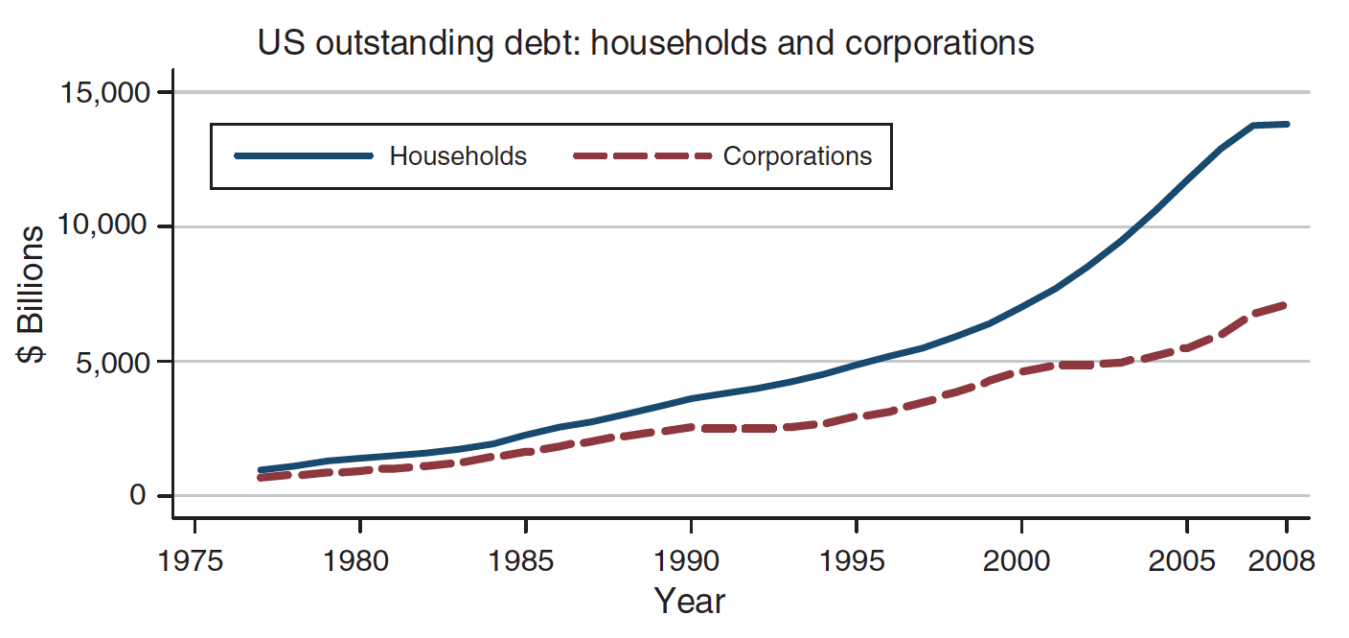
The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis

