

Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market

Giovanni Dell'Ariccia (IMF and CEPR)

Deniz Igan (IMF)

Luc Laeven (IMF, CEPR, and ECGI)

The views expressed in this presentation are those of the author and do not necessarily represent those of the *IMF*.

Credit Booms: Curse or Blessing?

- Financial deepening is associated with economic growth
- Booms can be good: only a minority ends in crises, and there is evidence that they contribute to long-term financial deepening
- Yet, credit booms are often seen as a recipe for financial disaster, possibly because several major banking crises have been preceded by booms
- While there are theoretical explanations linking booms to crises
- Empirical work has primarily relied on aggregate data
- Can we use U.S. subprime mortgage market as a lab study for credit booms?

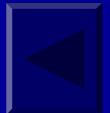
Credit Booms Can Be a Good Thing

- Cyclical^{ity} of credit:
 - Favorable economic conditions might justify extension of credit at less stringent terms
 - Wealth of profitable opportunities justify fast credit expansion
- Low interest rate environment reduces agency problems allowing sound credit growth (opposite of “flight to quality”)
- Booms promote financial deepening and widen access
- “Unfortunate tendency” to lend aggressively at the peak of a cycle (Greenspan)



Why Credit Booms Lead to Crises

- **“*Financial accelerators*”** (Kiyotaki and Moore, JPE 1997): an increase in value of collateralizable goods releases credit constraints. Boom fuels further wealth effects etc. Negative shocks invert cycle, leaving banking system overexposed
- **“*Institutional memory*”** (Berger and Udell, JFI 2004): in periods of fast credit expansion banks find it difficult to recruit enough experienced loan officers (especially if there has not been a crisis for a while). This leads to a deterioration of loan portfolios
- **“*Informational capital and adverse selection*”** (Dell’Ariccia and Marquez, JF 2006): during expansions, adverse selection is less severe and banks find it optimal to trade quality for market share, increasing crisis probability



Subprime Market Ideal Testing Ground

- Asymmetric info relevant since subprime borrowers:
 - Have poor or blemished credit histories
 - Provide little or no documentation
 - Have risky income profiles
- Market has grown fast and is now in a crisis
 - Loan originations tripled since 2000
 - Significant changes in market structure and financial innovation
 - Apparent relationship between delinquencies and credit growth
- Wealth of information on borrowers and lenders
 - Loan application data
 - Rich set of macro variables
 - Significant geographical variation within country

Main Contribution

- Examine evolution of lending standards during subprime boom to explain origins of current crisis
- Shed light on relationship between booms and banking crises in general
- Lend some empirical support to recent theories explaining cyclicity of standards and their links to financial instability

Data Sources

- Loan application data:
Home Mortgage Disclosure Act (HMDA)
- Subprime delinquency rate:
LoanPerformance
- Economic and social indicators:
Bureau of Economic Analysis, Bureau of Labor
Statistics, Census Bureau, Office of Federal Housing
Enterprise Oversight

Data: HMDA

- Millions of loan applications / Coverage from 2000 to 2006
- Depository and non-depository institutions issuing mortgages in a metropolitan statistical area (MSA)
- Both prime and subprime loans
- Subprime lenders identified using list by Dept. of Housing and Development (HUD)
 - Robustness using interest rate data after 2004
- Descriptive statistics

Measuring Lending Standards

- Did banks become less choosy during the boom?
- Two measures of lending standards at MSA level:
 1. Denial rate (DR) = $\text{Loans denied} / \text{Applications}$
 2. Loan-to-income ratio (LIR)
- Preference for DR as more robust to measurement error and fraud

Linking Boom and Lending Standards

- Regress measures of lending standards at MSA level on:
 1. Measures of credit expansion (boom)
 2. Controls for market structure and entry
 3. Loan sales (securitization)
 4. Macro and local variables controlling for economic conditions (including time and MSA fixed effects)

Baseline Methodology

- OLS regressions with MSA and time fixed effects
- 379 MSAs, 7 years
- Basic specification:

$$DR_{it} = \alpha_t + \gamma_i + \beta_1 AVGINC_{it} + \beta_2 INCGROW_{it} + \beta_3 UNEMP_{it} + \beta_4 SELFEMP_{it} + \beta_5 POP_{it} + \beta_6 COMP_{it} + \beta_7 HPAPP_{it-1} + \beta_8 APPL_{it} + \varepsilon_{it}$$

Measuring the Boom

- Main boom variable is the growth rate in the number of loan applications in an MSA
- For robustness we also use:
 - Growth rate in the number of loan originations in an MSA
 - Growth rate in the volume of originated loans in an MSA
- Preference for application measure because of greater exogeneity
 - Growth in originations is obviously the result of changes in denial rates
 - Exogeneity remains concern – “Neighbor effect” (more on this later)

Other Control Variables

- Macro variables
 - Income growth, unemployment rate, population, self-employment rate
- Market structure variables
 - Number of competing lenders
 - Entry by large (top 20) national player (market share of entrants)
- Other sectoral variables
 - House price appreciation (endogeneity issues here)
 - Percentage of loans sold

Loosening Subprime Lending Standards

<u>Dependent variable: Denial rate</u>	<u>All</u>	<u>Prime</u>	<u>Subprime</u>
House price appreciation	-0.234***	-0.150***	-0.308***
Average income	-0.002***	-0.003***	-0.004***
Income growth	0.003	-0.021	0.100
Unemployment	0.003**	0.002	0.003*
Self employment	0.046	0.080	-0.311**
Log population	-0.180***	-0.232***	-0.353***
Log number of competitors	0.018***	-0.003	-0.069***
Log number of applications	-0.017***	0.025***	-0.030***
Constant	2.697***	3.065***	5.749***
R-squared	0.69	0.71	0.44

