

# Economics 742 Lecture 3: Housing II: The 2000s Boom and Bust

Adam M. Guren

Boston University

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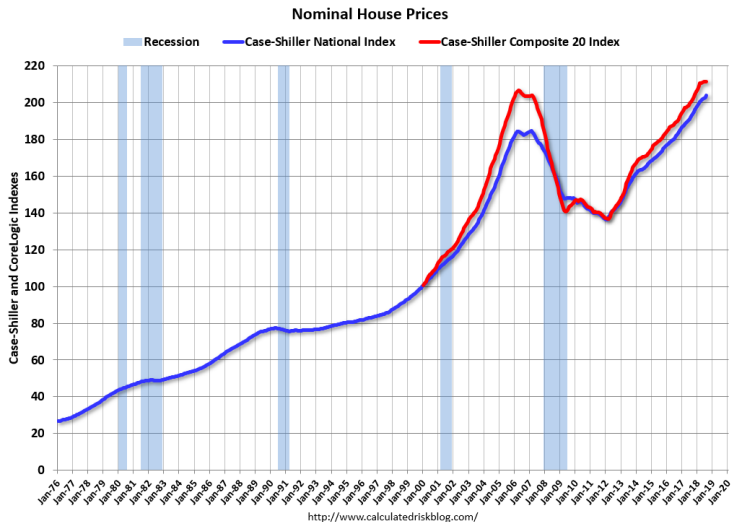
# Housing and Macro

1. Introduction
  - 1.1 Why is housing and macro interesting?
  - 1.2 How did I get to housing?
  - 1.3 My JMP: House Price Momentum
2. Question 1: How big are housing wealth effects? Why do they exist? Are they big in the aggregate?
3. Question 2: What explains the 2000s housing boom and bust (and rebound)?
4. Question 3: What types of housing market stabilization policy are effective?
5. Bonus: References for interesting topics I did not cover
  - 5.1 Monetary Policy and Housing Markets
  - 5.2 Behavioral Housing Economics
  - 5.3 Housing Supply

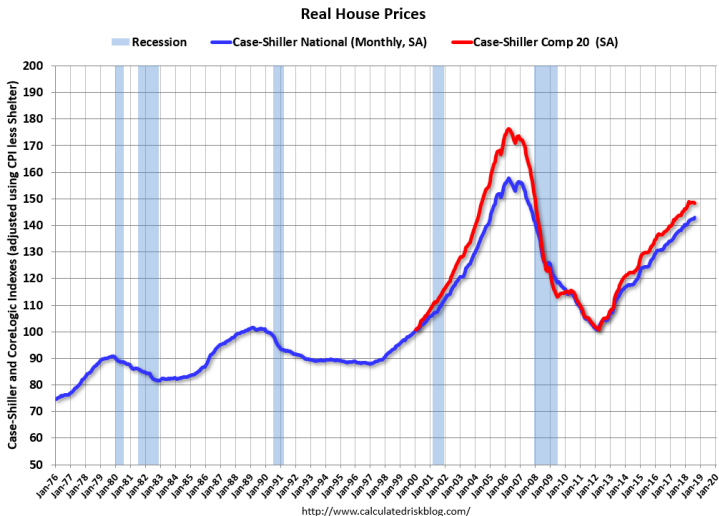
## Question 2:

What Explains the 2000s Housing Boom and Bust (and Rebound)?