Atif Mian and Amir Sufi

Motivation

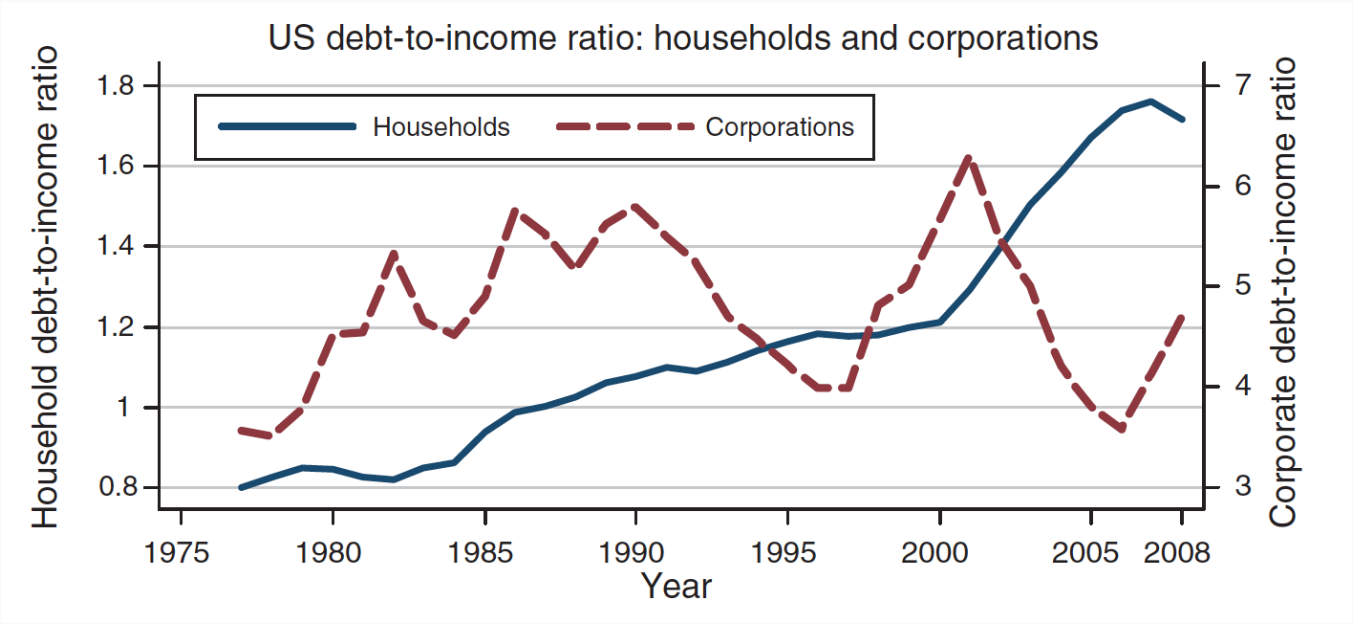
- The build up to the great recession saw an unprecedented increase in household debt



Mian & Sufi (2011)

Motivation

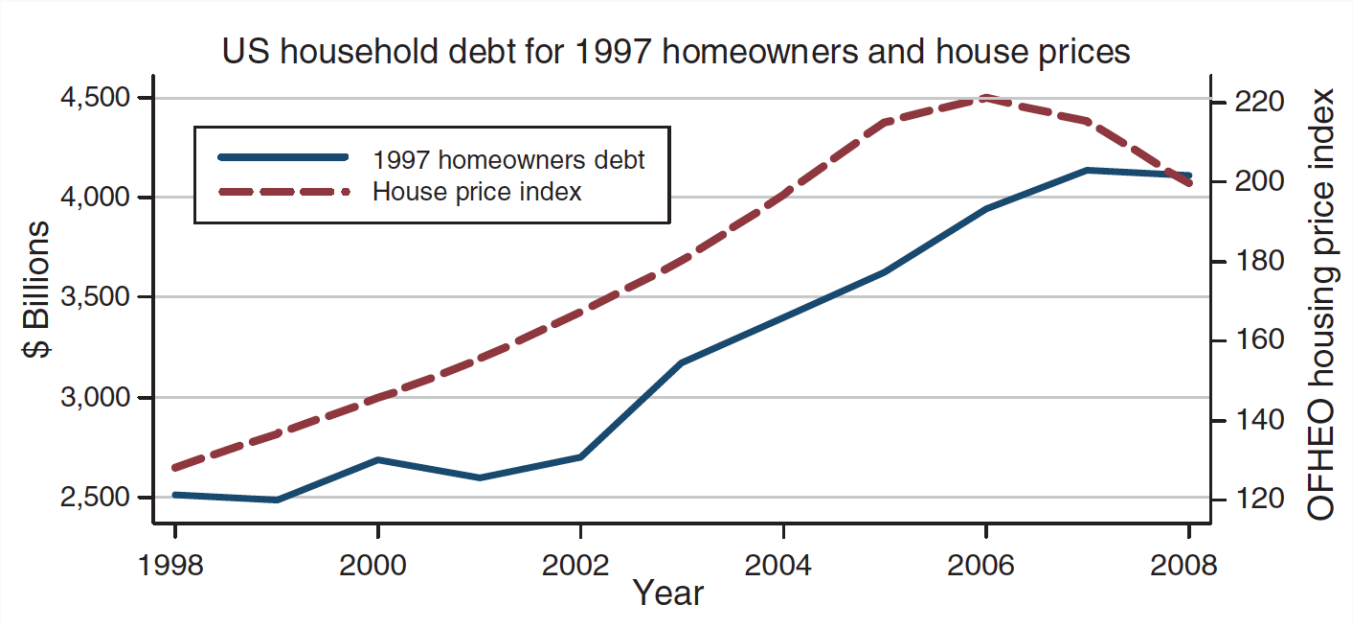
- The increase in household debt was not matched by subsequent increases in income $\rightarrow$ rise in the debt-to-income ratio



