# Behavioral Shifts over the Business Cycle: New Evidence from Residential Mortgage Default

Xudong An, Yongheng Deng and Stuart Gabriel

January 15, 2015

---

# Background

- Mortgage default was emblematic of the crisis period
  - Caused the failure of numerous big financial institutions
    - Bearn Sterns, Lehman Brothers, Washington Mutual, AIG, Fannie Mae, Freddie Mac, ...
  - Caused many borrowers to lose their homes
    - 9 million foreclosures between 2009 and 2011
  - Had a chain effect and triggered the "Great Recession" in the broader economy
    - Between June 2007 and November 2008, Americans lost more than a quarter of their net worth.
    - Unemployment skyrocketed and consumption plummeted

# Background (cont'd)

- Vast academic literature on mortgage default
  - Foote, Gerardi and Willen (2008); Danis and Pennington-Cross (2008); Bostic and Lee (2008); Mayer, Pence and Sherlund (2009); Demyanyk and Van Hemert (2009); Mian and Sufi (2009); Keys et al (2010); Ghent and Kudlyak (2011); Campbell and Cocco (2011); Haughwout, et al (2011); An, Deng and Gabriel (2011); Agarwal, Chang and Yavas (2012); Agarwal et al (2013); Rajan, Seru and Vig (2010, 2014); Guiso, Sapienza and Zingales (2013); Corbae and Quintin (2014), Agarwal, Green and Yao (2014); etc.
  - von Furstenberg (1969, 1970a,b); Herzog and Earley (1970) ; von Furstenberg and Green (1974); Williams, Beranek and Kenkel (1974); Sandor and Sosin (1975); Morton (1975); Follain and Struyk (1977); Vandell (1978); Cunningham and Capone (1980); Webb (1982) Campbell and Dietrich (1983); Cunningham and Hendershott (1984); Foster and Van Order (1984, 1985); Epperson et al (1985); Kau et al (1987); Titman and Torous (1989); Quigley and Van Order (1991); Giliberto and Ling (1992); Kau, et al (1992); Riddiough and Wyatt (1994a,b); Kahn and Yavas (1994); Vandell et al (1995); Quigley and Van Order (1995); Childs, Ott and Riddiough (1996a,b); Archer and Ling (1996, 1997); Capozza, Kazarian and Thomson (1997,1998); Avery, et al (2000); Deng, Quigley and Van Order (2000); Van Order and Zorn (2000); Ambrose, Capone and Deng (2001); Archer et al, 2002; Kau and Slawson (2002); Ambrose and Sanders (2003); LaCour-Little and Malpezzi(2003); Clapp, Deng and An (2006); Deng and Gabriel (2006); among many others

3

# Background (cont'd)

- Long line of research on mortgage default due to its wide impact
  - Portfolio lending
  - Mortgage Insurance: FHA and PMI
  - Fannie Mae and Freddie Mac guarantee business
  - ABS, CMBS and CDO investment
  - CDS
  - Credit rating
  - Government regulation and government bailout
  - US single-family mortgage debt $9.4 trillion (2014.10); commercial mortgage debt $2.6 trillion (2014Q2)

4

# Our Focus

- Behavioral shifts of mortgage borrowers
  - How has borrower sensitivity to negative equity changed over time?
  - In a parametric model context

  $$y = f\left(x \mid \beta\right)$$

  - If x is negative equity, then has beta changed over time?
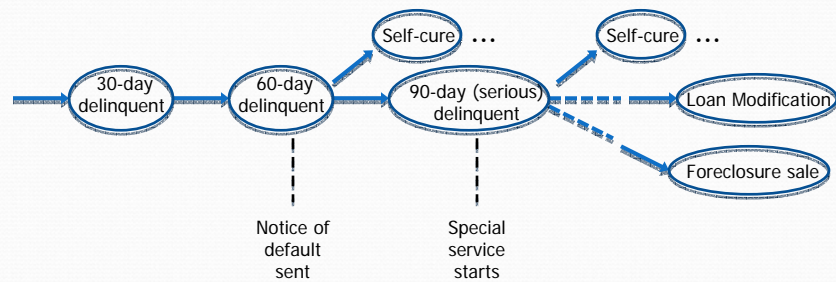
# Motivation