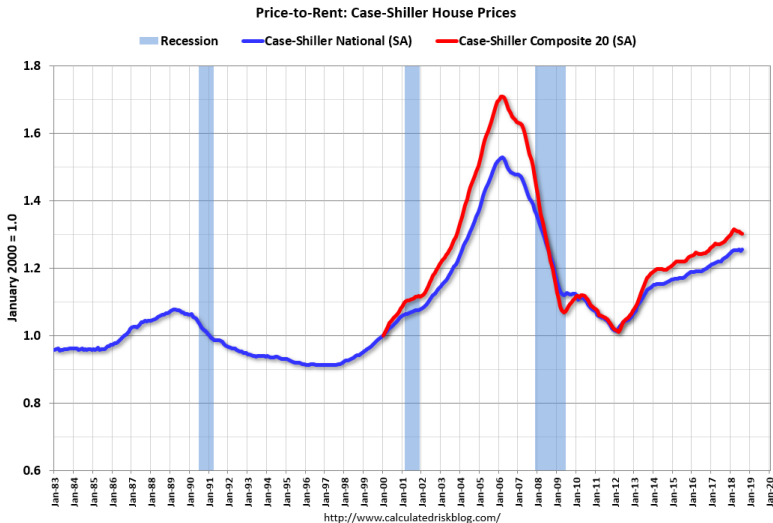
# What Happened: Nominal HPI



# What Happened: Real HPI

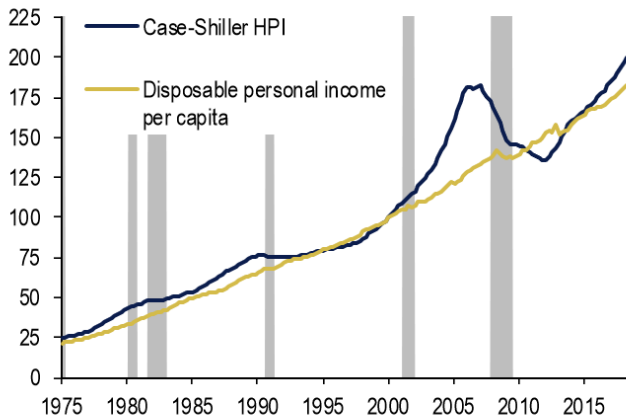


# What Happened: Price/Rent



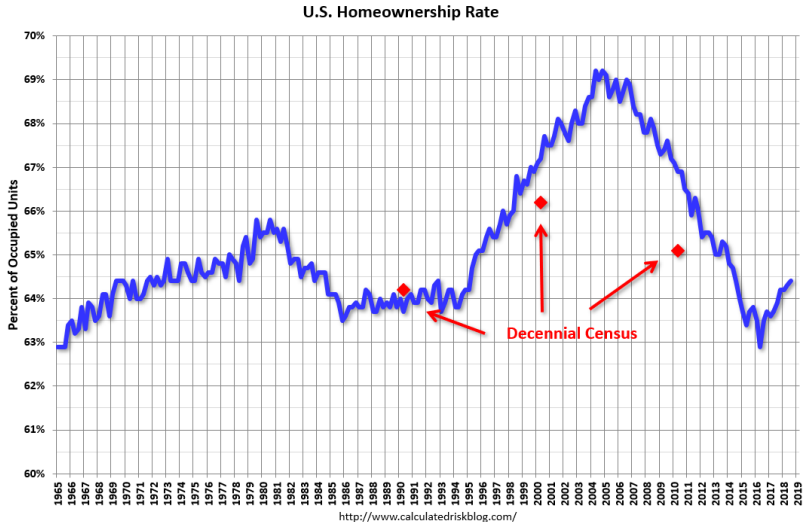
# What Happened: Prices and Income

**Chart 4: Home prices are overvalued relative to income (100=1Q 2000)**



Source: BofAML Merrill Lynch Global Research, S&P CoreLogic, Bureau of Economic Analysis