Mian & Sufi (2011)

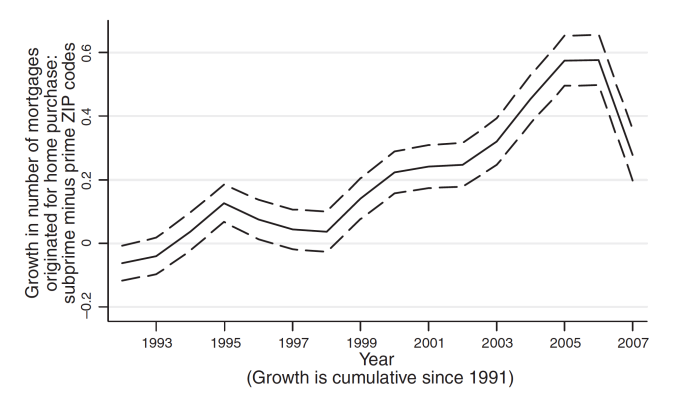
Motivation

- The increase in household debt was matched by unprecedented increases in house prices

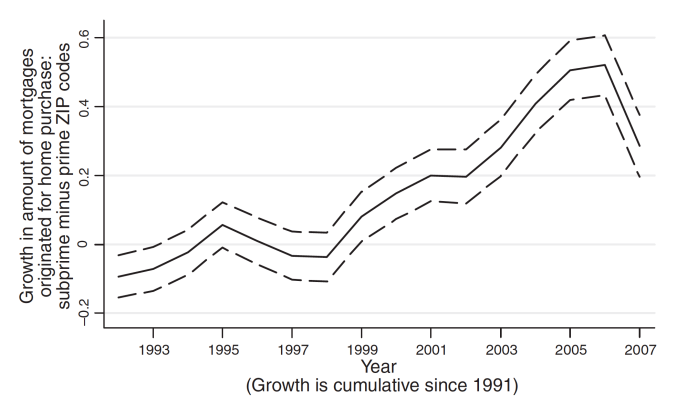


Mian & Sufi (2011)

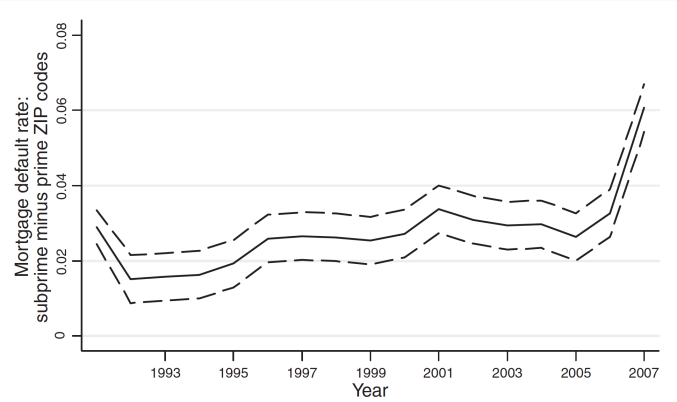
Motivation



Increase in mortgage origination ...



growth and ...



defaults ...

in areas with higher shares of subprime borrowers

Overview

- **This paper**: Explores three hypotheses as to the cause of increase in household debt in subprime areas
  1. Income-based hypothesis
     - Improvements in the creditworthiness of subprime borrowers
  2. Credit supply hypothesis
     - Perverse incentives, financial innovation, securitization ...
  3. Expectations-based hypothesis
     - Higher house price growth expectations lowered the estimated loss given default
- **Finding**: growth in mortgage credit to subprime areas occurs despite
  - decreases in the creditworthiness of subprime borrowers and
  - house price expectations staying low

Contribution to the literature

- The paper contributes seminally to our understanding of the causes of the mortgage crisis that preceded the great recession
- The paper highlights the role of changes in incentives in the financial sector in the historically unprecedented levels of credit growth between 2002-2005
- The paper emphasizes the disproportionate allocation of this increase in credit supply to subprime borrowers at unsustainable levels
- The paper highlights how the decoupling of credit growth from income growth can lead to severe macroeconomic consequence

