Empirical Insights into Systemic Risk: From Housing Boom to Global Financial Crisis

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Outline

- Introduction
- Purpose / Research Question
- Literature review
- Related events and empirical work
- Empirical methodology
- Results
- Suggestions for future research / limitations
- Conclusion

Outline

> ## **Introduction**

- ❖ Purpose / Research Question

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GLOBAL FINANCE CRISIS- "Red September"

September 15, 2008:
Merrill Lynch sold to Bank of America amidst fears of a liquidity crisis and Lehman Brothers collapse

September 15, 2008:
Lehman Brothers files for bankruptcy protection

September 19, 2008:
Paulson financial rescue plan unveiled after a volatile week in stock and debt markets.

September 25, 2008:
Washington Mutual was seized by the Federal Deposit Insurance Corporation, and its banking assets were sold to JP Morgan Chase for $1.9bn.
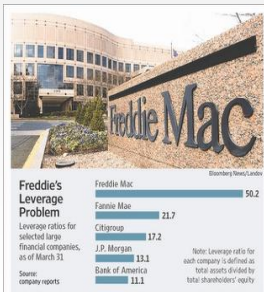
Sep-08   Sep-08   Sep-08   Sep-08   Sep-08   Oct-08

September 7, 2008:
Federal takeover of Fannie Mae and Freddie Mac

September 17, 2008:
The US Federal Reserve loans $85 billion to American International Group (AIG) to avoid bankruptcy.

September 29, 2008:
The House rejected bail-out bill, DJIA down 7%

October 3,2008: The House pass the bail out bill

September 16, 2008:
Moody's and Standard and Poor's downgrade ratings on AIG's credit on concerns over continuing losses to mortgage-backed securities, sending the company into fears of insolvency.

Outline

Purpose/ Research Question

- Provide a high level understanding of factors that resulted in the global financial crisis.

- Specifically, we seek to answer *:*

  - How did the housing bubble originate? What role did monetary policy play in creating the housing bubble?

  - What factors other than the housing bubble caused the global financial crisis? Was monetary policy combined with additional factors of regulations, financial innovations, GSEs, structural change, and international capital flows popularly known as the global saving glut hypothesis responsible for the bubble?

  - What are the key takeaways from this thesis?

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Housing "Bubble"
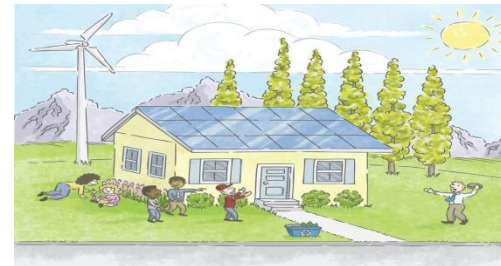
Easy Money Policy

A "Global Saving Glut"
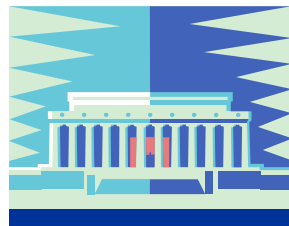
Capital Inflows

Innovative Banks

Ambitious Mortgage Brokers
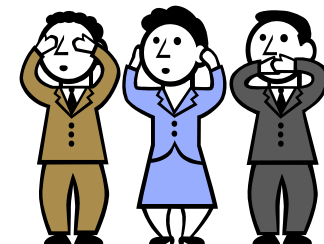
Eager Home Buyers

Escalating House Prices

Bank Regulators

Gov't Sponsored Enterprises

Securitization →MBSs
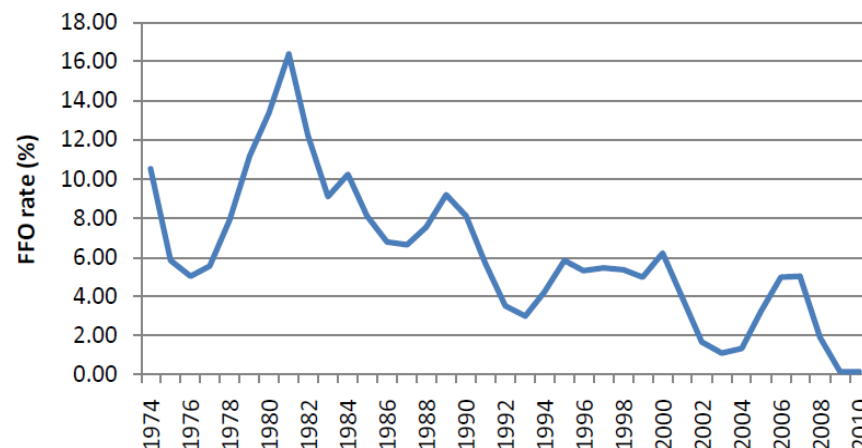
Rating Agencies

The Bubble Trouble

- Housing price bubble ⟹ homebuyers think buying house 'affordable' compensated by price increases ⟹ don't need to save as much ⟹ increased value of their home is their saving SO 'barely any perceived risk' ⟹ First-time homebuyers ⟹ do not buy now ⟹ may not be able to afford a home later ⟹ BUT Prices cannot keep going up forever ⟹ when individuals perceive this ⟹ support for high home prices breaks ⟹ bubble now bursts

- Robert Shiller (Yale economist) found that home prices in 2004 were looking like a 'rocket taking off.' It looked like the rocket might come crashing back down to earth.

Monetary policy and the housing bubble

The Target Federal Funds Rate and the Taylor (1993) Rule Prescriptions

— Target Rate   - - - Taylor Rule (output gap and headline CPI inflation as currently measured)
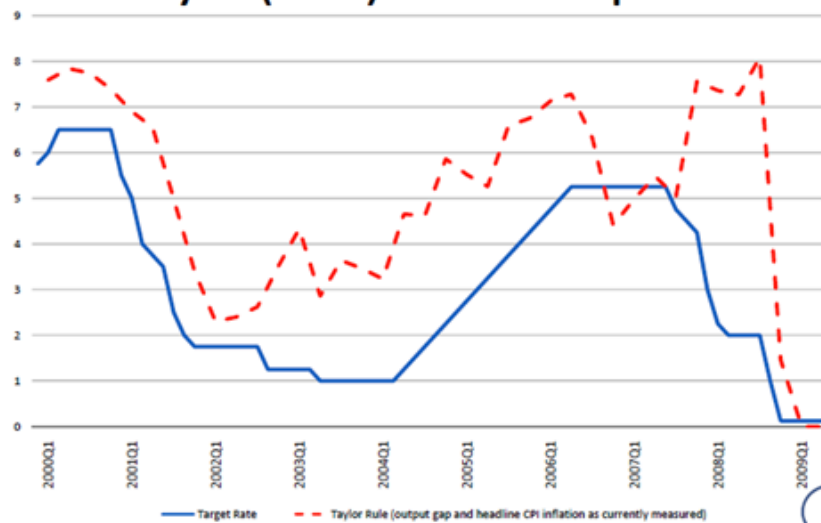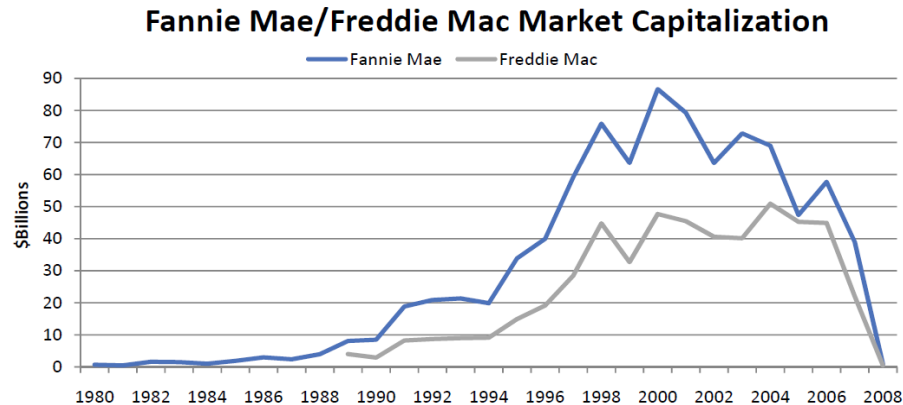