- Lucas Critique
  - Change of behavior in response to public policy experiment
  - Large scale of government intervention in the mortgage market
    - Foreclosure mitigation programs such as the Home Affordable Modification Program (HAMP)
  - Default as a game
  - Riddiough and Wyatt (1994); Guiso, Sapienza and Zingales (2013)

# Motivation (cont'd)

- Mortgage default process

```
                                    Self-cure  …              Self-cure  …
   ┌──────────┐    ┌──────────┐    ┌────────────────┐    ┌──────────────────┐
→  │ 30-day   │ →  │ 60-day   │ →  │ 90-day (serious)│ ⇢  │ Loan Modification│
   │ delinquent│   │ delinquent│   │  delinquent     │    └──────────────────┘
   └──────────┘    └──────────┘    └────────────────┘    ┌──────────────────┐
                                                          │ Foreclosure sale │
                                                          └──────────────────┘

                    Notice of         Special
                    default           service
                    sent              starts
```

- We define default as "60+ day delinquency"

# Motivation (cont'd)

- Default as a compound option
  - Borrower's option to wait to default in the next period
  - Impact of different trajectories of house price and income

9

# Motivation (cont'd)

- Mortgage payment timeline
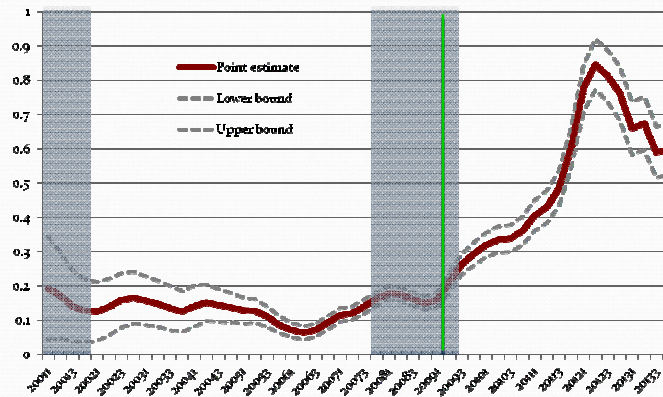


Default?     Default?

- The option to default in the next period

10

# Preview of Results

Negative equity beta



Shades indicate NBER recession dates. The Green line indicates the HAMP starting date.

---

# Our Major Contributions

- For the first time in the literature, we document the time-varying behavior of borrowers' default option exercise
  - Changes in behavior during the crisis period were more salient to the rise in defaults than were increases in negative equity
  - We identify some important drivers of changing negative equity beta
  - Results point to unintended consequence of HAMP
  - Results provide clues on how to deal with model instability due to behavioral shifts

## Theoretical Framework

- Borrower decision on default vs. non-default
- Consider the net benefit of default
  - House value is $H_t$ and the value of the mortgage is $M_t$
  - If default, two possible outcomes: foreclosure with probability $p_t$, and workout with probability $(1-p_t)$
    - If foreclosed, borrower incurs tangible transaction costs $R_t$ (moving costs, credit impairment, etc.) and intangible transaction costs $S_t$ (stigma, emotional distress, etc.)
    - If workout happens, he receives a benefit of $V_t$ (e.g., payment reduction and/or balance writedown)

---

## Theoretical Framework (cont'd)

- Let $B_T$ denote the benefit of the borrower's default

$$B_t = p_t \left[ -\left(H_t - M_t\right) - R_t - S_t - \left(1 + r_t\right)^{-1} E_t B_{t+1} \right] + \left(1 - p_t\right)V_t,$$

$$\text{where } B_{t+1} = p_{t+1}\left[ -\left(H_{t+1} - M_{t+1}\right)\cdots\right]\cdots$$

At time $T$ (terminal point)

$$B_T = p_T\left[ -\left(H_T - M_T\right) - R_T - S_T \right] + \left(1 - p_T\right)V_T$$

## Theoretical Framework (cont'd)

- Now consider the borrower's budget constraint

  $$Y_t \geq P_t + D_t + C_t$$

  - There's a possibility $q_t$ that the borrower becomes insolvent. In such circumstances, the borrower can sell the property to pay off the loan to avoid a default. But the fire sale involves transaction costs .
  - Therefore, when the borrower is insolvent an additional benefit of default is to avoid $W_t$.