Empirical framework

- Individuals buy a house in a ZIP code z in county c in time t
- In the mortgage market, a home that costs P_{zt} requires a deposit of γP_{zt}
- A fraction of buyers in a ZIP code, f_z, are "prime" $\rightarrow$ income level is greater than mortgage payments with little risk of default
- Denote this income, $I_{jzt} \rightarrow$ buyer j's expected income (at time t) in ZIP code z in period $t+1$
- The remaining $(1 - f_z)$ buyers are "sub-prime" $\rightarrow$ higher probability of default
- Denote the probability of default, $\delta(I_{jzt})$

Empirical framework

- In the event of a default, the lender recovers a fraction, α, of the full house value
- Banks are willing to lend to a subprime borrower at a risk premium of θ_t
- The interest rate offered to a subprime borrow in time t is therefore

$$r = \frac{1}{1-\delta} - (\frac{\alpha\delta}{(1-\gamma)(1-\delta)}\Delta P^e_{zt} + \theta_t$$

- where $\Delta P^e_{zt} = (P_{zt+1}/P_{zt})$ denotes expected house price appreciation
- Let the fraction of subprime borrowers in a ZIP code who obtain a mortgage be denoted by g_{zt}

The income-based view

$$r = \frac{1}{1-\delta} - \left(\frac{\alpha\delta}{(1-\gamma)(1-\delta)}\Delta P^{e}_{zt} + \theta_t\right.$$

- An improvement in the income profile of borrowers, I_{jzt}, reduces the likelihood of default, δ
- A reduction of δ leads to a higher acceptance rate for mortgages
- More generally, an increase in I_{jzt} improves the creditworthiness of borrowers, increasing their ability to repay
  - Increases in income, better employment prospects ...

The credit supply-based view

$$r = \frac{1}{1-\delta} - (\frac{\alpha\delta}{(1-\gamma)(1-\delta)}\Delta P^{e}_{zt} + \theta_t$$

- A reduction in the risk premium, θ_t, increases the affordability of mortgage debt
- What would potentially cause a reduction in θ_t?
  - Diversification of risk across institutions
  - Lax lending standards
  - Government interventions which subsidize risk
  - Misperception of the true underlying risk

The expectations-based view

$$r = \frac{1}{1-\delta} - (\frac{\alpha\delta}{(1-\gamma)(1-\delta)}\Delta P^{e}_{zt} + \theta_t$$

- An increase in expected house price appreciation, ΔP^{e}_{zt}, lowers the lenders loss given default and increases the acceptance rate for mortgages

Empirical model

- Using the framework, the paper develops an empirical specification to test for the various hypotheses
- The total number of customers with access to the mortgage market in a ZIP code is given by

$$L_{zt} = f_z + g_z * (1 - f_z)$$

- There may however be (i) time-varying factors at the county level, such as local productivity shocks and other (ii) ZIP code level idiosyncratic shocks

Empirical model

- Controlling for these effects

$$L_{zt} = f_z + g_z * (1 - f_z) + \alpha_{ct} + \epsilon_{zt}$$

- The country by time fixed effect, α_{ct}, removes the effects of changes in income, home prices, or other variables that uniformly affect ZIP codes in a given county

- Taking the first difference

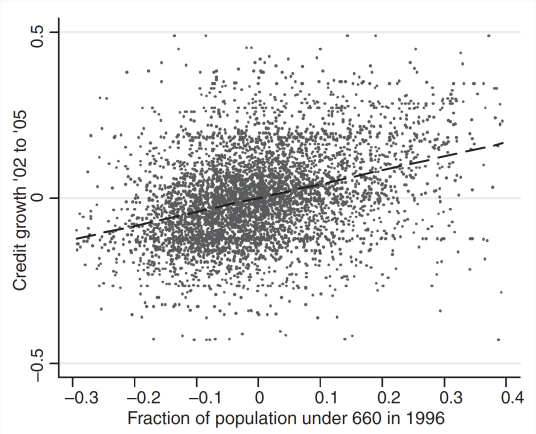
$$\Delta L_{zt} = \beta_t * (1 - f_z) + \alpha_c + \Delta\epsilon_z$$