Federal Funds Rate across years

- Fed's Chairman Bernanke (2010) defended the lose monetary policy while Taylor believed that it played a central role in the housing bubble which led to the crisis

Securitization of sub-prime mortgages

- Historically, banks had a buy-and-hold business model but with securitization that changed to originate-to-distribute - banks originate loans and then securitize them

- Home purchase - mortgage loan agreement - 'originator' - sells these mortgages to a securitizing firm - bundle these mortgages into pools - new securities - private label ABS (asset backed securities)

- Were home buyers making sounding decisions regarding their ability to repay ?

- Did ultimate investors recognize the additional risk ?

Role of GSE's in the Housing Bubble

Fannie Mae/Freddie Mac Market Capitalization

Fannie Mae ——— Freddie Mac

(chart: $Billions on y-axis from 0 to 90, years 1980 to 2008 on x-axis)

- Fannie Mae (started in 1938) to purchase loans insured by the Federal Housing Administration. In 1970, Congress chartered a second GSE, Freddie Mac.

- In 1995, the Department of Housing and Urban Development (HUD) came out with a target goal of 70% homeownership. In 1999, HUD directed Fannie Mae and Freddie Mac to relax their requirement standards on mortgage loans.

- Between 2005-07 Freddie and Fannie purchased c. $1 trillion in sub-prime and Alt-A loans adding up to 40% of their mortgage purchases. As subprime delinquencies increased, both GSEs took significant losses on their mortgage holdings.

- For every $100 they had guaranteed or lent via securities all they had was $1.2 of equity.

Global Savings Glut / Global supply of saving

- The hypothesis is that post the East Asian financial crisis in 1997, investment dropped in these economies in comparison to savings, a significant increase in the global supply of saving occurred - a global saving glut, so excess savings from these economies got invested in US explaining the increase in the U.S. current account deficit and the relatively low level of long-term real interest rates in the world. These low interest rates in turn gave rise to the housing market bubble

Savings & investment World in1996

Savings & investment World after1997
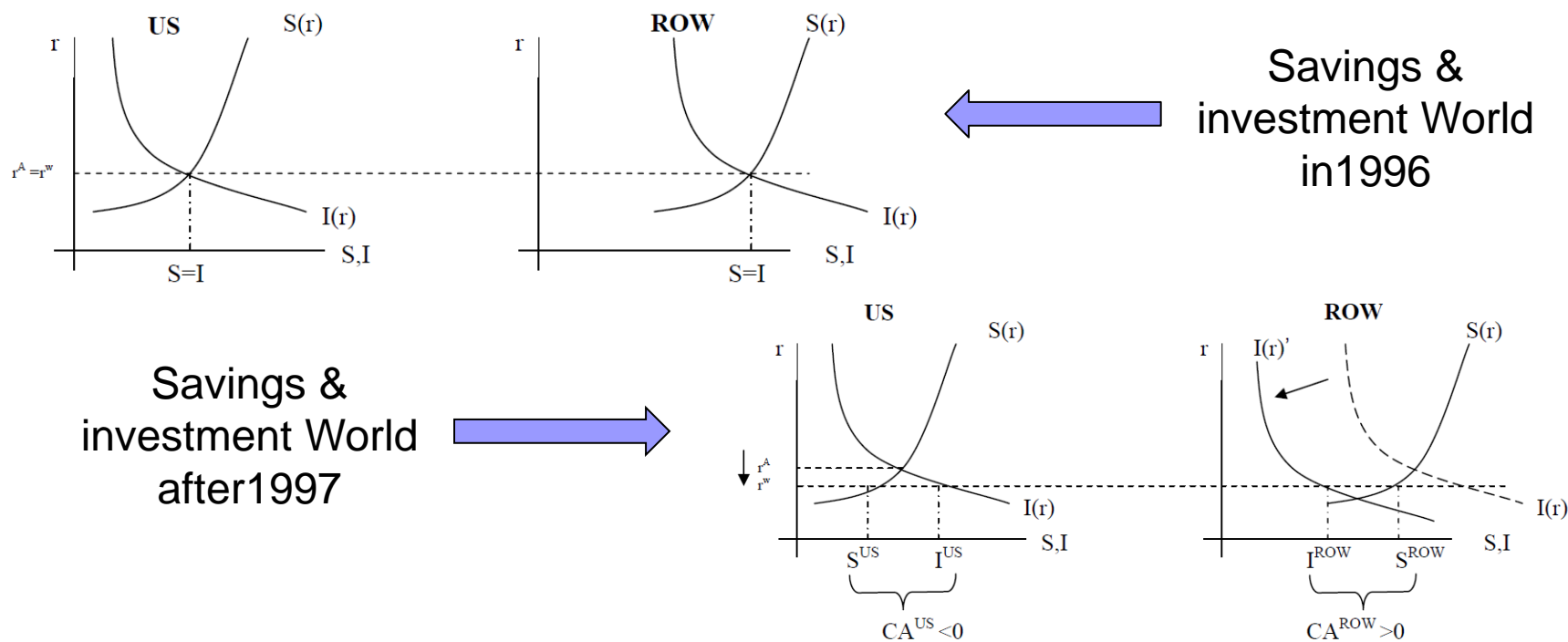
Basel II – What Happened ?