- The ultimate benefit of default is:

  $$G_t = (1 - q_t)B_t + q_t(W_t \mid H_t - M_t > W_t)$$

- Default condition is

  $$G_t \geq 0$$

---

## Theoretical Framework (cont'd)

- Observations
  - To solve the model we need to know the full dynamics of
    $$p_t,\ H_t,\ M_t,\ R_t,\ S_t,\ V_t, r_t, Y_t, D_t, C_t, q_t, W_t$$
  - However, we can see
    - The probability of default is a function of negative equity; it's also a function of borrower's expectation of future house price, his assessment of foreclosure/workout probability, borrower's insolvency probability, and transaction costs
    - Default probability is determined by the interaction of negative equity and borrower's assessment of the conditional probability of foreclosure, and the interaction of borrower's insolvency probability. So borrower sensitivity depends on $p_t,\ q_t$
    - Borrower sensitivity also depends on changes in house price expectation

## Theoretical Framework (cont'd)

- In a hazard model context $h_i = h_0 \exp(X\beta)$
  - Beta can vary over time and across borrower groups
  - Specifically,
    - beta can vary over the business cycle and local market conditions
    - beta can be affected by mortgage assistance programs (which change anticipated probability of foreclosure/modification)
  - Additionally, beta can be affected by sentiment

## Data

- Mortgage data from BlackBox (BBX)
  - Over 21 million securitized non-agency loans
    - Non-Fannie/Freddie/Ginnie
    - Data from major loan servicers such as Wells, JPM, Deutsche Bank, Citi, WAMU, IndyMac, etc.
    - From 7,400 deals, over $1.2 trillion in outstanding principal
    - Data verified and standardized by BBX
    - Various grades: prime (jumbo), AA (Alt-A), B and C (subprime)
    - 9 million FRMs; 12 million ARMs (including hybrid)
    - About 13 million are first-liens
  - Tracked over 1998.2 to 2013.12, over 700 million monthly obs.
  - Various purposes and documentation types
    - Home purchase, rate/term refinance, cash out refinance, etc.
    - Full doc, low doc (almost 6 million), no doc, reduced doc

# Data (cont'd)

- Our sample
  - First-lien, FRM only
  - Alt-A and subprime loans in the main tests
    - FICO concentrated in 620- (subprime), 620-660 (Alt-A)
    - Jumbo loans in the augmented tests
  - In the top 10 MSAs
    - New York, Los Angeles, Chicago, Dallas, Miami, Atlanta, Detroit, Boston, Las Vegas and Washington DC
    - To make sure we have good HPI, and that we can conduct by-MSA analysis
  - Matched with HMDA data
    - About 75% match ratio
  - 198,374 loans, originated between 1998-2008

# Data (cont'd)

- Other data
  - HMDA
  - HPI (Case-Shiller, FHFA, CoreLogic zip-code level)
  - Unemployment rate, business cycle indicators, mortgage interest rate, etc.