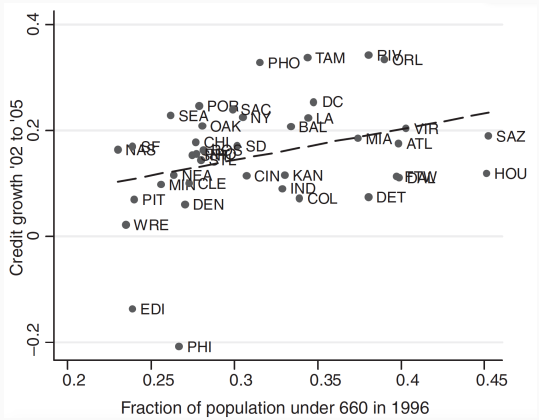
- where β_t is equal to Δg_{zt}

Empirical model

$$\Delta L_{zt} = \beta_t * (1 - f_z) + \alpha_c + \Delta \epsilon_z$$

- $\beta_t \rightarrow$ Changes in mortgage origination (ΔL_{zt}) are strongly and positively associated areas of high subprime borrowers ($1 - f_z$)





- The paper examines three potential causes of the positive relationship

- The income-based, credit supply and expectations-based views

Empirical model

- Challenge: three competing hypothesis are likely linked $\rightarrow$ disentangling effects is difficult
- The authors make use of detailed data to overcome this challenge
- Empirically, the authors examine the joint evolution of various factors, including indebtedness, income, mortgage origination ...
- Critically, the paper examines this evolution at a ZIP code level across the US
- The authors do not attempt to establish causality
- Rather the aim of the paper is to establish certain facts about the build-up of household debt

Data

- The authors collect a vast collection of ZIP code level datasets covering the period 1990-2007
- Credit bureau data - Equifax
  - Consumer debt and credit score by type of loan and degrees of delinquency
- New mortgage loan originations - HMDA
  - Purpose of borrowing, loan amount, race, sex, home ownership status ...
- House prices - Case Shiller Index
  - Repeat sales house price indices
- Additional data
  - Census data on demographics & employment, IRS data on income ...

Income-based hypothesis I

- Can the strong relative growth in mortgage originations to subprime ZIP codes be explained by improvements in subprime borrower income?

TABLE III
CAN PRODUCTIVITY/INCOME GROWTH EXPLAIN SUBPRIME CREDIT EXPANSION FROM 2002 TO 2005?

	Mortgage origination growth 2002–2005 (1)	Income growth 2002–2005 (2)	Employment growth 2002–2005 (3)	Establishment growth 2002–2005 (4)
Fraction subprime borrowers, 1996	0.469**	−0.141**	−0.074**	−0.042**
	(0.029)	(0.006)	(0.011)	(0.005)
N	2,946	2,946	2,946	2,946
R^2	.42	.35	.15	.33

- The data suggests "no"
- Implication: mortgage origination growth in high subprime ZIP codes is stronger despite worsening income prospects

Income-based hypothesis II

- Can the strong relative growth in mortgage originations to subprime ZIP codes be explained by improvements in the *growth* of subprime borrower income?
- A negative correlation would suggest credit growth larger in areas with relative decreases in income
- A positive correlation would suggest credit growth larger in areas with relative increases in income

Income-based hypothesis II

- Can the strong relative growth in mortgage originations to subprime ZIP codes be explained by improvement in the *growth* of subprime borrower income?

TABLE IV
HISTORICAL MORTGAGE CREDIT GROWTH AND INCOME GROWTH CORRELATIONS

	Dependent variable: Mortgage originations for home purchase growth, annualized							
	2002–2005 (1)	1991–1998 (2)	1998–2001 (3)	2001–2002 (4)	2002–2004 (5)	2004–2005 (6)	2005–2006 (7)	2006–2007 (8)
Income growth, annualized	−0.662** (0.089)	0.537** (0.084)	0.517** (0.092)	0.425 (0.368)	−0.394** (0.122)	−0.383** (0.077)	0.103 (0.078)	0.716** (0.093)
N	3,014	2,809	3,014	3,014	3,014	3,014	3,014	3,014
R^2	.34	.55	.27	.44	.24	.39	.27	.26

- 2002-2005 the only period associated with a negative relationship
- Implication: mortgage origination to high subprime ZIP codes is stronger despite worsening relative income prospects, only between 2002-2005

Income-based hypothesis III

- Are the results sensitive to relative housing supply elasticity?
  - Areas with more inelastic housing supply may exhibit stronger relative origination growth in response to changes in income
  - Finding: controlling for housing supply elasticity has no meaningful impact