- **Basel I** : **1988 Basel Capital Accord** - a well designed incentives structure, with banks themselves free to choose their preferred risk/return profile, is more effective than structural controls. Players started exploiting flaws - widespread use of the OTD model, increasing off balance-sheet exposures, a significant role being played by non-regulated and highly-leveraged intermediaries

- **Basel II** : **2004 Second of the Basel Accords** - uses a "three pillars" concept
  - **First pillar** : minimum capital requirement
  - **Second pillar** : supervisory review process
  - **Third pillar** : market discipline.
  - Several shortcomings – undercapitalization, losses in the portfolios, encourage "structured investment vehicle" SIV's

- **Basel III** : **Third Basel Accord** – To overcome Basel II shortcomings and address deficiencies in regulation revealed by the 2007-08 financial crisis
  - Scheduled for 2013, but has been postponed to 2018

Structured Finance Meltdown
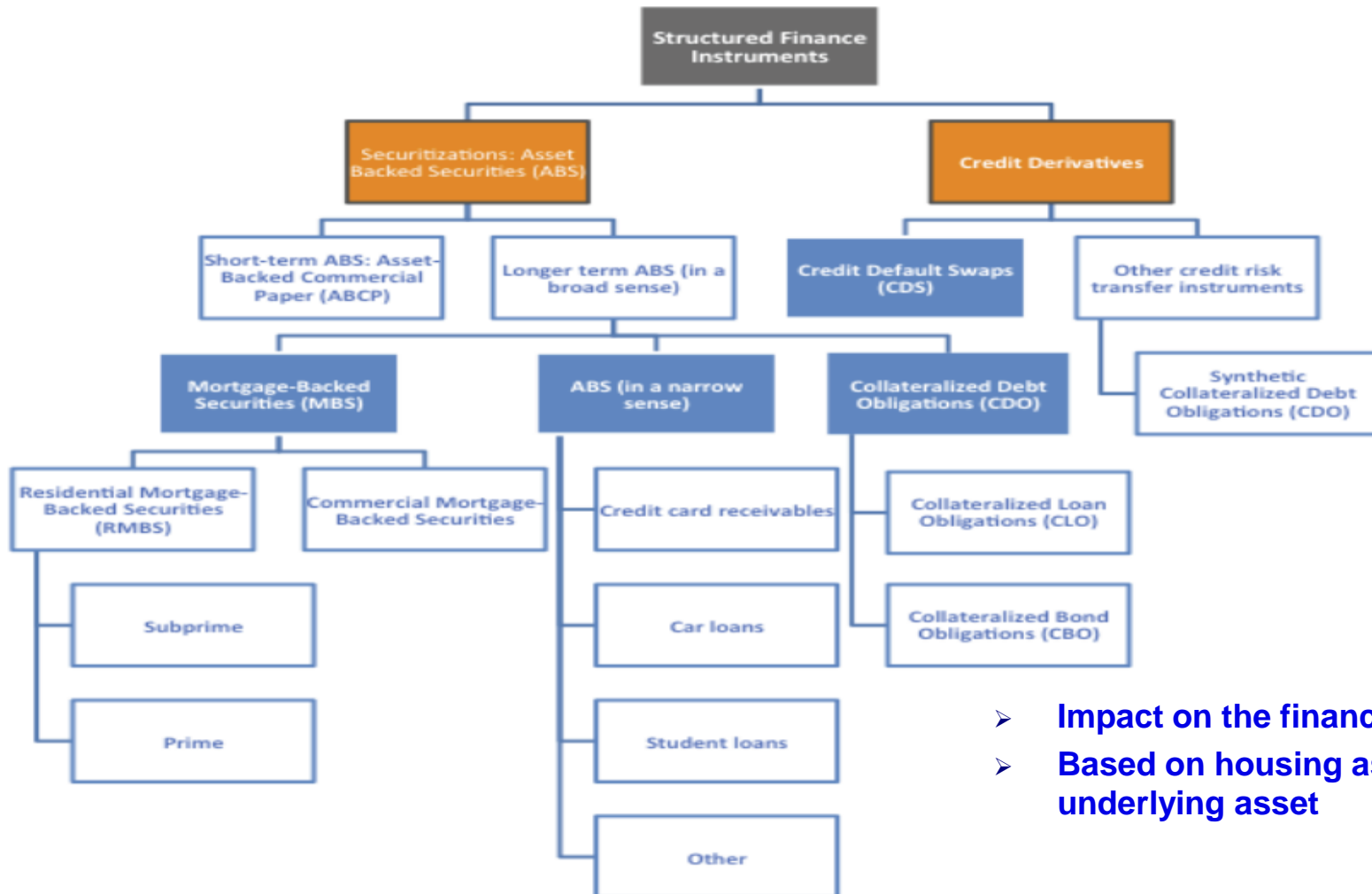
➢ **Impact on the financial crisis**
➢ **Based on housing as the underlying asset**

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Related events
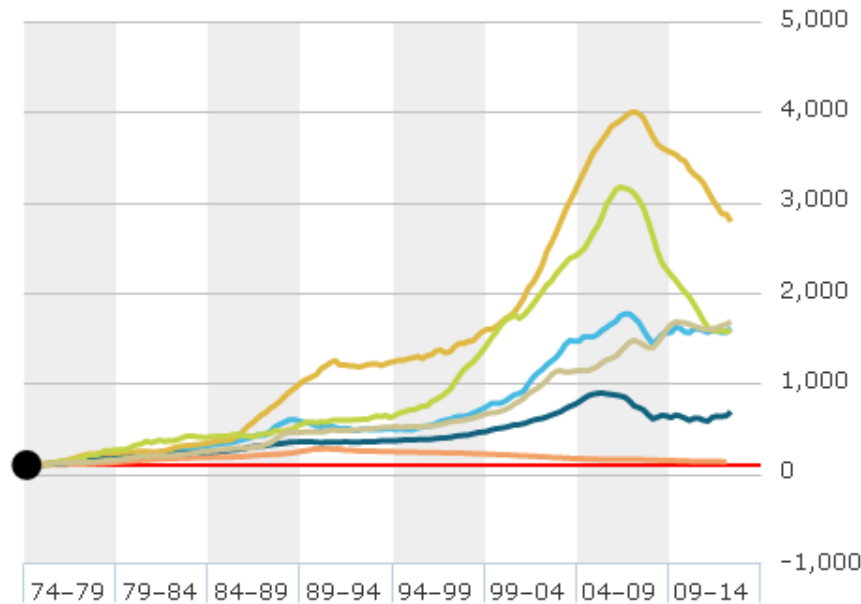
Nominal house-price index in several countries rebased to 100

- **Was U.S. alone facing the housing bubble ?**

  - □ Gonzalo Bernardos (2009) and Greenspan's (2010) analysis says that many countries other than the U.S. were having their own homegrown real estate bubbles

  - □ Thus, clearly the housing bubble was global in nature, not just a U.S. phenomenon