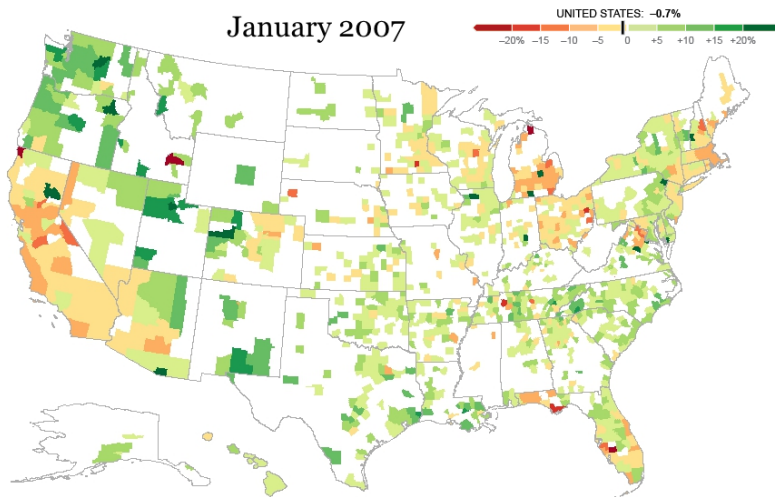
# What Happened: Homeownership





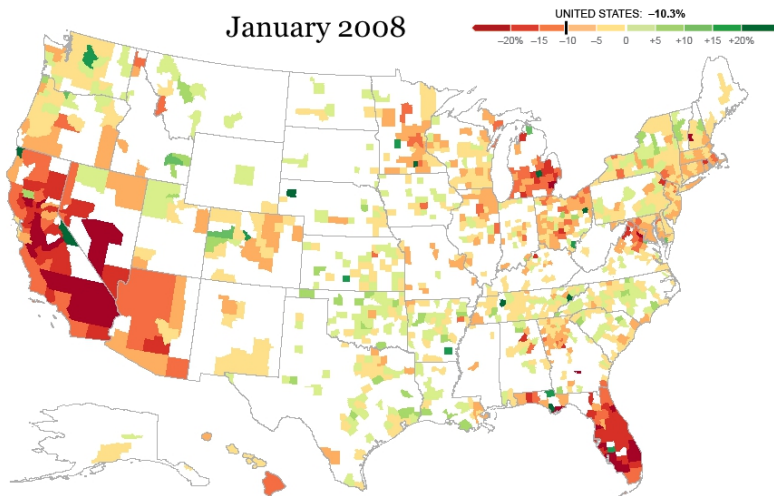
# House Prices Across The Country

January 2007



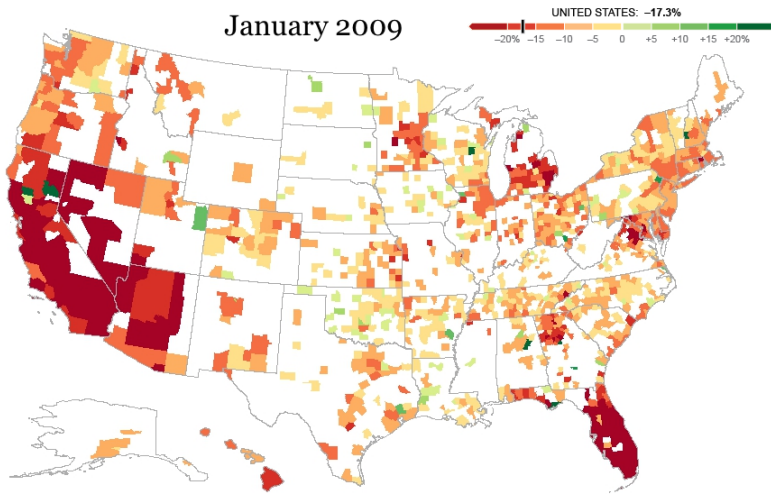
# House Prices Across The Country

January 2008



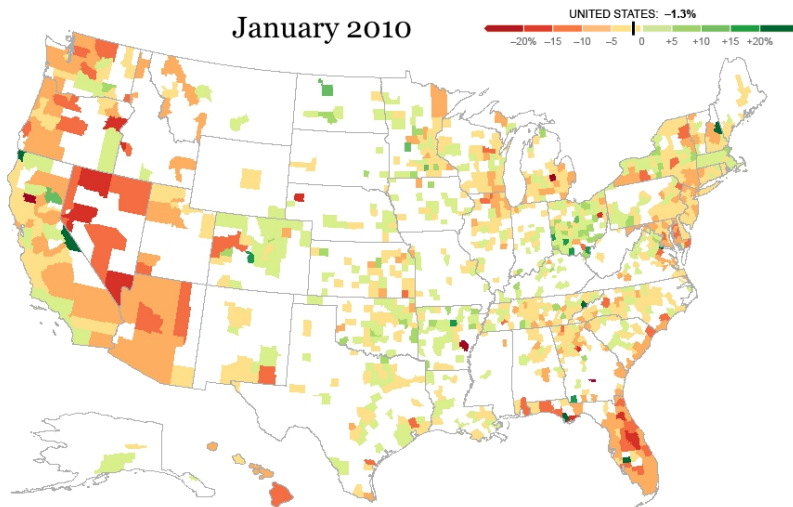
# House Prices Across The Country

January 2009



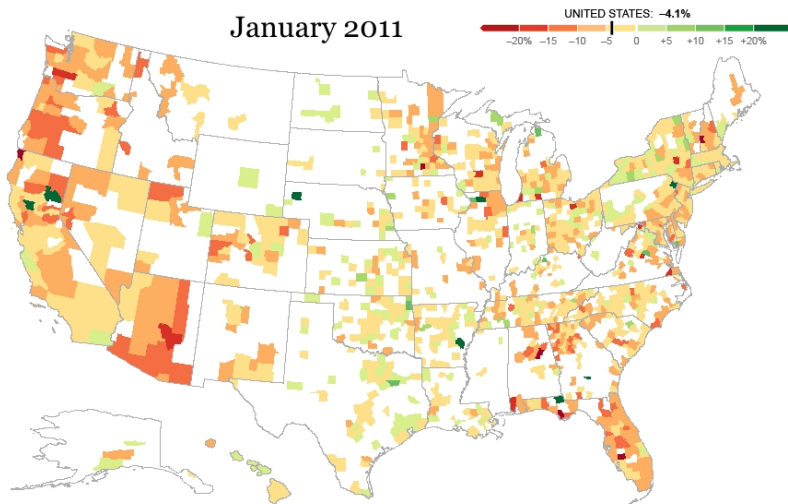
# House Prices Across The Country

January 2010



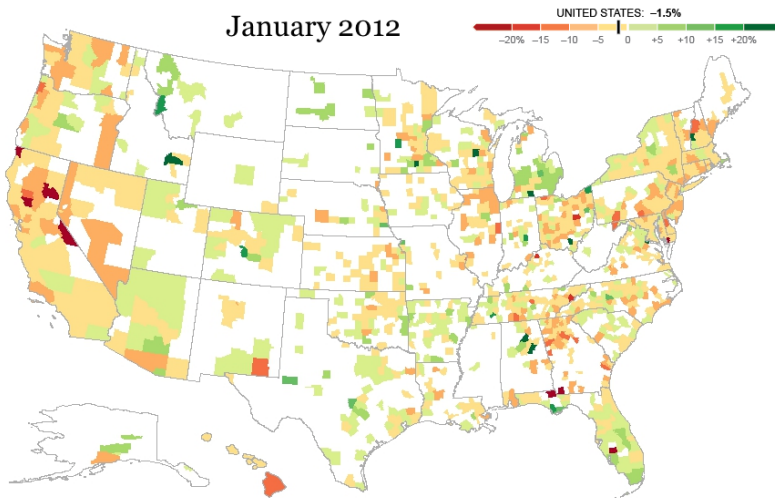
# House Prices Across The Country

January 2011



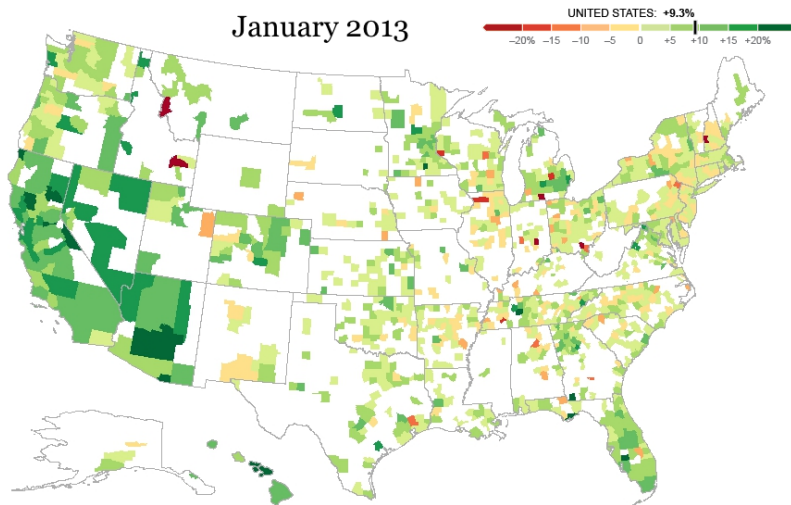
# House Prices Across The Country

January 2012



# House Prices Across The Country

January 2013



# Theories of What Happened

1. **Credit and Lending Standards** (will go in detail next)
2. **Speculation**
  - Scheinkman-Xiong (2003) style stories of speculative bubbles with belief disagreements
  - Geanakoplos-style models, Simsek (2013) type models
  - Housing and Supply application: Nathanson and Zwick (2018) on why elastic places like Las Vegas had big booms
  - My view: Good at explaining later stages of boom (2004-2006) in some elastic places, but not full story
3. **Out of Line Expectations about House Prices**
  - Sunspot changes in beliefs and overoptimism (lots, e.g. KMV)
  - Epidemiological spread of optimism (Burnside et al, 2016)
  - Adaptive learning with limited data (Jacobson, 2022)
  - Overreaction to fundamental shock  
(Chodorow-Reich, Guren, and McQuade, 2024 at end)
4. **Monetary Policy:** Timing not right, interest rate elasticities not big enough



## Credit and Lending Standards

- Big literature! Will only scratch surface today
- Empirical literature finds **quasi-experimental changes in credit affect house prices**