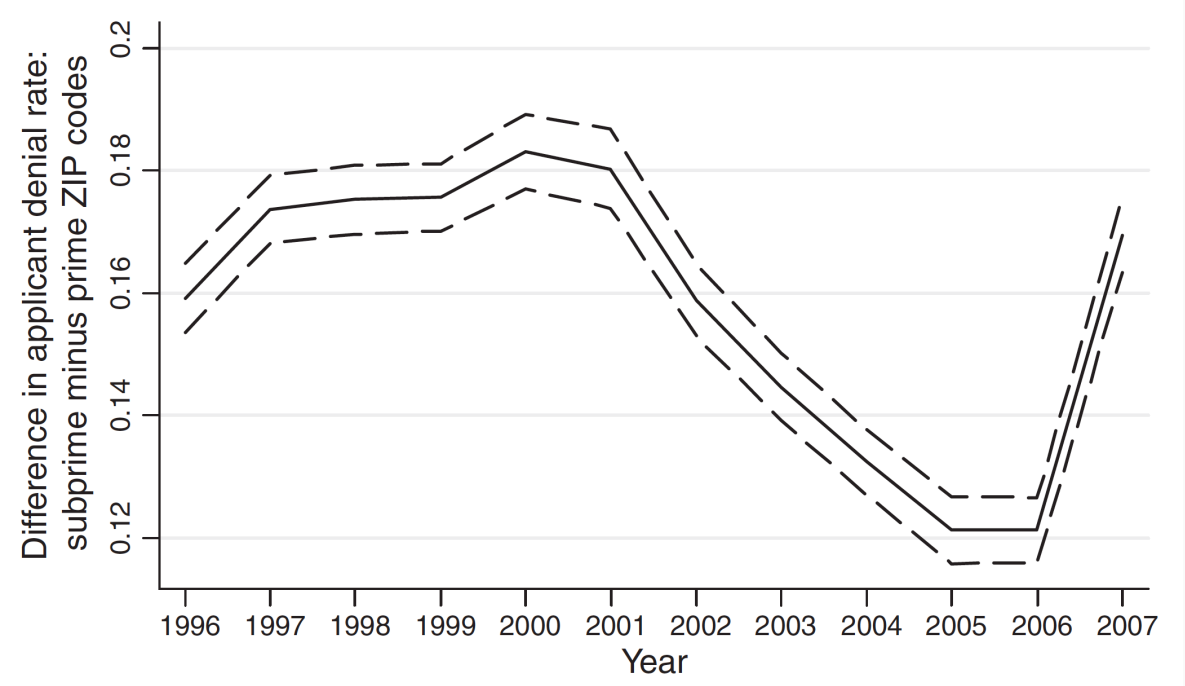
- Was the increase in leverage mortgage-driven?
  - Increased leverage across different credit products suggest broader factors are at play
  - Finding: non-mortgage debt balances experience a relative decline in subprime areas $\rightarrow$ mortgage origination is the driving force

- What was the role of broader macroeconomic effects?
  - The increase in mortgage credit may reflect changes in macroeconomic conditions: interest rates, business cycle effects ...
  - Ambiguous whether improved macroeconomic conditions should increase mortgage originations disproportionately for subprime borrowers

Credit supply hypothesis

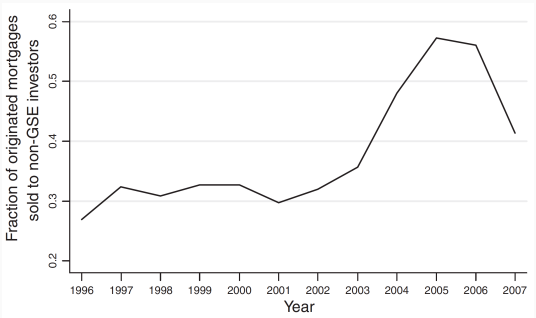
- So far: Growth in mortgage credit to subprime areas occurs despite decreases to the creditworthiness of subprime borrowers that historically lead to decreases in mortgage growth

- Implication: 2002-2005 saw a strong outward shift in the supply of credit strong enough to increase mortgage originations to subprime ZIP codes despite worsening borrower income prospects

