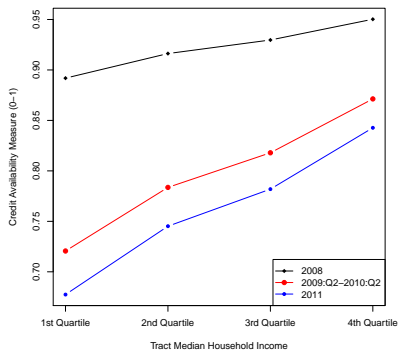


# Heterogeneity (2)

## Credit Availability



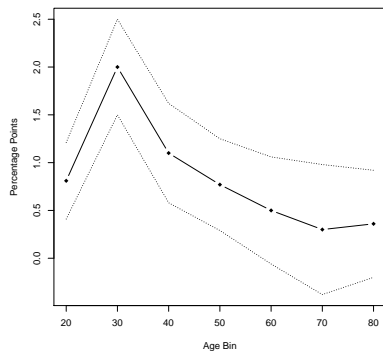
Age



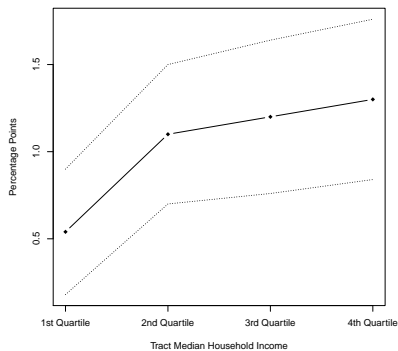
Income

# Heterogeneity (3)

## Marginal Effects



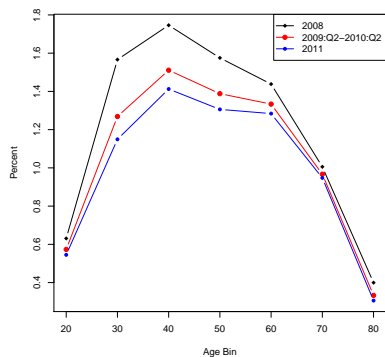
Age



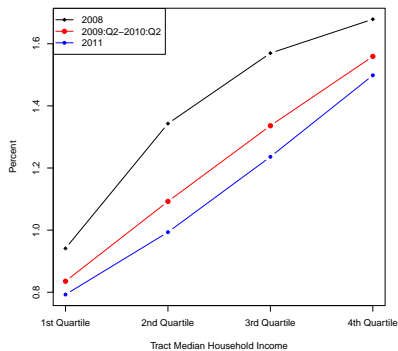
Income

# Heterogeneity (4)

## Net Implied Effects



Age



Income

- What are the aggregate effects of credit score thresholds?
  - Estimate models relating joint and individual mortgage counts to credit availability
  - Predict number of mortgages that would have been originated if use of thresholds had remained at 2008 levels, holding all else constant

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- In 2011, thresholds lowered originations by about 260,000
  - 16 percent of actual originations in our sample (530-730 credit scores)
  - 3.5 percent of actual originations to all individuals (HMDA)

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- In 2011, thresholds lowered originations by about 260,000
  - 16 percent of actual originations in our sample (530-730 credit scores)
  - 3.5 percent of actual originations to all individuals (HMDA)
- 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

- New measure of mortgage credit availability that captures effect of minimum credit score lending rules
  - Based on credit score but allows us to isolate the supply channel by controlling for demand factors correlated (linearly) 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
  - Aggregate effects of thresholds themselves are fairly modest, although other forms of credit tightening may also be important
- Also find salutary effects on delinquency and auto borrowing, particularly among prior borrowers, but little effect on cross-MSA migration
- Policy makers need to balance effects of credit constraints on individual households against macroeconomic effects and financial stability concerns