# Origination Year Distribution

| Origination Year | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|---|---|---|---|
| 1998 | 1165 | 0.59 | 1165 | 0.59 |
| 1999 | 2825 | 1.42 | 3990 | 2.01 |
| 2000 | 5166 | 2.6 | 9156 | 4.62 |
| 2001 | 7197 | 3.63 | 16353 | 8.24 |
| 2002 | 10931 | 5.51 | 27284 | 13.75 |
| 2003 | 28472 | 14.35 | 55756 | 28.11 |
| 2004 | 30362 | 15.31 | 86118 | 43.41 |
| 2005 | 43268 | 21.81 | 129386 | 65.22 |
| 2006 | 50898 | 25.66 | 180284 | 90.88 |
| 2007 | 18039 | 9.09 | 198323 | 99.97 |
| 2008 | 51 | 0.03 | 198374 | 100 |

# Geographic Distribution

| MSA Name | MSA Code | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|---|---|---|---|---|
| Atlanta | 12060 | 13464 | 6.79 | 13464 | 6.79 |
| Boston | 14460 | 8431 | 4.25 | 21895 | 11.04 |
| Chicago | 16980 | 23491 | 11.84 | 45386 | 22.88 |
| Dallas | 19100 | 20701 | 10.44 | 66087 | 33.31 |
| Detroit | 19820 | 14317 | 7.22 | 80404 | 40.53 |
| Los Angeles | 31100 | 29262 | 14.75 | 109666 | 55.28 |
| Miami | 33100 | 27803 | 14.02 | 137469 | 69.3 |
| New York | 35620 | 41750 | 21.05 | 179219 | 90.34 |
| Phoenix | 38060 | 12186 | 6.14 | 191405 | 96.49 |
| Washington DC | 47900 | 6969 | 3.51 | 198374 | 100 |
| As a share of the national sample | | | 22.79% | | |

## Default Incidence

|                          | Frequency | Percent |
| ------------------------ | --------- | ------- |
| 60-day delinquency       | 93, 790   | 47.28   |
| Foreclosure and short sale | 30,768  | 15.51   |
| Total number of loans    | 198,374   | 100     |

# Methodology

- Time-varying coefficient hazard models
  - A standard hazard model

$$h_i(T, Z'_{i,t}) = h_0(T)\exp{(Z'_{i,t}\beta)}$$

  - We allow the coefficient to be time-varying

$$h_i(T, Z'_{i,t}) = h_0(T)\exp{(Z'_{i,t}\beta_t)}$$

# Methodology (cont'd)

- Estimation of the time-varying coefficient hazard model
  - Local estimator (Fan and Zhang, 2008)
    - Coefficient to be constant in a short time window
    - Quarterly rolling windows
  - Covariates interaction approach (Fan and Zhang, 1999)
    - Some known determinants of beta time-variation

  $$h_i(T, Z'_{i,t}) = h_0(T)\exp\left[a(t)Z'_{i,t}\beta\right]$$

---

# Methodology (cont'd)

- Our focus is on the changing beta of negative equity
- Control variables
  - Alt-A loan indicator (interacted with negative equity)
  - Low/no doc indicator (interacted with negative equity)
  - Investment property indicator (interacted with negative equity)
  - FICO score (interacted with negative equity)
  - MSA-fixed effect (interacted with negative equity)
  - Vintage-fixed effect
  - Call option value
  - Loan features such as loan size, LTV, loan product type, property type, purpose, prepayment penalty clause
  - Borrower characteristics such as payment-to-income ratio, race and ethnicity, and gender
  - Change in MSA unemployment rate from loan origination to the current

# Model Results

- Pooled sample baseline model

| Covariate | Estimate (S.E.) |
|---|---|
| Negative equity | 0.832*** |
|  | (0.081) |
| Negative equity square | 0.000* |
|  | (0.000) |
| Negative equity * Alt-A loan indicator | 0.152*** |
|  | (0.016) |
| Alt-A loan indicator | -0.339*** |
|  | (0.009) |
| Negative equity * Low/no doc indicator | 0.072*** |
|  | (0.011) |
| Low/no doc indicator | 0.166*** |
|  | (0.007) |
| Negative equity * Investment property indicator | -0.009 |
|  | (0.021) |
| Investment property indicator | 0.139*** |
|  | (0.012) |
| Negative equity * FICO score | 0.067*** |
|  | (0.005) |
| FICO score | -0.057*** |
|  | (0.005) |