Related events (contd.)
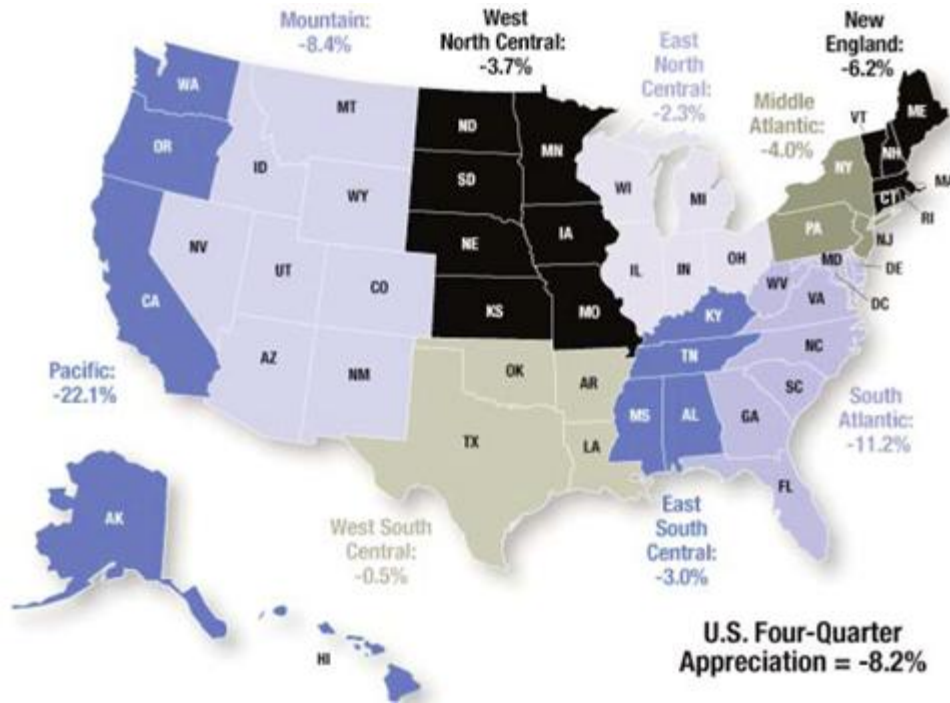
Four-quarter price change purchase-only index, For period ending Q4:2008

- **Were some U.S. cities more impacted than others ?**

  - 'Sand States' - Arizona, California, Florida, and Nevada - highest rates of home price appreciation (bubble) and - the most acute housing downturn (bubble went bust)

  - For Q4:2008, West Coast states suffered the worst house price decreases, followed by South Atlantic states

Related empirical work

- **Case and Shiller (2003)** – housing bubble a result of unrealistic expectations – **mailed out survey** to 500 people who bought houses in 2002 in Los Angeles, San Francisco, Boston, and Milwaukee - **expectations of future prices and market perceptions play an influential role** - **use linear and log-linear regressions** - dependent variables: level of home prices, quarter-to-quarter change in home prices, price-to-income ratio - independent variables: per capita income, population, and employment from 1985-2003 – **mostly income is sufficient to explain price movements**

- **Mikhed and Zemcik (2009)** – test **cointegration** between house prices and rents, with and without a bubble term - **use cross-section panel data tests** for unit root testing and Pedroni test statistic - cover 1978-2006 time period – **No cointegration - indicates the presence of a bubble term – ECM cannot be applied** - use Granger causality tests - house price changes are helpful in predicting changes in rents

- **Kohn and Bryant (2010)** – detection and root causes of the bubble - standard **multiple regression** - pre-bubble (1988 – 96), bubble (1997 - 2007) and full model (1988 – 2007) - **found significant differences in results between pre-bubble & bubble**

MAP= F(CPI, Housing Inventory, Mortgage rates, PI, Population, Vacancy Rates)

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Empirical methodology

❑ Trend Analysis

❑ Correlation Analysis

❑ Bivariate & Multivariate regression analysis

❑ Cointegration analysis

    ❑ Stationarity

    ❑ Johansen- Juselius procedure

❑ Error correction model

❑ Granger Causality test

Empirical methodology (contd.)

❑ Trend Analysis
  ❑ Graphical method of plotting observations over time

❑ Correlation Analysis
  ❑ Describes the **strength** of the relationship in terms of a number from -1.0 to +1.0
  ❑ Describes the **direction** of the relationship as positive or negative
  ❑ **Positive Correlation**: Variable X increases, Variable Y increases; Value ranging from .00 to 1.00
  ❑ **Negative Correlation**: Variable X increases, Variable Y decreases; Value ranging from -1.00 to .00
  ❑ Correlation **IS NOT** causation: only establishes that a relationship exists
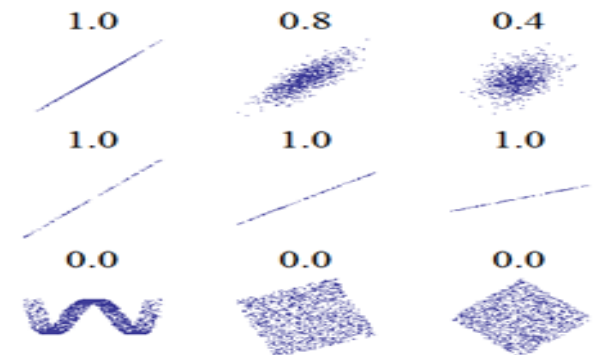
Empirical methodology (contd.)

- **Regression Analysis**
  - Predict the value of a dependent variable based on the value of at least one independent variable
  - Explain the impact of changes in an independent variable on the dependent variable
  - Bi-variate regression model
    - $Y_t = \alpha + \beta X_t + \varepsilon_t$ (where t= 1,2,3,….,T)
    - H_0: $\beta = 0$; H_1: $\beta \neq 0$
    - Mostly use a 5% level of significance, 95% confidence level
    - If t-value is ≥ 2 in absolute value, we reject the null
  - Multi-variate regression model
    - $Y_t = \alpha + \beta_1 X_t + \beta_2 Z_t + \varepsilon_t$ (where t= 1,2,3,….,T)
    - F-test: H_0: $\beta_1 = \beta_2 = 0$; H_1: $\beta_1 = \beta_2 \neq 0$

Empirical methodology (contd.)

❑ Stationary
  ❑ A given time series $\{y_t\}$ is stationary when mean and variance are constant or independent of time
    ❑ Constant Mean $E\left(y_t\right) = \mu$
    ❑ Constant Variance $\mathrm{var}\left(y_t\right) = \sigma^2$
❑ Non-Stationary
  ❑ A given time series is non-stationary if the mean and variance is not constant or is changing over time. Consequences:
    ❑ t-values, F stats, R-squared, forecasts will be invalid. OLS method cannot be employed
    ❑ Makes two time series appear related when they are not Spurious Regression i.e. $R^2 > d$
    ❑ If source of non-stationarity is difference-stationary – take first differences
    ❑ If source of non-stationarity is trend-stationary – detrend
❑ Unit root tests
  ❑ Examine ACF, if it decays slowly it implies non-stationarity
  ❑ Dickey-Fuller Test (1979); Augmented Dickey-Fuller Test (1981); DF-GLS / ERS Test (1996)

Empirical methodology (contd.)