  - Empirical: Favara-Imbs (2015), Di Maggio-Kermani (2017), Loutskinia-Strahan (2015), Johnson (2025), Johnson and Tsur-Ilan (2025)
  - But hard to extrapolate these LATEs to contribution of credit to the boom
- **Theoretical Literature** as well
  - Iacoviello (2005): Collateral constraints tied to housing values means amplification of shocks
  - Justiniano-Primiceri-Tambalotti (2019): Facts in boom consistent with supply shock to credit
  - Landvoigt-Piazzesi-Schneider (2015): Sorting model with credit relaxation consistent with cross-section of boom
  - Favilukis, et al. (2017): Risk premia (discussed next)

## Subprime View of the Boom

- Mian and Sufi (2009) document expansion in subprime that appears unrelated to fundamentals like income
  - “Predatory banks” taking advantage of naive borrowers view of the boom; implies need for regulatory changes
  - Related to securitization reducing lender screening incentives due to lack of skin in the game, deregulation
  - Also related to improvements in lending technology: Automated underwriting, securitization, etc.
- Countervailing evidence
  - Recent papers: credit expansion was broad-based; subprime was just extensive margin (Adelino, Schoar, Severino (2015), Foote-Loewenstein-Willen (2019), Albanesi-De Giorgi-Nosal (2022))
  - Banks just as overly optimistic (Foote et al., 2017), insiders did poorly with own investments and housing

Name	Scenario	Probability	Cum Loss
(1) Aggressive	11% HPA over the life of the pool	15%	1.4%
(2)	8% HPA for life	15%	3.2%
(3) Base	HPA slows to 5% by end-2005	50%	5.6%
(4) Pessimistic	0% HPA for the next 3 years 5% thereafter	15%	11.1%
(5) Meltdown	-5% for the next 3 years, 5% thereafter	5%	17.1%

Table 2. CONDITIONAL FORECASTS OF LOSSES ON SUBPRIME INVESTMENTS FROM LEHMAN BROTHERS.