Continues on the next page

---

| | |
|---|---|
| FICO score square | 0.037*** |
|  | (0.002) |
| Log balance | 0.036*** |
|  | (0.004) |
| LTV at origination >= 80% | 0.133*** |
|  | (0.006) |
| Call option in the money but covered by prepayment penalty | 0.024*** |
|  | (0.003) |
| Call option in the money and out of prepayment penalty coverage | 0.000 |
|  | (0.002) |
| 15-year FRM | -0.141*** |
|  | (0.011) |
| Planned-unit development | -0.056*** |
|  | (0.01) |
| Condominium | -0.085*** |
|  | (0.011) |
| Rate/term refinance | -0.287*** |
|  | (0.008) |
| Cash out refinance | -0.018* |
|  | (0.008) |
| Second/vacation home | -0.027 |
|  | (0.039) |
| With prepayment penalty clause | -0.059*** |
|  | (0.015) |

Continues on the next page

| | |
|---|---|
| **Unknown prepayment penalty clause** | -0.137*** |
| | (0.015) |
| **Change in MSA unemployment rate** | 0.079*** |
| | (0.005) |
| **Payment-to-Income (PTI) ratio** | 0.018*** |
| | (0.001) |
| **Asian** | -0.056** |
| | (0.017) |
| **Black** | 0.080*** |
| | (0.007) |
| **Other non-white race** | 0.020** |
| | (0.007) |
| **Female** | 0.003 |
| | (0.005) |
| **MSA dummy * Negative Equity** | Yes |
| **MSA dummy** | Yes |
| **Vintage fixed-effect** | Yes |
| | |
| N | 4,806,790 |
| -2LogL | 3,517,853 |
| AIC | 3,517,967 |

# Model Results (cont'd)

- Rolling window beta estimates
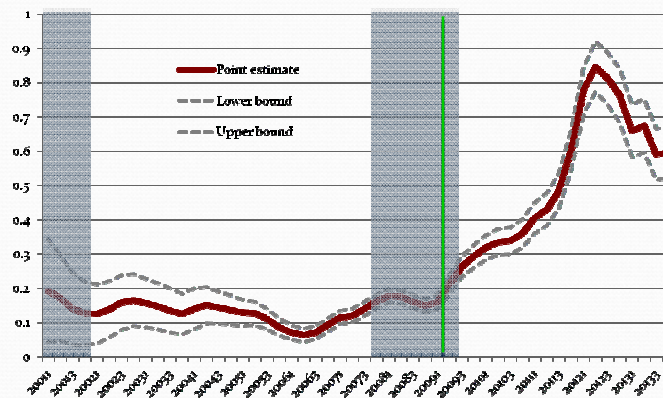


Shades indicate NBER recession dates. The Green line indicates the HAMP starting date.

# Model Results (cont'd)

- Beta Variation



Hazard ratio

- - - Negative equity impact in 2006
——— Negative equity impact in 2012
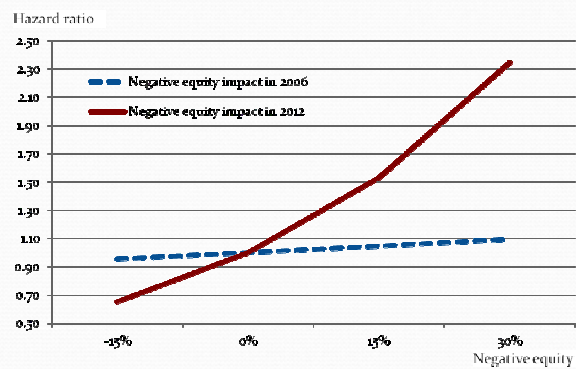
Negative equity

# The Next Big Question

- What drives beta to change over time?