- ❑ Cointegration Analysis
  - ❑ **Engle and Granger (1987)**: If there exists a relationship between two non stationary I(1) series, Y and X , such that the residuals of the regression are stationary, then the variables in question are said to be cointegrated. There is a Long Run Relationship towards which they always come back
  - ❑ **Johansen (1995)**: Multiple equation approach, which is a Vector Autoregressive (VAR) based method. Tests for more than one cointegrating relationship. Provides two test statistics for cointegration: Trace Test and the Maximum Eigenvalue test

- ❑ Granger Causality Test
  - ❑ Introduced by **Granger (1969)**, it is a test for determining causal relationship between two or more variables. Indicates which variable leads and which variable lags. Can be unidirectional, bidirectional or No Granger causality

$$X_t = \alpha_1 + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{j=1}^{p} \gamma_j X_{t-j} + u_{1t}$$

$$Y_t = \alpha_1 + \sum_{i=1}^{p} \lambda_i Y_{t-i} + \sum_{j=1}^{p} \delta_j X_{t-j} + u_{2t}$$

Empirical methodology (contd.)

❑ Error Correction Model

  ❑ If two variables are cointegrated, then we can also represent the relationship as an error-correction model

  ❑ Helps to explain how much deviation is possible from a long-run equilibrium relationship in the short run

$$\Delta y_t = \alpha \left(y_{t-1} - \beta x_{t-1} \right) + \Delta x_t + \varepsilon_t$$

  ❑ y can wander away from its long-run (equilibrium) path in the short run, but will be pulled back to it by the ECM over the longer term

  ❑ Engle-Granger bivariate cointegration approach corresponds to the ECM model

  ❑ Multivariate VAR-based Johansen cointegration approach corresponds to the VECM model

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➢ **Discussion of Results**

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Discussion of Results

❑ Trend Analysis: 1987:Q1- 2013:Q1
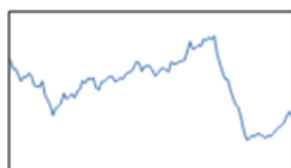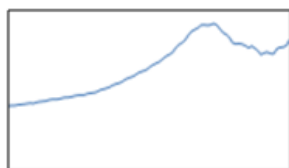
| Housing Starts | FHFA Purchase only | S&P Case Shiller | Fed Funds rate | HAI |

| Mortgage Rate | Unemployment rate | GDP growth rate | Housing starts yoy | FHFA Purchase only yoy |

| S&P Case Shiller yoy | HAI yoy | CA/GDP ratio | Debt service ratio | Ratio CS/ FHFA |
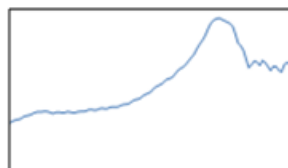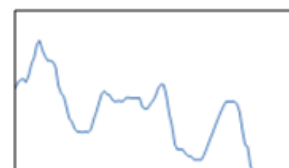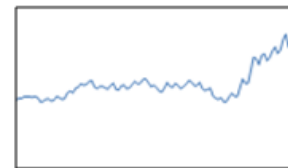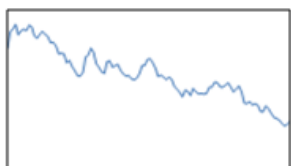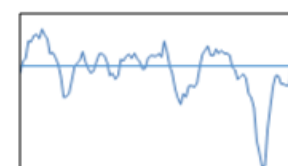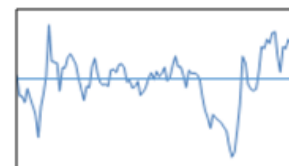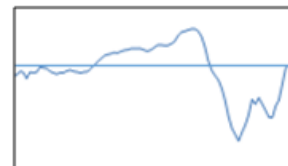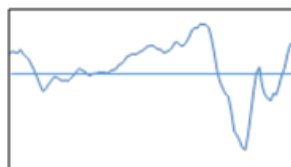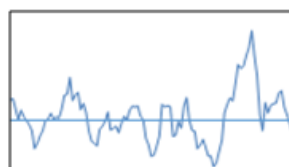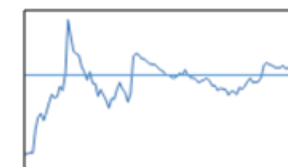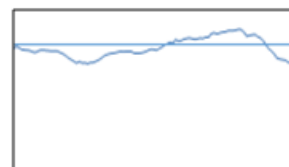
➢ **YOY percentage change format:** Housing Starts, Home Prices, Housing Affordability Index

➢ **Rate/ Percent Format:** Fed Funds Rate, Mortgage Rate, Unemployment Rate, GDP Growth Rate

➢ **Ratio Format:** Current account / GDP, Debt Service Ratio, Ratio of Financial Innovation (S&P case-shiller home price index yoy / FHFA home price index yoy)

Discussion of Results

❑ Correlation Analysis

TABLE 1: The correlation analysis (pre-bubble period)

Variables	1987:Q1 – 2001:Q2			
	Housing Starts	Case-Shiller HPI	FHFA-P HPI	Ratio (CS/FHFA)
Fed Funds	0.06	0.25***	-0.16	0.52*
CA_GDP	0.14	-0.31**	0.29***	-0.50*
Debt / Income	-0.19	0.30**	-0.36**	0.36*
HAI	0.27**	-0.38*	0.25	-0.44*
Mortgage Rate	0.23***	0.15	-0.01	0.28**
Unemployment Rate	-0.24***	-0.15	0.22	-0.46*
GDP Growth Rate	0.05	0.49*	-0.03	0.67*

TABLE 2: The correlation analysis (bubble period)

Variables	2001:Q3 – 2006:Q2			
	Housing Starts	Case-Shiller HPI	FHFA-P HPI	Ratio (CS/FHFA)
Fed Funds	-0.22	0.46**	-0.19	-0.17
CA_GDP	0.48**	-0.32	0.46**	0.42***
Debt / Income	-0.08	0.01	-0.03	-0.29
HAI	-0.09	-0.45**	0.18	0.35
Mortgage Rate	0.03	0.11	-0.20	-0.06
Unemployment Rate	-0.14	-0.41***	-0.04	-0.06
GDP Growth Rate	0.08	0.60*	-0.01	-0.01

> **Number of statistically significant correlations go down**

TABLE 3: The correlation analysis (entire period)

Variables	1987:Q1 – 2013:Q1			
	Housing Starts	Case-Shiller HPI	FHFA-P HPI	Ratio (CS/FHFA)
Fed Funds	0.22**	0.41*	0.17	-0.04
CA_GDP	0.11	-0.24**	0.36*	-0.13
Debt / Income	-0.04	0.36*	-0.05	0.15
HAI	-0.39*	-0.80*	0.06	0.05
Mortgage Rate	0.16***	0.17***	-0.09	0.03
Unemployment Rate	-0.57*	-0.51*	0	0.11
GDP Growth Rate	0.38*	0.63*	-0.16	0.01