## Credit: How Big of a Role?

- Favilukis, Ludvigson, and Van Nieuwerburgh (2017) quantify using a structural equilibrium model
  - Finding: 60% of boom can be explained by credit alone; all can be explained by combination of credit and business cycle
- Model features
  - Two-sector GE model (housing and non-housing) with endogenous interest rates
  - Overlapping generations of heterogeneous households face idiosyncratic and aggregate income risk; realistic wealth dist
  - Risk is uninsurable due to incomplete markets and borrowing collateral constraints
- **Key Mechanism: Risk Premium**
  - Loosening of borrowing constraints and lower transaction costs improve ability of households to insure against income risk, lowering risk premium and pushing up house prices
  - To get interest rates to fall, need infusion of foreign capital

## Kaplan, Mitman, and Violante (2020)

- Large, structural, heterogeneous-agent OLG equilibrium model of housing market
  - Multiple shocks that could move house prices
    - Income (fundamentals), credit, and beliefs
    - Realistic mortgage finance and household consumption
  - Use model to disentangle role of shocks
  - This paper is the literature's standard: highly cited, comprehensive, and well executed (but not without flaws)
- Findings:
  1. Main driver was beliefs, *not* credit conditions (very minor role)
  2. House prices explain half of consumption decline in bust due to housing wealth effect
  3. Debt forgiveness and other related foreclosure mitigation policies reduce foreclosures but does not raise house prices

## KMV: Model Setup for Households

- Overlapping generations of households w/ lifecycle earnings
  - Preferences over consumption and housing with bequest motive (so older households do not eat housing at end of life)
  - Labor supplied inelastically; income process has aggregate, idiosyncratic, and age profile components; save in bonds
- Housing:
  - Finite number of sizes for renting and owning
  - Largest homes only owned, ownership utility premium
- Long-term mortgages amortized over remaining life
  - Common interest rate, loans priced by risk neutral lenders with up-front “points”
  - Origination cost. Can prepay and refi if repay cost
  - Subject to LTV limit  $m' \leq \lambda_m p_h h'$ , PTI limit  $\pi^{\min}(m') \leq \lambda_\pi y$  at *origination only* where  $\pi^{\min}$  is min payment
  - Default: Household loses house and incurs utility cost of default, lender recovers fraction of value

## KMV: Household Choices

- Renters decide to:
  1. Rent: House size, savings, consumption
  2. Own: House size, mortgage, saving, consumption  
s.t. LTV, PTI constraints
- Owners decide:
  1. Stay current: Mortgage s.t. min payment, saving, consumption
  2. Refinance: Mortgage, savings, consumption s.t. LTV and PTI
  3. Sell: House size, mortgage, saving, consumption s.t. LTV, PTI
  4. Default: House size, savings, consumption
- Bellman equations for each choice, overall Bellmans for renters and owners maximizes over choice Bellmans

## KMV: Construction, Production, Shocks

- Competitive rental sector with deep-pocketed landlords → user cost equation relating rents to prices and expected future prices
- Competitive construction sector that uses land (flow of permits available each period) and labor; CRS final goods
- Shocks
  - Agg shocks to labor productivity
  - Shocks to LTV  $\lambda_m$ , PTI  $\lambda_\pi$ , mortgage orig cost and spread
  - Shocks to future preferences for housing services
    - 3 states: Low housing preference with low prob of switching, low with high prob of switching, high
    - “Expectation” shock is news shock about fundamentals: Move from low with low prob to low with high prob
- Boom-bust episode is two “MIT” shocks:
  - Boom: Initially shift to high productivity, loose credit, low state with high prob of switching to high state
  - Bust: Second MIT shock reverts back

## Heterogeneous Agents and Krusell-Smith

- Solving heterogeneous agent models with aggregate shocks is hard because there is a large infinite-dimensional state variable
  - Seminal paper is Krusell and Smith (1998)
  - Examine an Aiyagari model with aggregate shocks, which has an infinite dimensional wealth distribution
- Idea: Use approximate equilibrium where agents use simplified model with a few moments or sufficient statistics instead of full infinite dimensional state variable
  - Interpretation: Best “simple” forecast or bounded rationality
  - Method: Solve simplified model with simple forecast rules that hold in equilibrium. Then show these simple forecasts come close to the true heterogeneous agent optimum
  - Krusell and Smith use first moment of capital distribution



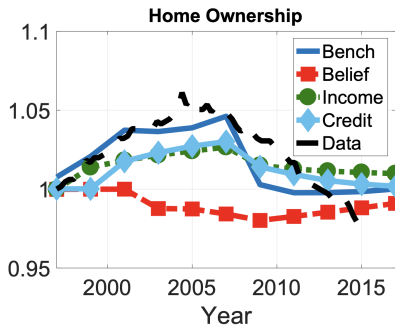
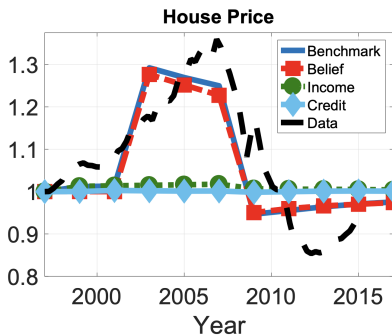
# KMV: Computation and Calibration