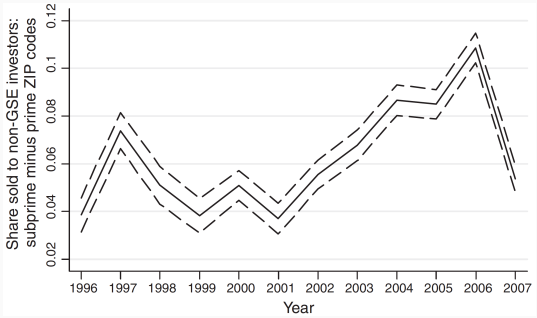


Credit supply hypothesis II

- What would cause an outward shift in the supply of credit to subprime borrowers?
- The paper considers one explanation for this outward shift, which saw an



increase in mortgages sold ...



which was disproportionately greater for subprime mortgages

- Between 1996 and 2002: 30% of all mortgages originated are sold to non-GSE institutions
- Between 2002 and 2005: this number increases to almost 60%

Credit supply hypothesis III

- Results reflect the increasing prominence of securitization in the mortgage market
- The HMDA dataset also contains information on the type of institution a mortgage was sold to

EVIDENCE OF A SECURITIZATION CHANNEL

	Panel A: Secondary mortgage sales and subprime ZIP codes					
	Change in applicant denial rate 2002–05	Change during 2002–05 in the fraction sold to non-GSE investors	Change during 2002–2005 in the fraction sold to non-GSE investors who are			
			Affiliates	Commercial banks	Securitized pools Of mortgages	Noncommercial bank fin. firms
	(1)	(2)	(3)	(4)	(5)	(6)
Fraction of subprime borrowers, 1996	−0.094**	0.048**	−0.055**	−0.007*	0.104**	0.077**
	(0.006)	(0.009)	(0.005)	(0.003)	(0.004)	(0.004)
N	2,946	2,946	2,946	2,946	2,946	2,946
R^2	.58	.46	.56	.46	.68	.61

Credit supply hypothesis IV

- Increases in mortgages sold for securitization purposes is strongly linked to subsequent default

Panel B: Mortgage sales and changes in default rate

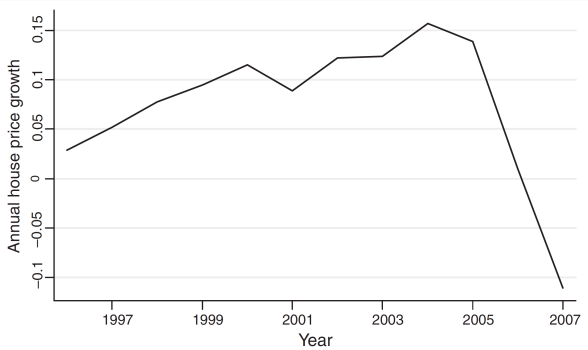
	Change in mortgage default rate from 2005 to 2007				
	(1)	(2)	(3)	(4)	(5)
Change during 2002–05 in the fraction sold to non-GSE investors	0.027				
	(0.015)				
Change during 2002–2005 in the fraction sold to non-GSE investors who are					
Affiliates		−0.247**			
		(0.027)			
Commercial banks			−0.116*		
			(0.046)		
Securitized pools of mortgages				0.360**	
				(0.031)	
Noncommercial bank financial firms					0.314**
					(0.029)
N	2,946	2,946	2,946	2,946	2,946
R^2	.39	.40	.39	.41	.41

- Indicates the role of securitization, financial innovation and related moral hazard

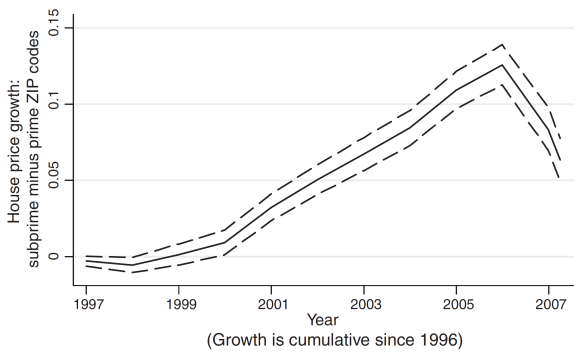
Expectations-based hypothesis

- Can lenders expectations of future house price growth explain the relative expansion of mortgage originations in subprime ZIP codes from 2002 to 2005?