Robustness and Identification Issues

- Effects of changes in applicant pool
 - Estimate denial model with loan level data for 2000
 - Forecast denials at loan level for 2001-2006
 - Aggregate errors at MSA level and use as dependent variable
- Endogeneity of application and house appreciation variables
 - Instrument subprime applications with prime applications
 - Lag house appreciation
 - Instrument house appreciation with “Rapture Index”
- Alternative measures of lending standards and credit boom
 - Loan-to-income ratio
 - Loan originations and volumes

Extensions I

- Effects of changes in market structure
 - Focus on role of entry of large national players
 - Threat of competition may induce incumbents to cut standards
 - Augment model with measure of Top20 entrants' market share
 - Focus on incumbents denial rates
- Effects of increased recourse to securitization
 - Decreased incentives to monitor
 - Augment model with proportion of loans sold within 1 year
 - Distinguish between earlier and later periods as securitization became more relevant in the second half of the sample

Extensions II

- Nonlinearities in boom and market size
 - Focus on larger MSA markets
 - Focus on MSA with more pronounced booms
- Was there a role for monetary policy?
 - Low interest rates may have further favored lax standards
 - Interact our boom variable with Federal Funds rate
 - Also control for time trend
- Similar findings for “Jumbo loan” market
 - Is this the next problem market?

Summary of Findings I

- Fall in lending standards associated with credit boom
 - Shed light on relationship between booms and crises
 - Lend support to recent asymmetric information based theories

- Trend exacerbated by:
 1. Housing boom
 - Role as collateral
 - Evergreening and speculative behavior
 2. Competition by large and aggressive entrants
 3. Disintermediation through loan sales weakening monitoring incentives
 4. Lax monetary policy

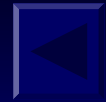
Summary of Findings II

- Results appear robust across several specifications:
 - Lending standard measures
 - Credit boom measures
 - Controlling for pool quality
 - Endogeneity in house prices
 - Endogeneity of boom variables
 - Market size effects

Discussion

- Evidence on role of monetary policy in lax lending among subprime lenders
- Should bank risk-taking behavior play role in monetary policy decision making?
- A case for cyclical capital regulation?
- Booms can still be optimal

Controlling for Applicant Pool



<u>Dependent variable: Prediction error</u>	<u>All</u>	<u>Prime</u>	<u>Subprime</u>
House price appreciation	-0.178***	-0.104***	-0.281***
Average income	-0.004***	-0.005***	-0.003
Income growth	-0.015	0.007	-0.002
Unemployment	-0.001	-0.004***	0.003
Self employment	-0.120*	-0.048	-0.414***
Log population	-0.183***	-0.166***	-0.335***
Log number of competitors	0.021***	0.008	-0.051***
Log number of applications	-0.019***	-0.002	-0.026***
Constant	2.660***	2.355***	5.026***
R-squared	0.90	0.87	0.42

Controlling for Endogeneity



<u>Dependent variable: Denial rate</u>	<u>APPL S</u>	<u>IV: APPL P</u>	<u>IV: Rapt</u>	<u>Lag HPA</u>
House price appreciation	-0.329***	-0.334***	-0.576***	
House price apprec., lagged				-0.226***
Average income	-0.004**	-0.003*	-0.004*	0.002
Income growth	0.108	0.051	0.189***	-0.103
Unemployment	0.003*	0.003	0.000	0.005**
Self employment	-0.271**	-0.263**	-0.289**	-0.167
Log population	-0.385***	-0.266***	-0.304***	-0.313***
Log number of competitors	-0.074***	-0.035***	-0.057***	-0.055***
Log number of all applications				-0.033***
Log number of subprime appl.	-0.013**	-0.074***	-0.014***	
Constant	5.996***	4.679***	4.918***	5.094***
R-squared	0.43	0.40	0.40	0.40

Alternative Measure of Standards



<u>Dependent variable: LIR</u>	<u>All</u>	<u>Prime</u>	<u>Subprime</u>
House price appreciation	0.105	0.103	0.222***
Average income	0.037***	0.038***	0.029***
Income growth	-0.886***	-0.871***	-0.924***
Unemployment	-0.018***	-0.020***	-0.009*
Self employment	1.559***	1.523***	1.578***
Log population	0.255*	0.315**	-0.176
Log number of competitors	0.120***	0.123***	0.277***
Log number of applications	0.109***	0.090***	0.265***
Constant	-4.301**	-4.915***	-0.801
R-squared	0.67	0.65	0.60

Effect of Loan Sales



<u>Dependent variable: Denial rate</u>	<u>All</u>	<u>Prime</u>	<u>Subprime</u>
House price appreciation	-0.193***	-0.122***	-0.269***
Average income	-0.002**	-0.004***	-0.002
Income growth	0.043	0.025	0.096
Unemployment	0.003**	0.001	0.004*
Self employment	0.092	0.112	-0.271**
Log population	-0.199***	-0.296***	-0.256***
Log number of competitors	0.035***	0.009	-0.057***
Log number of applications	-0.010*	0.034***	-0.032***
Proportion of loans sold	-0.256***	-0.226***	-0.123***
Prop. loans sold * Year \geq 2004	0.024	0.076***	-0.110***
Constant	2.864***	3.838***	4.444***
R-squared	0.73	0.74	0.45