- Krusell-Smith on price
  - Here, one price that households need to forecast:  $p_h$ . So do forecast rule for price rather than moments of distribution
  - Assume households use one-period-ahead forecast rule as function of current price, current state, next state:

$$\log p'_h(p_h, Z, Z') = a_0(Z, Z') + a_1(Z, Z') \log p_h$$

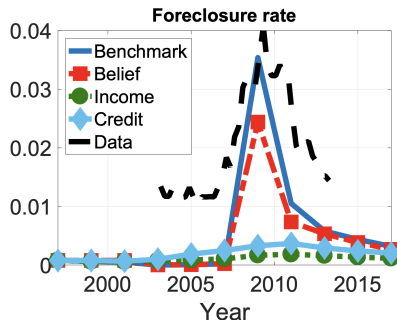
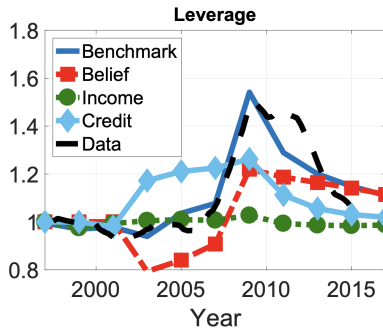
- Algorithm:
  1. Simulate economy conditional on forecast rules
  2. Estimate forecast rules as regressions based on simulated data
  3. Update forecast rules and iterate until convergence  
(Den Haan (2010): Check *long-run* forecasts are accurate)
- Detailed calibration of model based on microdata and standard params
  - Credit relaxation:  $\lambda_m$  goes from .95 to 1.1,  $\lambda_\pi$  from 0.25 to 0.5.
  - Expectations parameters based on survey evidence on house price expectations from Case-Shiller-Thompson
  - Model matches life-cycle patterns in data

# KMV: Results For Prices and Homeownership



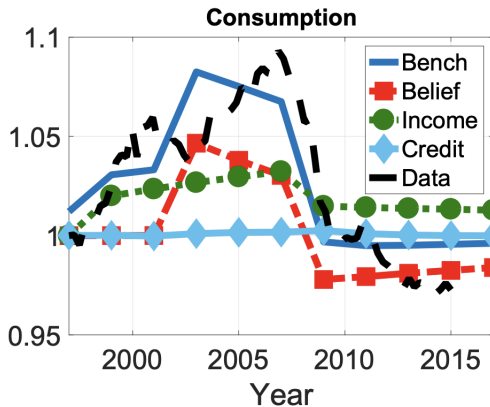
- Model does good job capturing boom-bust in data for prices
- Belief shock does *everything* for prices and price-rent
  - Credit relaxation does *essentially nothing*
- Credit and income crucial for homeownership

## KMV: Results For Lending and Foreclosure



- Credit is important for constant leverage in boom
- Interaction between beliefs (prices) and credit (leverage) matter for foreclosures
  - Both contribute to households being underwater

## KMV: Results For Consumption



- Consumption half house prices and half income
  - House prices through standard housing wealth effect

# KMV: Why Does Credit Not Affect House Prices?

- KMV say two things are crucial:

## 1. Presence of Rental Markets

- Ability to rent rather than own means fewer households are constrained in their consumption of housing
  - Housing demand changes less when credit constraints relax
- House prices predominantly determined by demand from largely unconstrained existing owners, who upsize/downsize when expectations change

## 2. Long-Term Mortgages

- Dampen link between credit and housing risk premium as in Favilukis et al. (2017)
- When prices change, do not need to immediately satisfy collateral requirement, which is what makes consumption and risk premium volatile

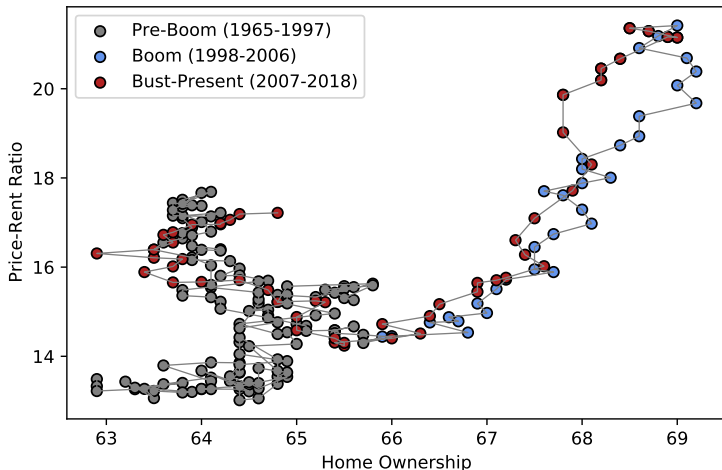
## What Explains Differences? Greenwald and Guren