Discussion of Results

❑ Regression Analysis - Bivariate

TABLE 4: Bivariate regression analysis: individual factors (bubble period)

Variables	Time Period: 2001:Q3-2006:Q2	Dependant			
		Housing Starts	Case-Shiller HPI	FHFA-P HPI	Ratio (CS/FHFA)
Independent					
Fed Funds	Estimate	-3.72	3.41	-0.34	-0.11
	t-value	-0.95	2.2	-0.81	-0.73
	R-squared	0.05	0.21	0.04	0.03
CA_GDP	Estimate	17.76	-5.11	1.8	0.59
	t-value	2.32	-1.42	2.17	1.95
	R-squared	0.23	0.1	0.21	0.17
HAI	Estimate	0.12	-0.27	0.03	0.01
	t-value	0.36	-2.13	0.75	1.56
	R-squared	0	0.2	0.03	0.12
Mortgage Rate	Estimate	0.76	1.28	-0.57	-0.06
	t-value	0.12	0.47	-0.86	-0.26
	R-squared	0	0.01	0.04	0
GDP Growth Rate	Estimate	0.39	1.28	0	0
	t-value	0.34	3.2	-0.03	-0.03
	R-squared	0	0.36	0	0
Unemployment Rate	Estimate	-4.93	-6.29	-0.13	-0.08
	t-value	-0.59	-1.89	-0.15	-0.25
	R-squared	0.02	0.17	0	0

➤ **At an individual level several factors were contributing to the bubble**

Discussion of Results

❑ Regression Analysis - Multivariate

TABLE 5: Multivariate regression analysis: dependent variable – housing starts

Time Period: 2001:Q3-2006:Q2	Housing Starts						
	FF	C/G	MR	UR	HAI	GDPR	R²
Estimate	13.37	42.91					0.38
t-value	2.06	3.04					
Estimate	17.07	55.15	10.6				0.51
t-value	2.72	3.83	2				
Estimate	7.59	45.84	9.27	-15.67			0.57
t-value	0.85	2.99	1.77	-1.44			
Estimate	6.03	47.26	7.24	-15.01	-0.29		0.58
t-value	0.65	3	1.2	-1.36	-0.72		
Estimate	7.71	56.67	4.62	-1.78	-0.18	3.18	0.69
t-value	0.91	3.82	0.83	-0.15	-0.5	2.09	

TABLE 7: Multivariate regression analysis: dependent variable – FHFA-P HPI

Time Period: 2001:Q3-2006:Q2	FHFA-P HPI						
	FF	C/G	MR	UR	HAI	GDPR	R²
Estimate	1.5	4.61					0.38
t-value	2.16	3.07					
Estimate	1.6	4.95	0.29				0.39
t-value	2.15	2.9	0.46				
Estimate	1.35	4.7	0.26	-0.42			0.39
t-value	1.2	2.43	0.39	-0.3			
Estimate	1.22	4.81	0.1	-0.36	-0.02		0.4
t-value	1.03	2.4	0.12	-0.26	-0.45		
Estimate	1.41	5.89	-0.21	1.15	-0.01	0.37	0.52
t-value	1.28	3.03	-0.28	0.75	-0.22	1.83	

TABLE 6: Multivariate regression analysis: dependent variable – Case Shiller HPI

Time Period: 2001:Q3-2006:Q2	Case Shiller HPI						
	FF	C/G	MR	UR	HAI	GDPR	R²
Estimate	5.47	5.18					0.24
t-value	1.75	0.76					
Estimate	5.97	6.83	1.43				0.25
t-value	1.78	0.89	0.5				
Estimate	6.14	6.99	1.45	0.28			0.25
t-value	1.2	0.8	0.48	0.04			
Estimate	5	8.03	-0.02	0.76	-0.21		0.29
t-value	0.95	0.9	-0.01	0.12	-0.93		
Estimate	6.1	14.17	-1.74	9.4	-0.14	2.08	0.53
t-value	1.36	1.8	-0.59	1.5	-0.73	2.56	

TABLE 8: Multivariate regression analysis: dependent variable – ratio (CS/FHFA)

Time Period: 2001:Q3-2006:Q2	Ratio (CS/FHFA)						
	FF	C/G	MR	UR	HAI	GDPR	R²
Estimate	0.5	1.5					0.31
t-value	1.9	2.7					
Estimate	0.58	1.82	0.25				0.37
t-value	2.15	2.91	1.1				
Estimate	0.47	1.7	0.24	-0.19			0.37
t-value	1.14	2.41	0.98	-0.38			
Estimate	0.62	1.57	0.43	-0.26	0.03		0.47
t-value	1.53	2.31	1.66	-0.53	1.59		
Estimate	0.68	1.9	0.34	0.21	0.03	0.11	0.55
t-value	1.76	2.8	1.34	0.38	1.89	1.6	

Discussion of Results

❑ Time Series Econometrics – Stationarity test/ ADF Test

TABLE 9: Results: unit root testing, data in levels (entire period)

Variables	1987:Q1 – 2013:Q1		
	Mean	S.D.	Unit Root
Housing Starts	-1.3	16.74	No
Case-Shiller HPI	3.31	7.24	No
FHFA-P HPI	3.20	4.84	Yes
Ratio (CS/FHFA)	0.42	5.83	No
Fed Funds	3.96	2.63	Yes
CA_GDP	-1.2	0.67	No
Debt / Income	0.12	0.01	Yes
HAI	2.62	7.60	No
Mortgage Rate	7.15	1.89	Yes
Unemployment Rate	6.05	1.53	Yes
GDP Growth Rate	4.97	2.13	No

TABLE 10: Unit root testing, first difference of data (entire period)

Variables	1987:Q1 – 2013:Q1		
	Mean	S.D.	Unit Root
FHFA-P HPI	0.06	1.07	No
Fed Funds	-0.06	0.47	No
Debt / Income	0.00	0.00	No
Mortgage Rate	-0.05	0.36	No
Unemployment Rate	0.01	0.29	No

Discussion of Results

❑ Cointegration Analysis – lag order selection

PRE BUBBLE: 1987:Q1 – 2001:Q2   BUBBLE: 2001:Q3 – 2006:Q2

CI	No. of lags	SBC	AIC	AR
Housing Starts vs. Fed Funds				
Y	1	7.4	7.1	N
N	2	7.1	6.7	N
N	3	7.3	6.8	N
Housing Starts vs. CA GDP				
N	1	6.6	6.4	N
N	2	6.8	6.5	N
N	3	7.0	6.5	N
Housing Starts vs. Fed Funds, CA GDP & Others				
Y	1	0.4	-1.6	N
Y	2	2.4	-1.4	N
N	3	4.3	-1.2	Y