Effect of New Entry



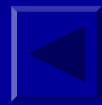
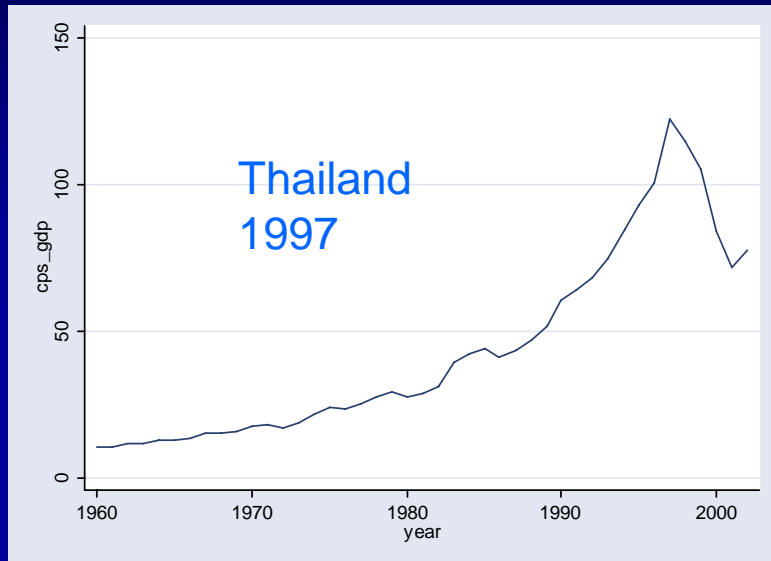
<u>Dependent variable: Incumb. denial rate</u>	<u>All</u>	<u>Prime</u>	<u>Subprime</u>
House price appreciation	-0.205***	-0.096***	-0.297***
Average income	-0.004***	-0.007***	-0.001
Income growth	0.009	0.041	0.031
Unemployment	0.001	-0.001	0.006**
Self employment	-0.087	-0.074	-0.291**
Log population	-0.164***	-0.224***	-0.348***
Log number of competitors	0.006	0.011**	-0.063***
Log number of applications	-0.052***	-0.031***	-0.022***
Market share of entrants	0.024		
MS of entrants to prime		-0.023*	
MS of entrants to subprime			-0.149***
Constant	2.990***	3.568***	5.572***
R-squared	0.76	0.74	0.34