# Business Cycle and Negative Equity Beta

| | Estimate (S.E.) | |
|---|---|---|
| Covariate | Model 1 | Model 2 |
| **Negative equity** | 0.832*** | 0.787*** |
| | (0.081) | (0.081) |
| **Negative equity square** | 0.000* | 0.002*** |
| | (0.000) | (0.000) |
| **Negative equity * recession indicator** | | 0.136*** |
| | | (0.016) |
| **Recession indicator** | | 0.053*** |
| | | (0.008) |
| **Control variables** | Yes | Yes |
| | | |
| N | 4,806,790 | 4,806,790 |
| -2LogL | 3,517,853 | 3,517,752 |
| AIC | 3,517,967 | 3,517,870 |

# Alternative Business Cycle Indicators

| | Business cycle indicator | | |
|---|---|---|---|
| | Change in state coincident indicator | State unemployment rate innovation | MSA unemployment rate innovation |
| **Negative equity * Business cycle indicator** | -0.110*** (0.009) | 0.111*** (0.007) | 0.140*** (0.008) |
| **Control variables** | Negative equity, negative equity square, business cycle indicator, negative equity * Alt-A loan indicator, Alt-A loan indicator, negative equity * low/no doc indicator, low/no doc indicator, negative equity * investment property indicator, investment property indicator, negative equity * FICO, FICO, FICO square, log loan balance, original LTV greater than 80%, call option value, 15-year FRM indicator, planned unit development indicator, condominium indicator, rate/term refinance indicator, cash-out refinance indicator, second/vacation home indicator, prepayment penalty indicator, prepayment penalty unknown indicator, change in MSA unemployment rate from origination to current, payment-to-income ratio, Asian borrower, African American borrower, other non-white race borrower, female borrower, MSA fixed effect in put option beta, MSA-fixed effect, vintage-fixed effect. | | |
| | | | |
| N | 4,806,790 | 4,806,790 | 4,806,790 |
| -2LogL | 3,517,286 | 3,517,283 | 3,517,285 |
| AIC | 3,517,404 | 3,517,401 | 3,517,403 |

# Business Cycle Effect: Propensity Score Match and DID Test
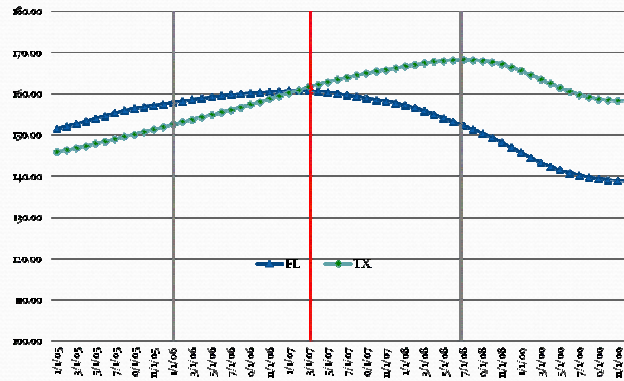


The grey vertical lines indicate our DID test sample starting and ending period. The red vertical line indicates the treatment (negative economic shock) start date. Data source: St. Louis Fed.

---

# Business Cycle DID Test: Miami vs. Dallas Loans

$$Y = \beta_1 T + \beta_2 T * After + \beta_3 After + Z'\gamma + \varepsilon$$

| Covariate | Estimate (S.E.) |
|---|---|
| Negative equity * Miami loan indicator | -0.107** (0.042) |
| Negative equity * Miami loan indicator * Post 2007Q2 | 0.598*** (0.094) |
| Post 2007Q2 | 0.175*** (0.028) |
| Control variables | Yes |
| | |
| N | 423,102 |
| -2LogL | 200,869 |
| AIC | 200,935 |

1. Based on propensity score-matched sample.

## Tests of the Impact of Sentiment and Structural Break

| Covariate | Estimate (S.E.) |
|---|---|
| **Negative equity * state unemployment rate innovation** | 0.165*** (0.008) |
| **State unemployment rate innovation** | 0.072*** (0.006) |
| **Negative equity * Orthogonalized MSA consumer distress index** | -0.099*** (0.008) |
| **Orthogonalized MSA consumer distress index** | -0.025*** (0.004) |
| **Negative equity * Post 2009Q3** | 0.169*** (0.023) |
| **Post 2009Q3** | 0.092*** (0.017) |
| **Control variables** | Yes |
| | |
| **N** | 4,091,397 |
| **-2LogL** | 3,100,050 |
| **AIC** | 3,100,176 |