CI	No. of lags	SBC	AIC	AR
Case Shiller HPI vs. Fed Funds				
N	1	-1.4	-1.6	Y
N	2	-2.0	-2.4	Y
Y	3	-1.9	-2.4	N
Case Shiller HPI vs. CA GDP				
N	1	-2.1	-2.3	Y
N	2	-2.2	-2.6	Y
N	3	-2.1	-2.6	N
Case Shiller HPI vs. Fed Funds, CA GDP & Others				
N	1	-8.0	-10.0	Y
N	2	-6.2	-10.0	Y
N	3	-5.2	-10.8	Y

CI	No. of lags	SBC	AIC	AR
Housing Starts vs. Fed Funds				
N	1	6.1	5.8	N
N	2	6.3	5.8	N
N	3	6.3	5.6	N
Housing Starts vs. CA GDP				
N	1	4.6	4.3	N
N	2	4.8	4.4	N
N	3	5.1	4.4	N
Housing Starts vs. Fed Funds, CA GDP & Others				
Y	1	-7.1	-9.9	N

CI	No. of lags	SBC	AIC	AR
Case Shiller HPI vs. Fed Funds				
N	1	-2.4	-2.7	Y
N	2	-2.2	-2.7	N
N	3	-2.5	-3.2	N
Case Shiller HPI vs. CA GDP				
N	1	-3.3	-3.6	Y
N	2	-3.5	-4.0	N
N	3	-2.9	-3.6	N
Case Shiller HPI vs. Fed Funds, CA GDP & Others				
N	1	-15.7	-18.5	Y

CI	No. of lags	SBC	AIC	AR
FHFA-P HPI vs. Fed Funds				
N	1	-2.1	-2.3	Y
N	2	-2.6	-3.0	Y
N	3	-3.1	-3.7	N
FHFA-P HPI vs. CA GDP				
N	1	-3.4	-3.7	Y
N	2	-3.2	-3.6	Y
N	3	-3.8	-4.4	N
FHFA-P HPI vs. Fed Funds, CA GDP & Others				
N	1	-10.2	-12.5	Y
N	2	-8.1	-12.5	Y
Y	3	-7.6	-14.1	N

CI	No. of lags	SBC	AIC	AR
Ratio (CS/FHFA) vs. Fed Funds				
N	1	-3.6	-3.9	Y
N	2	-4.0	-4.4	N
N	3	-3.9	-4.4	N
Ratio (CS/FHFA) vs. CA GDP				
N	1	-4.3	-4.5	Y
N	2	-4.2	-4.5	N
N	3	-3.9	-4.4	N
Ratio (CS/FHFA) vs. Fed Funds, CA GDP & Others				
N	1	-10.3	-12.4	Y
N	2	-8.3	-12.2	N
N	3	-6.2	-12.0	N

CI	No. of lags	SBC	AIC	AR
FHFA-P HPI vs. Fed Funds				
N	1	-2.3	-2.6	Y
N	2	-1.7	-2.2	Y
N	3	-2.5	-3.2	N
FHFA-P HPI vs. CA GDP				
N	1	-3.9	-4.2	N
N	2	-3.3	-3.8	N
N	3	-2.8	-3.5	N
FHFA-P HPI vs. Fed Funds, CA GDP & Others				
N	1	-14.9	-17.7	Y

CI	No. of lags	SBC	AIC	AR
Ratio (CS/FHFA) vs. Fed Funds				
N	1	-5.9	-6.2	Y
N	2	-6.4	-6.9	Y
N	3	-6.2	-6.9	Y
Ratio (CS/FHFA) vs. CA GDP				
N	1	-8.4	-8.7	Y
N	2	-7.7	-8.2	Y
N	3	-7.2	-7.9	N
Ratio (CS/FHFA) vs. Fed Funds, CA GDP & Others				
N	1	-20.9	-23.6	Y

Discussion of Results

❑ Cointegration Analysis – lag order selection

Entire Time-period: 1987:Q1 – 2013:Q1

CI	No. of lags	SBC	AIC	AR
Housing Starts vs. Fed Funds				
N	1	7.5	7.3	Y
N	2	7.0	6.8	N
N	3	7.2	6.8	N
Housing Starts vs. CA GDP				
N	1	6.2	6.1	Y
N	2	6.3	6.1	N
N	3	6.4	6.1	N
Housing Starts vs. Fed Funds, CA GDP & Others				
N	1	1.1	-0.3	N
N	2	1.7	-0.9	N
N	3	3.0	-1.0	N

CI	No. of lags	SBC	AIC	AR
Case Shiller HPI vs. Fed Funds				
N	1	1.0	0.9	Y
N	2	0.2	-0.1	Y
N	3	0.4	0.0	Y
Case Shiller HPI vs. CA GDP				
N	1	-0.1	-0.2	Y
N	2	-0.3	-0.6	Y
N	3	-0.1	-0.5	Y
Case Shiller HPI vs. Fed Funds, CA GDP & Others				
N	1	-5.2	-6.6	Y
N	2	-4.6	-7.3	Y
N	3	-3.5	-7.4	Y

➢ **No Cointegrating relations exist in the entire time period**

CI	No. of lags	SBC	AIC	AR
FHFA-P HPI vs. Fed Funds				
N	1	0.6	0.4	Y
N	2	-0.4	-0.7	Y
N	3	-0.2	-0.6	Y
FHFA-P HPI vs. CA GDP				
N	1	-1.1	-1.3	Y
N	2	-1.4	-1.7	Y
N	3	-1.2	-1.6	Y
FHFA-P HPI vs. Fed Funds, CA GDP & Others				
N	1	-6.5	-8.1	Y
N	2	-5.5	-8.5	Y
N	3	-4.1	-8.5	Y

CI	No. of lags	SBC	AIC	AR
Ratio (CS/FHFA) vs. Fed Funds				
N	1	2.3	2.2	Y
N	2	1.7	1.5	N
N	3	1.9	1.5	N
Ratio (CS/FHFA) vs. CA GDP				
N	1	1.0	0.9	Y
N	2	1.1	0.9	N
N	3	1.3	0.9	N
Ratio (CS/FHFA) vs. Fed Funds, CA GDP & Others				
N	1	-3.8	-5.2	N
N	2	-2.7	-5.5	N
N	3	-1.2	-5.3	N

Discussion of Results

❑ Johansen cointegration approach: Trace & Maximum Eigenvalue test

TABLE 12: Johansen cointegration approach (pre-bubble period)