Effect of Monetary Policy

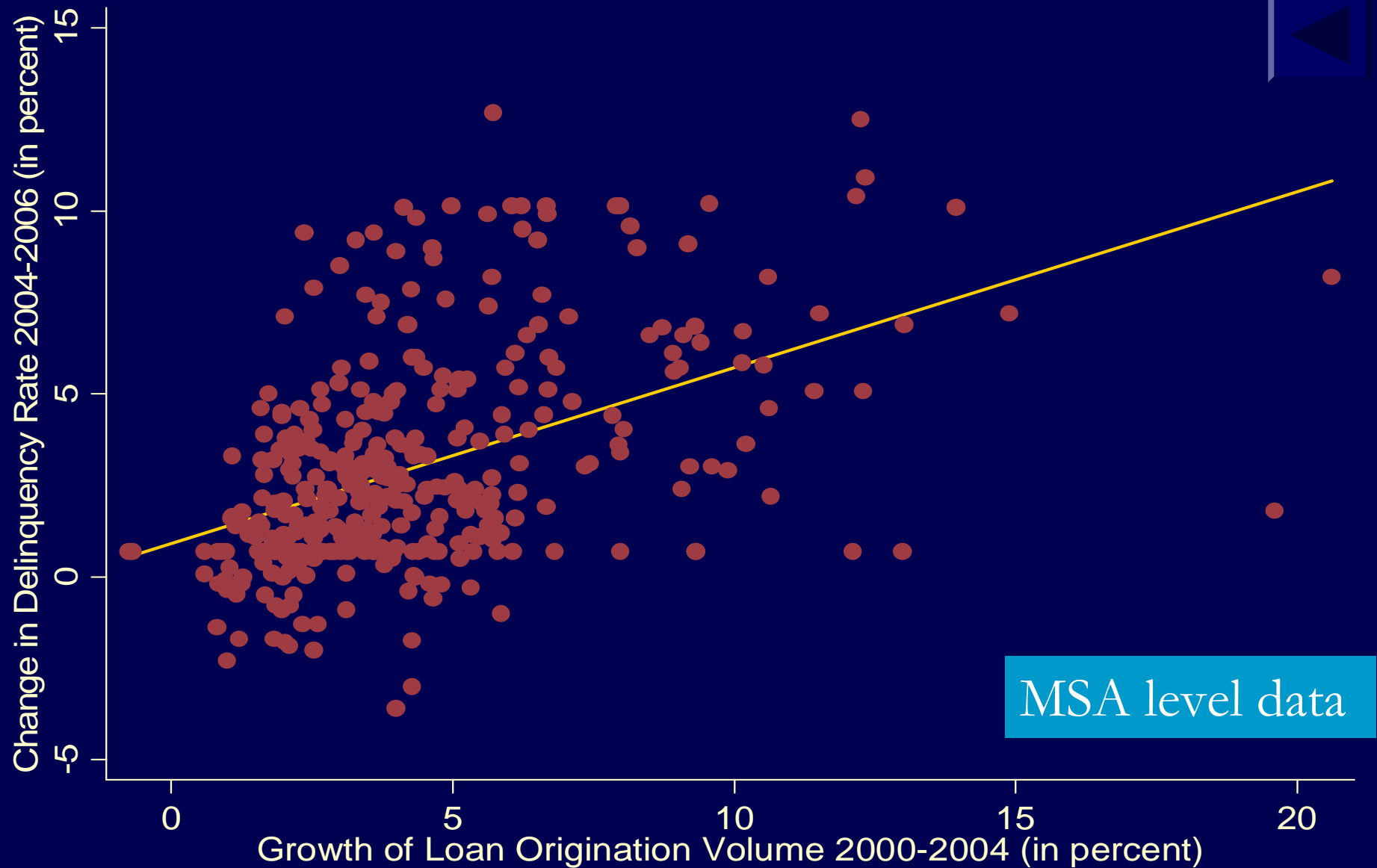


<u>Dependent variable: Denial rate</u>	<u>Time trend</u>	<u>Fed Fund rate</u>	<u>Both</u>
House price appreciation	-0.322***	-0.285***	-0.295***
Average income	-0.003**	-0.004***	-0.004***
Income growth	0.096**	0.072	0.070
Unemployment	0.004**	0.006***	0.006***
Self employment	-0.311**	-0.081	-0.091
Log population	-0.314***	-0.357***	-0.330***
Log number of competitors	-0.062***	-0.076***	-0.071***
Log number of applications	-0.025***	-0.032***	-0.029***
Log number of appl. * Trend	-0.001***		-0.001**
Log number of appl. * FFR		0.004***	0.003***
Constant	5.996***	4.679***	5.094***
R-squared	0.44	0.45	0.45

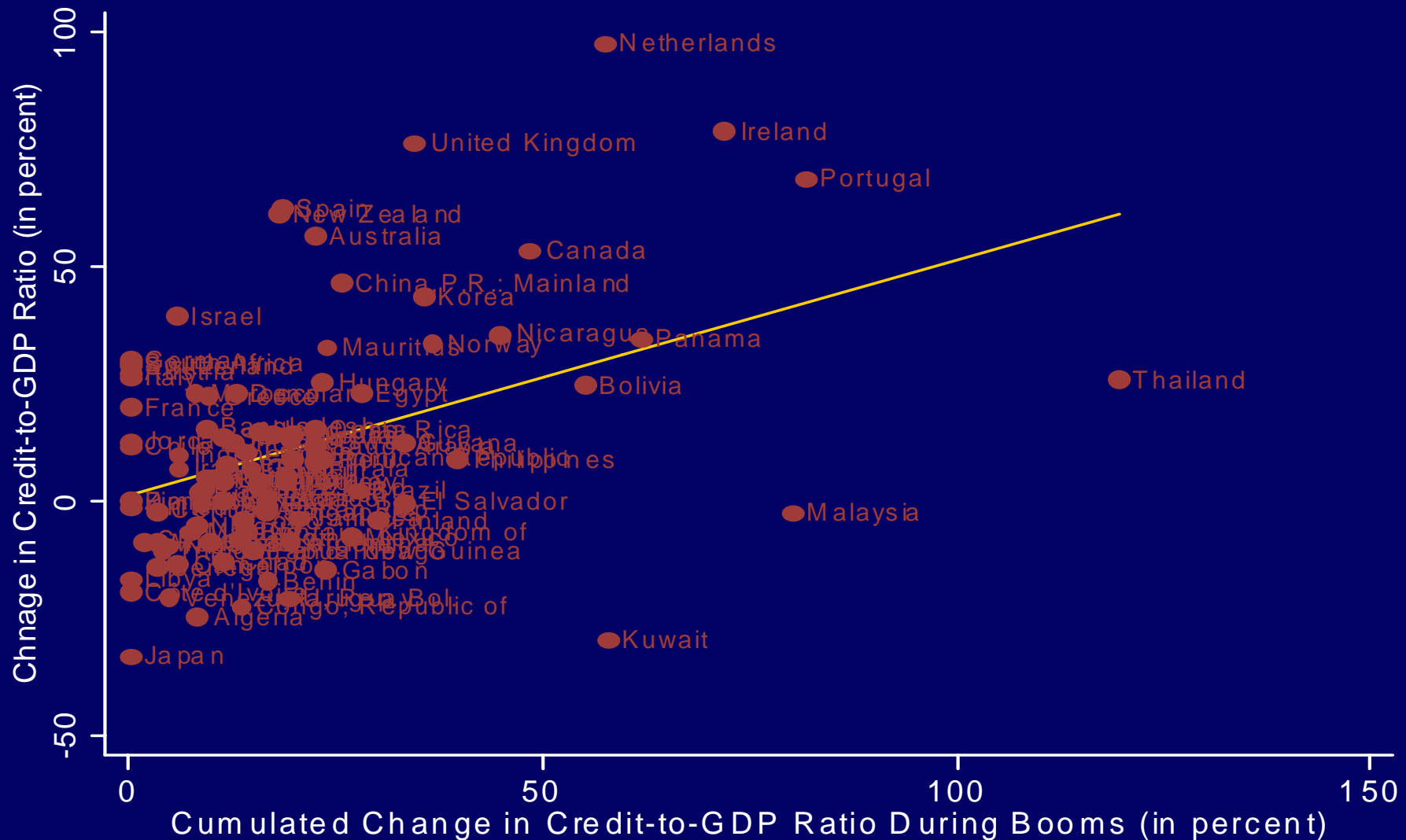
Booms and Crises



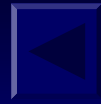
Subprime Crisis: A Credit Boom Gone Bad?