37

# The Impact of Various Factors Summarized
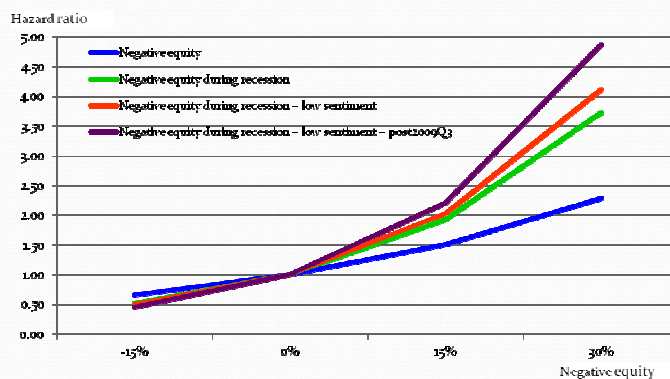


- Changes in behavior during the crisis period were more salient to the rise in defaults than were increases in negative equity.

38

# Structural Break and HAMP Effect

- The Home Affordable Modification Program (HAMP) program
  - To mitigate foreclosure and save borrowers from losing their homes
  - Use federal subsidy to encourage loan modification
    - Lender incentive
    - Servicer incentive
  - Mortgage borrowers are more likely to become delinquent once they expect lenders to modify defaulted loans under the HAMP program.
  - Similar to the strategic default argument: a borrower's delinquency decision may depend on the anticipated toughness of the lender response
    - Riddiough and Wyatt (1994) and Guiso, Sapienza and Zingales (2013)

# Test of Potential HAMP Effect

- Difference-in-difference (DID) tests
  - Treatment group and control group

  $$Y = \beta_1 T + \beta_2 T * After + \beta_3 After + Z'\gamma + \varepsilon$$

  - We utilize the HAMP eligibility rule to form the "control group" and the "treatment group"
  - HAMP eligibility
    - Owner-occupied loans (vs. investment loans)
    - Outstanding balance < 729,500
    - Originated before 2009.1
    - Payment-to-income ratio > 31%
    - HAMP implementation window: 2009Q1 to 2012Q4, extended to the current

# HAMP DID Test 1
## Owner-occupied vs. Investor Property Loans

$$Y = \beta_1 T + \beta_2 T * After + \beta_3 After + Z'\gamma + \varepsilon$$

| Covariate | Estimate (S.E.) |
|---|---|
| Negative equity * Owner-occupied property indicator | -0.129***<br>(0.026) |
| Negative equity * Owner-occupied property indicator * Post 2009Q1 | 0.378***<br>(0.018) |
| Post 2009Q1 | 0.197***<br>(0.014) |
| Control variables | Yes |
|  |  |
| N | 4,802,609 |
| -2LogL | 3,521,452 |
| AIC | 3,521,552 |

1. Sample limited to those loans originated before 2009.1, with PTI>31%, and remaining balance no higher than $729,500.

41

---

# HAMP DID Test 2
## Loan Size Over vs. Under the HAMP Threshold

$$Y = \beta_1 T + \beta_2 T * After + \beta_3 After + Z'\gamma + \varepsilon$$

| Covariate | Estimate (S.E.) |
|---|---|
| Negative equity * Outstanding balance ≤ $729,500 | -0.082***<br>(0.035) |
| Negative equity * Outstanding balance ≤ $729,500 * Post 2009Q1 | 0.218***<br>(0.017) |
| Post 2009Q1 | 0.224***<br>(0.016) |
| Control variables | Yes |
|  |  |
| N | 9,514,331 |
| -2LogL | 2,424,487 |
| AIC | 2,424,583 |

1. Jumbo loan sample.
2. Sample limited to those loans originated before 2009.1, with PTI>31%, and for owner-occupied properties only.