- **Reconcile and explain disparate findings** about role credit played in housing boom and bust
  - Key to design of macroprudential policy
  - Also matters for effect of foreclosure mitigation policies
- Argue key difference between existing papers is how model ***rental market***; two polar assumptions used:
  - **Full segmentation**: Fixed homeownership rate  
Credit  $\rightarrow$  demand  $\rightarrow$  prices (e.g., FLVN)
  - **No segmentation**: Deep-pocketed landlords who do not use credit. When credit loosens, renters buy from their landlords, prices pinned down by PV of rents (e.g., KMV)
  - Make these assumptions so Krusell-Smith is only over one price, not two
- More generally: Extent to which **credit insensitive** agents absorb credit-driven demand
  - Depends on degree of **segmentation** in housing markets
  - **Unconstrained savers** can play a similar role unless their housing is segmented

## Greenwald and Guren: Structure and Summary

- Approach: Tractable macro-housing framework and novel empirical estimates
  - **Introduce model** with arbitrary degree of segmentation through heterogeneity, nesting polar cases
  - **New empirical moment for calibration:** Relative causal elasticity of price-rent vs. homeownership to credit supply shock is sufficient statistic for degree of segmentation
  - **Calibrate model** to match empirical findings, then decompose boom-bust
- Main Findings:
  - Price-rent ratio responds at least  $4\times$  **more** than homeownership to identified credit shock
  - Change in credit standards that literature uses for 2000s explains **32% to 53%** of price-rent rise
  - Close to full segmentation model, much stronger than no segmentation model
  - Implies **macroprudential policy can rein in a housing boom and foreclosure policy matters for prices**

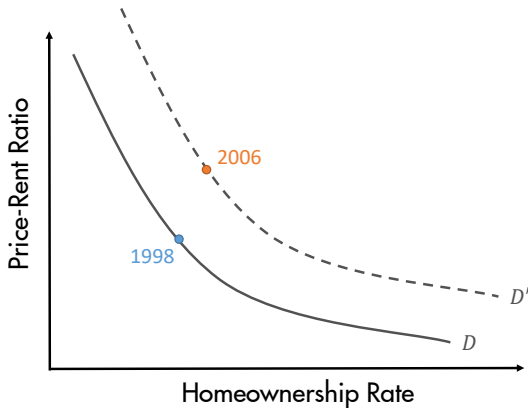
# Time Series: Price-Rent Ratio vs. Homeownership Rate





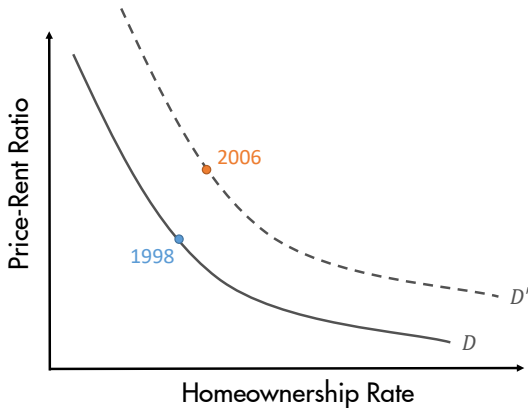
## Intuition: Modified Supply and Demand

- Plot demand for owner-occupied housing; price-rent ratio and homeownership rate robust to changes in housing stock



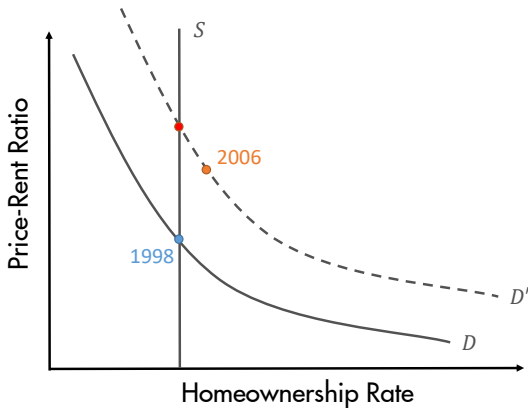
## Intuition: Modified Supply and Demand

- Credit Expansion: Demand for owner-occupied housing shifts right



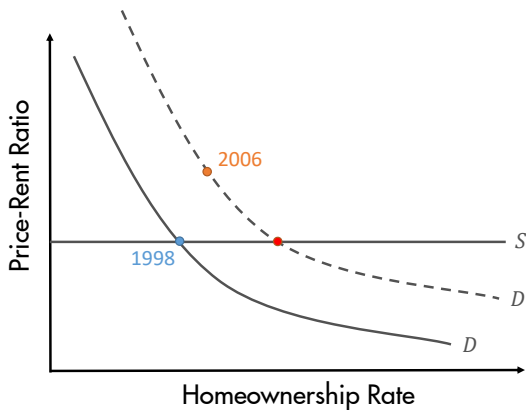
## Intuition: Modified Supply and Demand

- Fixed “supply” (homeownership rate)  $\implies$  all adjustment through price-rent ratio