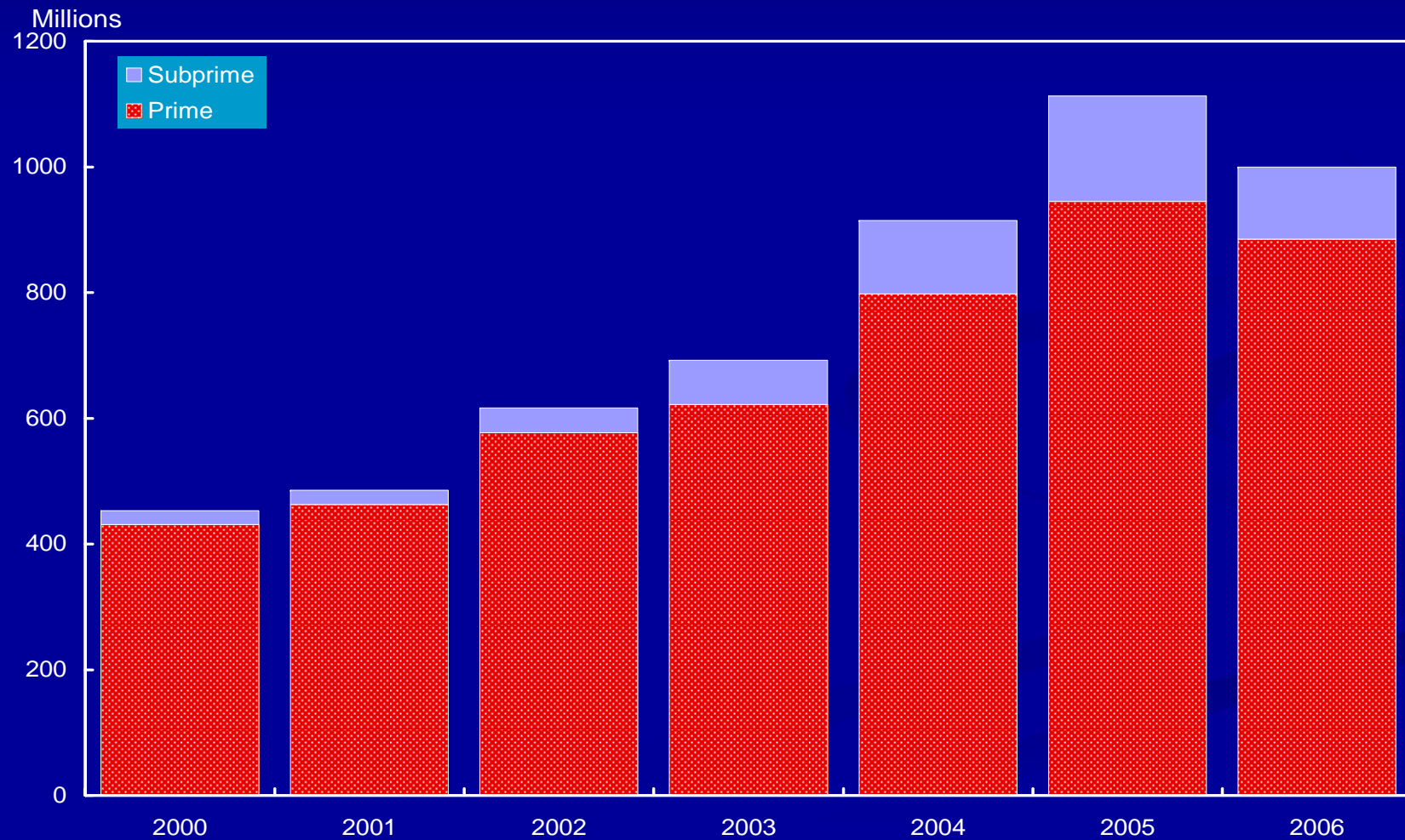
Credit Booms and Financial Deepening (1985-2004)



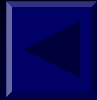
U.S. Subprime Mortgage Boom



Nationwide Home Purchase Loan Originations
(volume of loans in dollars)