- How would this channel work?
  - Against a backdrop of rising prices, lenders with unrealistic expectations of future price growth $\rightarrow$ underestimate default risk



House prices increased ...



disproportionately in high subprime areas

Expectations-based hypothesis II

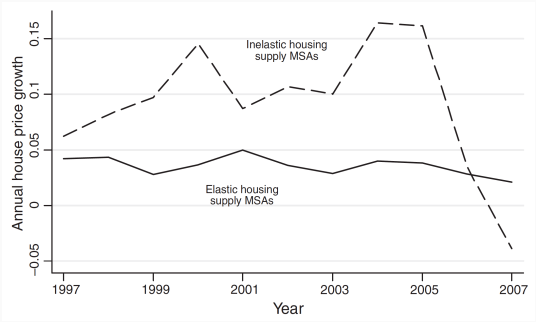
- Endogeneity concern: possible that an outward shift in the supply of mortgage credit increases both house price growth as well as mortgage credit growth
- Strategy: (i) find a setting where the shift in the supply of mortgage credit matters, but where (ii) it is unlikely that house price expectations change dramatically

Expectations-based hypothesis III

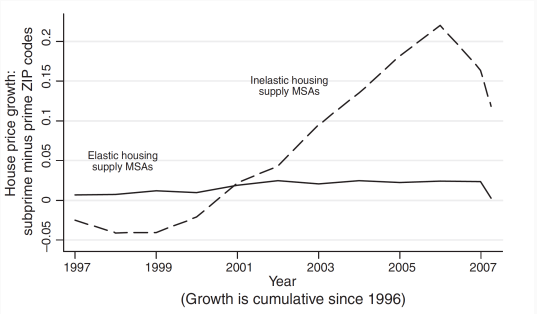
- The paper exploits differences in housing supply elasticity across areas
- Logic: house price expectations have a dampened effect in areas with relatively elastic housing supply - Glaeser, Gyourko, and Saiz (2008)
  - Upward pressure on house prices met by an increase in housing supply
- Implications
  - Expectations-based hypothesis holds in areas with low housing supply elasticity
  - Credit supply view holds irrespective of housing supply elasticity

Expectations-based hypothesis IV

- The data confirms the housing supply elasticity intuition



House price growth is flat in elastic areas



even in high subprime areas

- To distinguish between the credit-supply and house price expectation channel, the authors re-estimate their regression, sub-setting on areas in the top decile with respect to housing supply elastic

Expectations-based hypothesis V

TABLE VII
MORTGAGE ORIGINATION GROWTH AND MORTGAGE DEFAULT RATE CHANGES FOR HIGH–HOUSING SUPPLY ELASTICITY MSAS

	Income growth 2002–2005	Change in fraction sold in securitizations 2002–2005	Change in fraction to other financial firms 2002–2005	Mortgage origination growth 2002–2005		Change in mortgage default rate 2002–2005	
				With controls		With controls	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Fraction subprime borrowers, 1996	−0.069**	0.100**	0.061**	0.305**	0.413**	0.057**	0.056**
	(0.010)	(0.009)	(0.014)	(0.061)	(0.069)	(0.015)	(0.018)
N	655	655	655	655	655	655	655
R^2	.17	.28	.43	.10	.12	.04	.05

- Even in areas with highly elastic housing supply (lower house price expectations), the credit supply view still holds
- Suggests that the effects are driven by the credit supply view as opposed to the expectations-based view

What does the paper teach us about the crisis?

- 2002-2005 represented an unprecedented increase in household debt, particularly to ZIP codes with high shares of subprime borrowers
- The paper suggests that the driving factor behind this was an outward shift in mortgage credit supply
- This shift was likely influenced by changes in incentives in the financial sector which led to financial innovations, notably securitization
- Increases in securitization activity is strongly associated with the increase in household debt
- The effect is persistent, even after controlling for changes in income and house price expectations

What does the paper teach us about financial stability?

- The decoupling of credit growth from income growth can lead to severe macroeconomic consequence
  - For increases in household leverage to be sustainable, they must be matched by improvements in the productivity of borrowers
- The availability of cheap mortgages increases the demand for housing
  - Suggests that households are credit constrained
  - Implication: overly restrictive credit markets can amplify credit demand in boom periods
  - This demand for housing can push up house prices substantially
- House price growth is inextricably linked to mortgage-credit availability
  - This was largely ignored during the housing boom