42

# By-MSA Analysis

## Negative Equity Beta Time Series for the Top 5 MSAs

---
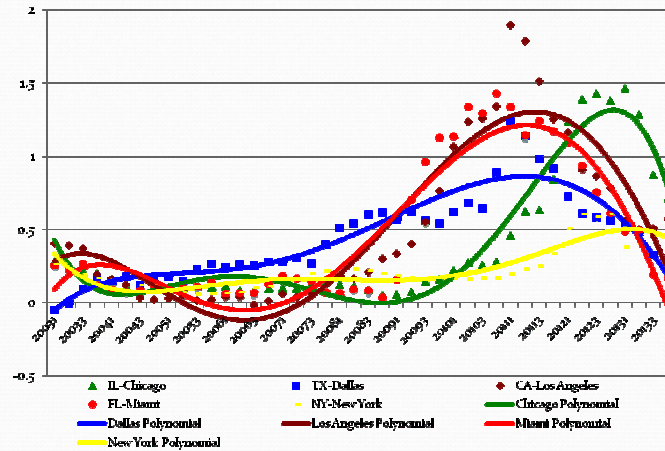
# Panel Data Model of Negative Equity Beta

*Dependent variable: negative equity beta (quarter * MSA)*

| Explanatory variable | Model 1 Estimate (S.E.) | Model 2 Estimate (S.E.) | Model 3 Estimate (S.E.) | Model 4 Estimate (S.E.) | Model 5 Estimate (S.E.) |
|---|---|---|---|---|---|
| State unemployment rate innovation | 0.260* | 0.643*** | 0.555*** | | 0.535*** |
| | (0.131) | (0.104) | (0.108) | | (0.104) |
| Post 2009Q3 | | 0.637*** | 0.654*** | | 0.655*** |
| | | (0.038) | (0.043) | (0.043) | (0.041) |
| MSA distress index | | | | -0.050*** | |
| | | | | (0.003) | |
| Orthogonalized MSA distress index | | | | | -0.046*** |
| | | | | | (0.009) |
| MSA-fixed effect | Yes | Yes | Yes | Yes | Yes |
| | | | | | |
| N | 440 | 440 | 330 | 330 | 330 |
| Adjusted R-Square | 0.136 | 0.482 | 0.555 | 0.576 | 0.586 |

## Robustness Tests

- Subprime loans only (vs. Alt-A and subprime)
- Separate owner-occupied loans from investor loans
- Different HPIs: FHFA HPI, CoreLogic zip-code level HPI (vs. Case-Shiller HPI)
- Negative equity dummy (vs. continuous variable)
- Different rolling window size: 24 months (vs. 36 months)
- Tightening of the HAMP test window
- By-cohort analysis
- Freddie Mac data

## Conclusions

- We find new evidence of cyclical variation in mortgage default option exercise.
  - For a given level of negative equity, borrower propensity to default rose markedly during the financial crisis and in hard-hit metropolitan areas.
  - Simulation shows that changes in behavior during the crisis period were more salient to the rise in defaults than were increases in negative equity.
- Analysis of time-series and panel data indicates the importance of local economic risk, consumer sentiment, and federal policy innovations in explanation of *changing* borrower default behavior.

# Implications

- Mortgage borrower behavior is cycle-dependent.
  - We need a new generation of default risk models that reflect those elements.
    - Important to lenders, insurers, Fannie, Freddie, investors and regulators.
- Mortgage default is not a one-stage process. It's a game.
  - Mortgage borrowers are strategic and are more likely to become delinquent once they expect lenders to modify defaulted loans.
    - Former FHFA Director DeMarco: principal write down faces a major moral hazard.
- Unintended consequence of HAMP
  - While HAMP saved many defaulted borrowers from foreclosure, it also may have induced many borrowers to enter into default.
  - More cost-benefit analysis needed.

47