Data: Summary statistics

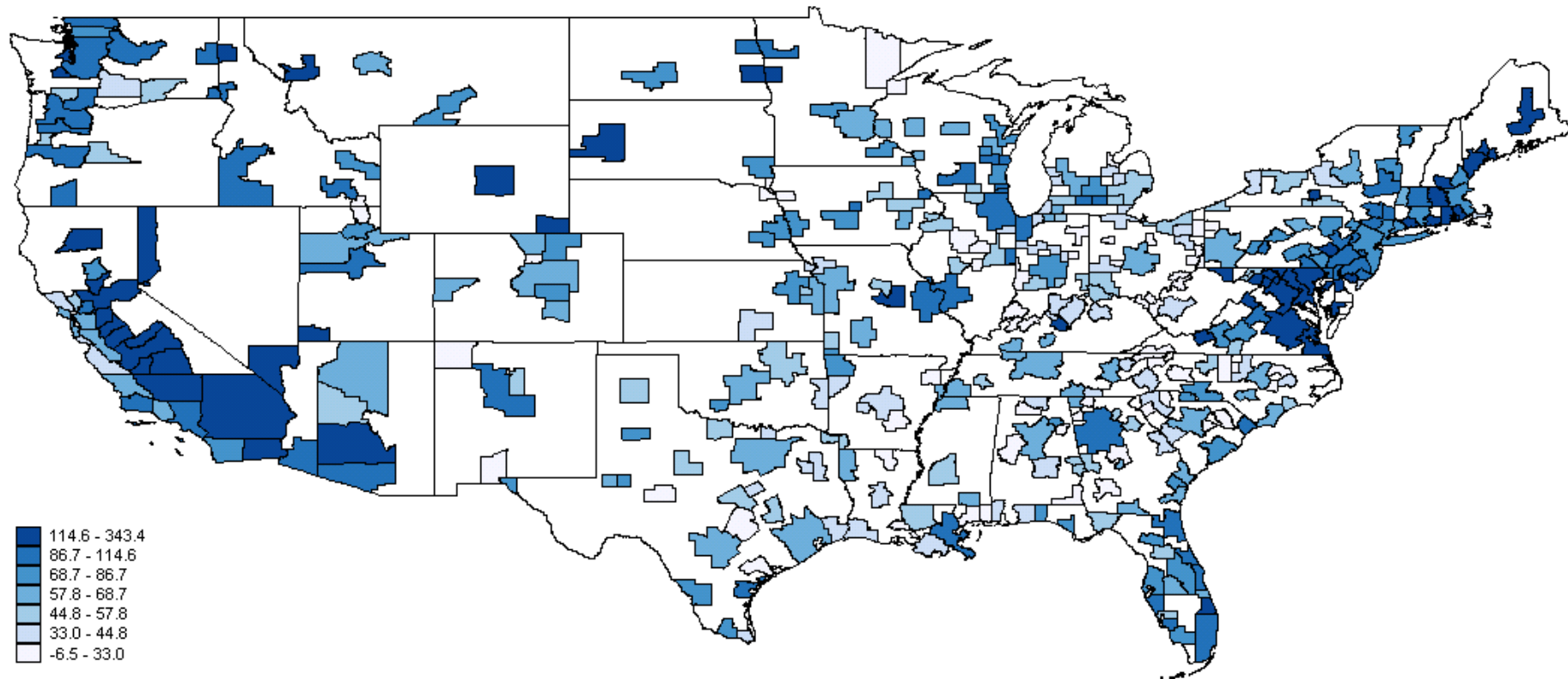


<u>Variable</u>	<u>Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>
<i><u>Loan application level</u></i>					
Denied	72,119,135	0.19	0.39	0	1
Subprime	72,119,135	0.23	0.42	0	1
Loan amount	72,119,135	160.59	125.41	1	1800
Applicant income	72,119,135	82.16	50.32	16	363
Loan-to-income	72,119,135	4.25	0.56	1	6
<i><u>MSA level</u></i>					
Denial rate	2,709	0.25	0.07	0.07	0.55
Denial rate, prime	2,709	0.18	0.07	0.04	0.52
Denial rate, subprime	2,703	0.50	0.08	0.00	0.73
House price appreciation	2,651	0.07	0.06	-0.05	0.41
Loan-to-income	2,709	1.88	0.37	1.05	3.40
Proportion of loans sold	2,709	0.46	0.10	0.00	0.78
Subprime delinquency rate	1,137	10.49	3.58	1.70	35.80

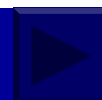
Where was the boom?



Credit growth: 2000-2004
Number of originations (percent increase)