1987:Q1 – 2001:Q2 Cointegration between	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Eigenvalue	Maximum Statistic	0.05 Critical Value
Housing Starts vs. Fed Funds	$H_0 : r = 0 \; H_1 : r > 0$	0.38 0.01	28.32 0.37	15.34 3.84	0.20 0.11	12.59 6.51	14.07 3.76
Case Shiller HPI vs. Fed Funds	$H_0 : r = 0 \; H_1 : r > 0$	0.33 0.05	25.76 2.96	15.34 3.84	0.38 0.01	27.94 0.37	14.07 3.76
Housing Starts vs. Fed Funds, CA_GDP & Others	$H_0 : r = 0 \; H_1 : r > 0$ $H_0 : r = 1 \; H_1 : r > 1$ $H_0 : r = 2 \; H_1 : r > 2$	0.76 0.59 0.32	190.92 108.62 56.66	123.04 93.92 68.68	0.76 0.59 0.32	82.30 51.96 22.75	45.28 39.37 33.46
FHFA-P HPI vs. Fed Funds, CA_GDP & Others	$H_0 : r = 0 \; H_1 : r > 0$ $H_0 : r = 1 \; H_1 : r > 1$ $H_0 : r = 2 \; H_1 : r > 2$ $H_0 : r = 3 \; H_1 : r > 3$ $H_0 : r = 4 \; H_1 : r > 4$ $H_0 : r = 5 \; H_1 : r > 5$	0.92 0.74 0.66 0.54 0.45 0.22	267.50 167.47 113.72 70.35 38.95 14.80	123.04 93.92 68.68 47.21 29.38 15.34	0.90 0.65 0.46 0.38 0.31 0.14	94.79 44.63 25.79 19.89 15.47 6.13	45.28 39.37 33.46 27.07 20.97 14.07

➤ **Cointegrating relationships that existed in the pre-bubble period become unstable in the bubble period, with none existing in the entire period**

TABLE 13: Johansen cointegration approach (bubble period)

2001:Q3 – 2006:Q2 Cointegration between	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Eigenvalue	Maximum Statistic	0.05 Critical Value
Housing Starts vs. Fed Funds, CA_GDP & Others	$H_0 : r = 0 \; H_1 : r > 0$ $H_0 : r = 1 \; H_1 : r > 1$ $H_0 : r = 2 \; H_1 : r > 2$	0.98 0.90 0.80	188.98 118.60 75.14	123.04 93.92 68.68	0.98 0.90 0.80	70.38 43.46 30.52	45.28 39.37 33.46

➤ **Confirms BUBBLE formation**

➤ **No ECM can be applied. Gallin (2006), Zhou and Sornette (2006)**

Discussion of Results

❑ Granger Causality Wald Test

Pre-Bubble Period: 1987:Q1 – 2001:Q2		
Group 1 Variables	**Group 2 Variables**	**Pr > ChiSq**
Housing Starts	Fed Funds	0.06***
Housing Starts	Fed Funds, CA_GDP, HAI, Mortgage Rate, GDP Rate, Unemployment Rate	0.002*
Case-Shiller HPI	Fed Funds	0.08***
FHFA-P HPI	Fed Funds, CA_GDP, HAI, Mortgage Rate, GDP Rate, Unemployment Rate	0.001*
Bubble Period: 2001:Q3 – 2006:Q2		
Group 1 Variables	**Group 2 Variables**	**Pr > ChiSq**
Housing Starts	Fed Funds, CA_GDP, HAI, Mortgage Rate, GDP Rate, Unemployment Rate	0.004*

* Significant at 1%
** Significant at 5%
*** Significant at 10%

Outline

❖ Introduction

❖ Purpose / Research Question

❖ Literature review

❖ Related events and empirical work

❖ Empirical methodology

❖ Discussion of Results

➢ **Suggestions for future research / limitations**

❖ Conclusion

# Suggestions for future research / limitations

- **Time series analysis has low power for smaller sample periods**
    - Use panel data
    - Cover longer study duration of above 30 years
- **Due to data and time limitations this study does not include every potential, or even plausible, variable**
    - Need more comprehensive models to avoid another such episode of financial fiasco
    - Some additional economic variables: Adjustable Mortgage Rate/ 12-month LIBOR; data on credit scores and mortgage applications, real median family income, homeowner rate, real house price/ rent, real Lehman mortgage backed securities index
- **Analyze the housing bubble at a national level**
    - Develop the same model using local housing indices and see if there were a number of local bubbles for the variables under consideration using state home prices data
- **Used multiple regression analysis: multi-co-linearity effects**
    - Use structural equation modeling
- **Hard to empirically quantify the role of: Basel II, GSE's, structured finance**
    - Come up with suitable proxy variables for these factors and analyze their contribution to the financial crisis

Outline

- Introduction
- Purpose / Research Question
- Literature review
- Related events and empirical work
- Empirical methodology
- Discussion of Results
- Suggestions for future research / limitations

➢ **Conclusion**

Conclusion
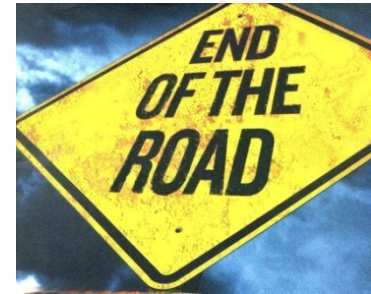
- **Purpose:** Get a high level understanding of the factors that caused the 2007-08 financial fiasco, specifically seeks to analyze the role of monetary policy, global savings glut and financial innovation in the crisis
- **Detailed literature review**
  - Bubble in the housing market, role of Fed's monetary policy, how securitization concentrated risk in the financial sector, housing initiatives and other policies followed by Fannie Mae and Freddie Mac, Basel rules and banks' leverage and credit default swaps were held responsible for the financial fiasco
- **Detailed econometric analysis**
  - Trend analysis, correlation, bivariate and multivariate regression, followed by time series statistical analysis including unit root testing, cointegration, granger causality and the possibility of an error correction model
  - Three sub-periods: pre-bubble (1987 – 2001), bubble (2001 – 06), entire period (1987 – 2013)
  - Statistical evidence - presence of a real estate bubble
  - Monetary policy and global savings glut caused the housing bubble at an individual level in the pre-bubble and at a cumulative level with other economic variables in the bubble period
  - Variables behaved in more complex ways in the bubble period when compared to the pre-bubble
  - No evidence of cointegration between variables in overall time period

Conclusion (contd.)
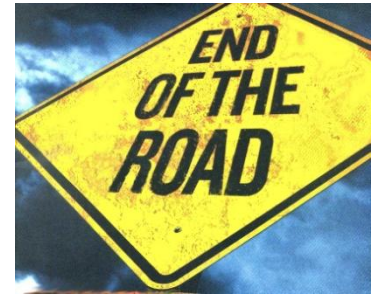
- **Contribution**
  - The time period this thesis focusses on includes the start of the rise in U.S. house prices up until its peak, and considerable period after the peak and bust till 2013
  - Provides a detailed theoretical understanding of potential explanatory factors of the housing bubble
  - Supports the evidence provided by other studies on the existence of a housing bubble
  - Econometric methodology employed in this thesis can be used to test for housing bubbles in countries across the globe
  - Technique employed in this research can help to verify bubbles in other asset markets

Thank You !!

Thesis Committee

Dr. Rob Roy McGregor, Professor Azhar Iqbal, Dr. Benjamin Russo

Q/A ??