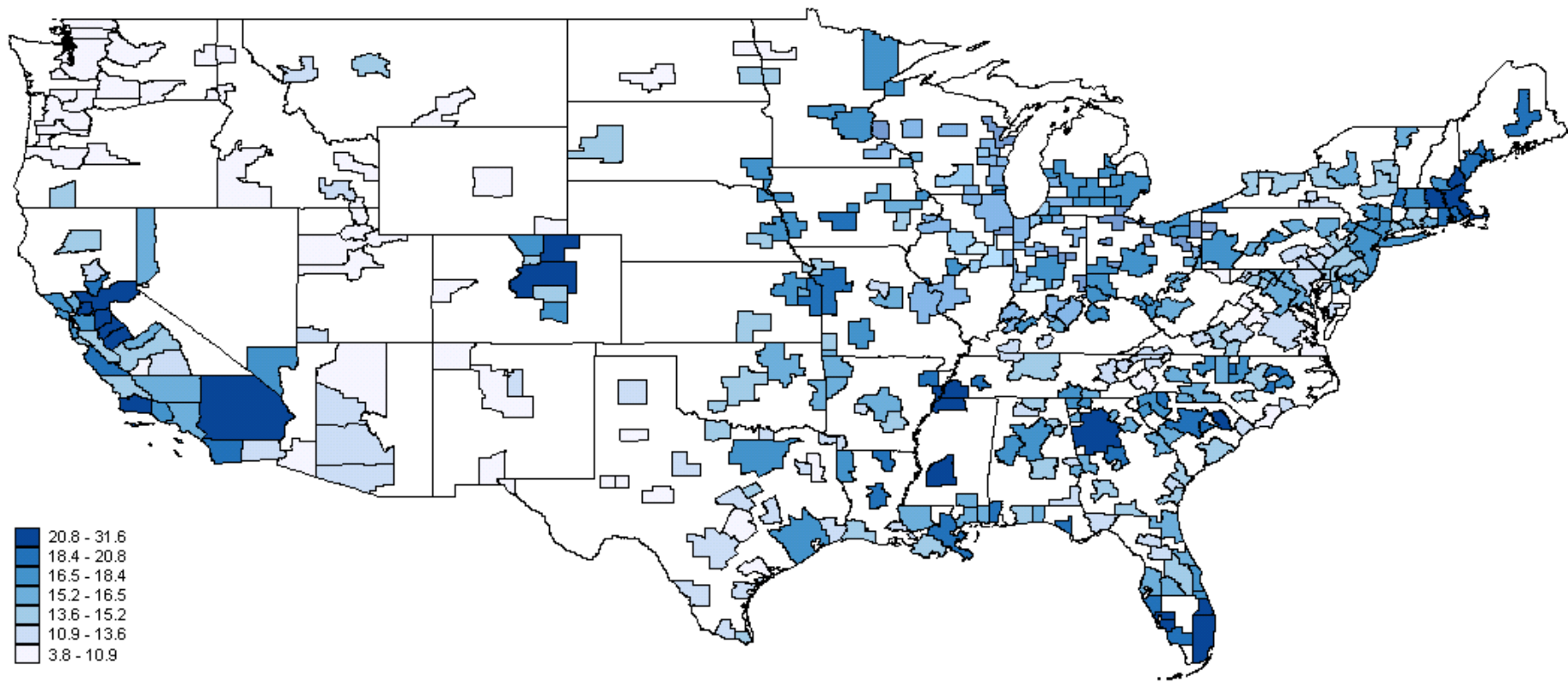
© IMF 2008



...And where are the delinquencies?



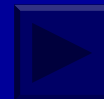
Home loans: 60+ days late
Percent of total loans, November 2007



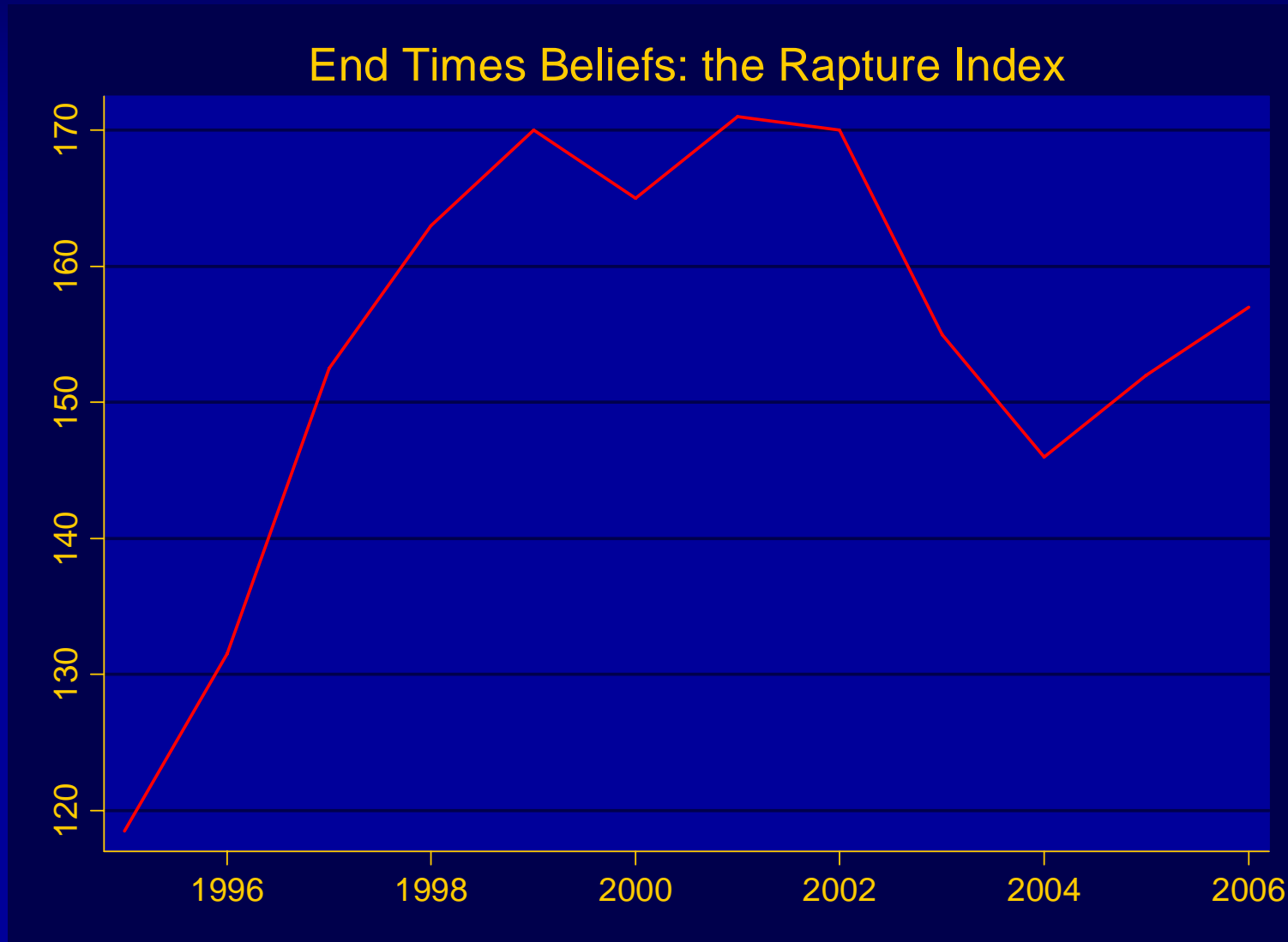
A Rather Exogenous Instrument



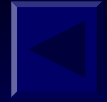
1. False Christs	3	18. Ecumenism	4	35. Date Settings	2
2. Occult	2	19. Globalism	3	36. Volcanoes	4
3. Satanism	2	20. Tribulation Temple	2	37. Earthquakes	5
4. Unemployment	3	21. Anti-Semitism	4	38. Wild Weather	5
5. Inflation	3	22. Israel	5	39. Civil Rights	3
6. Interest Rates	2	23. Gog (Russia)	5	40. Famine	3
7. The Economy	4	24. Persia (Iran)	5	41. Drought	5
8. Oil Supply/Price	4-1	25. The False Prophet	3	42. Plagues	3
9. Debt and Trade	3	26. Nuclear Nations	5	43. Climate	3
10. Financial unrest	5	27. Global Turmoil	4	44. Food Supply	5
11. Leadership	4	28. Arms Proliferation	4	45. Floods	5
12. Drug abuse	2	29. Liberalism	4		
13. Apostasy	4	30. The Peace Process	3+1	Rapture Index	159
14. Supernatural	1	31. Kings of the East	4	Net Change	unch
15. Moral Standards	3	32. Mark of the Beast	3		
16. Anti-Christian	3	33. Beast Government	4		
17. Crime Rate	4	34. The Antichrist	2	Udated Dec 3, 2007	



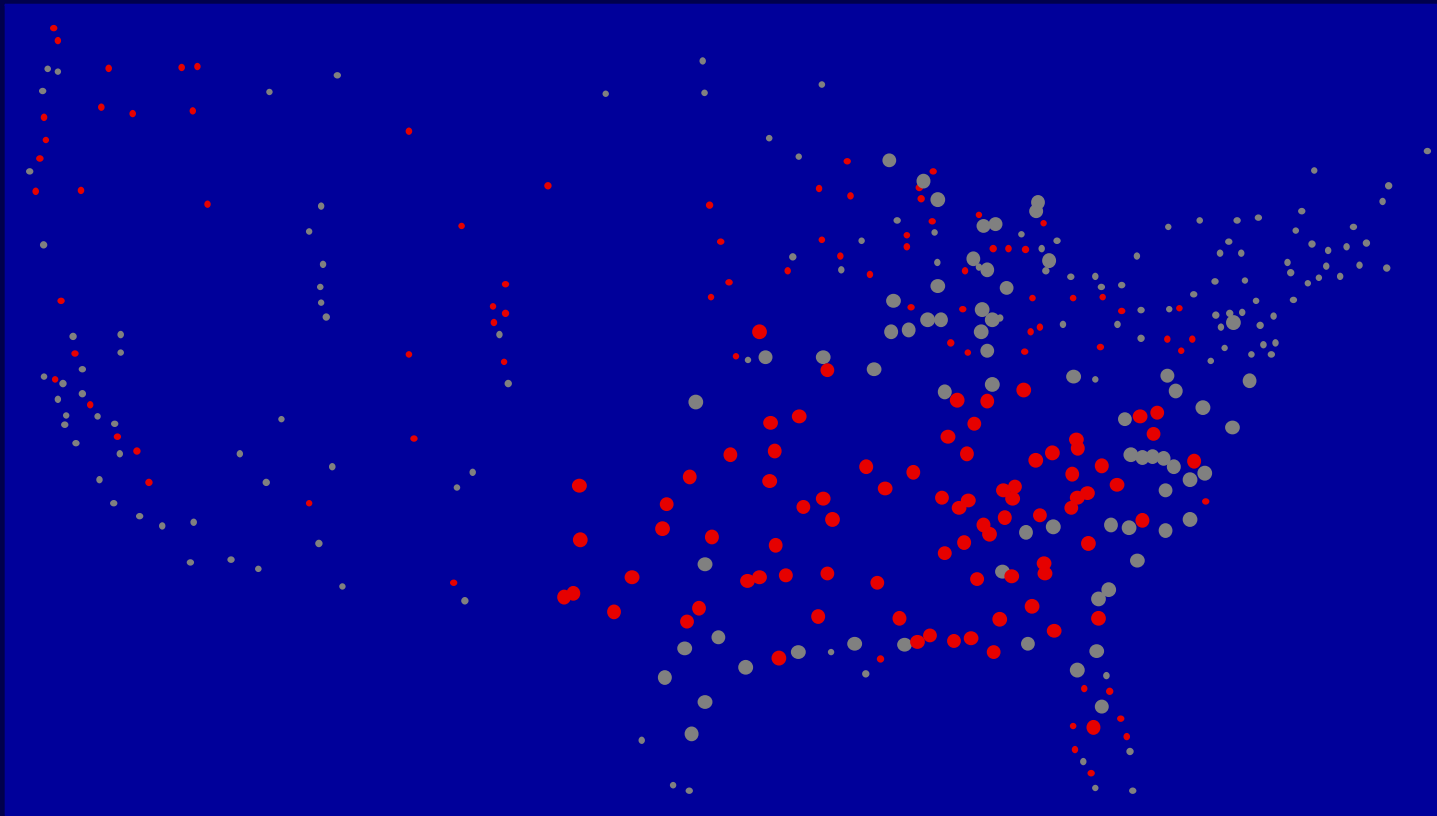
No obvious time-series pattern ...



Little overlap with boom areas



Evangelicals: Share of MSA Population



- Less than 10 percent
- 10-15 percent
- 15-25 percent
- More than 25 percent