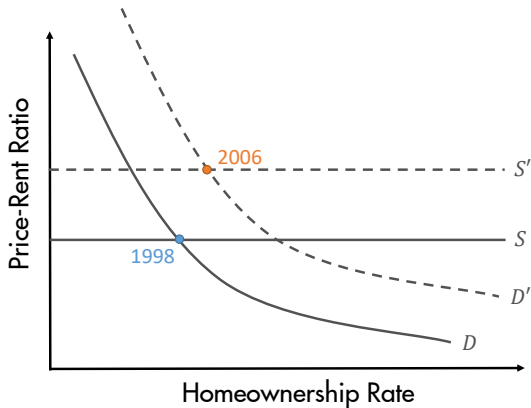
## Intuition: Modified Supply and Demand

- Perfectly frictionless rental market  $\implies$  all adjustment through homeownership rate



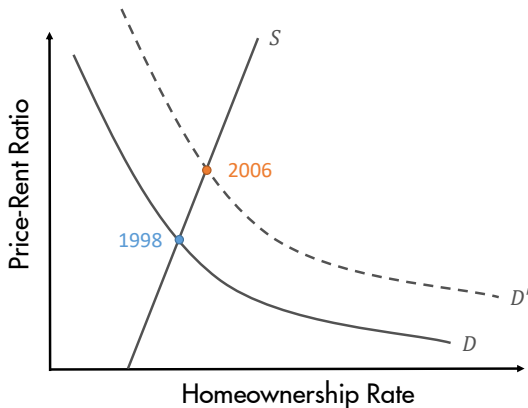
## Intuition: Modified Supply and Demand

- Increase in price-rent requires separate shock to supply, e.g. change in expectations about future rents



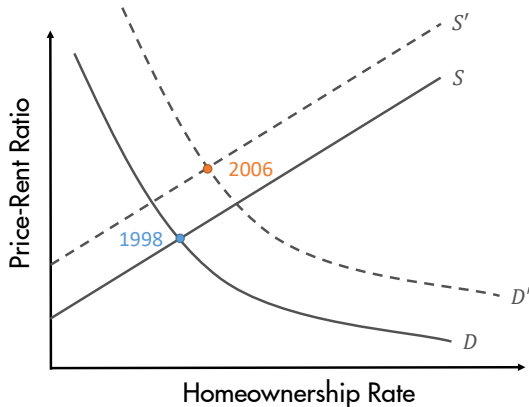
## Intuition: Modified Supply and Demand

- Alternate view: credit expansion + upward sloping supply (imperfect rental market)



## Intuition: Modified Supply and Demand

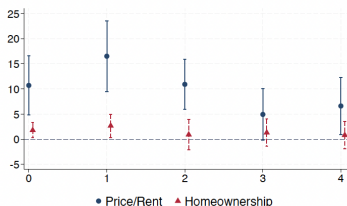
- Any intermediate combination of upward sloping supply and supply shift also possible
  - To separate role of credit from other shocks, need to identify slope of supply curve



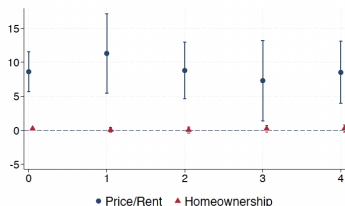
## Greenwald-Guren: Empirical Results

- Three off-the-shelf empirical approaches to estimate causal effect of credit supply on price-rent ratio (PRR) and homeownership rate (HOR)
  - Show only one here: Loutsikina-Strahan (2015), exploiting differential city-level exposure to national changes in conforming loan limits using share-shift design
- Panel Local Projection of reduced form: for  $k = 0, \dots, 5$

$$\log(\text{outcome}_{i,t+k}) = \xi_i + \psi_t + \beta_k \Delta Z_{i,t} + \theta X_{i,t} + \varepsilon_{i,t}$$



(a) Point Estimates (HVS)



(b) Point Estimates (GG Microdata)



## Greenwald-Guren: Model Setup

- Adapt Greenwald (2018) to allow for endogenous rental market
  - Within-period heterogeneity allows for long-term, fixed-rate, prepayable mortgages with LTV and PTI at origination
  - No heterogeneity across periods, allowing for log-linearization
- Why not a true heterogeneous agent model?
  - Benefits: No Krusell-Smith
  - Cost: Not true heterogeneous agent model; potentially misses channels that dampen shift in credit demand (which we will calibrate as best we can)
- 3 types of agents with perfect risk sharing within types:
  - Borrowers: Consume owned and rented housing, borrow with mortgages ( $\beta_B < \beta_S$ )
  - Landlords: Risk-neutral, own housing to rent (extension: landlord mortgages  $\rightarrow$  bigger price effect)
  - Savers: Finance mortgages, own fixed housing stock (extension: trade houses  $\rightarrow$  similar if recalibrate)

## Greenwald-Guren: Heterogeneity and Optimality

- Borrowers: Benefit  $\omega_{i,t}^B \text{rent}_t H_{i,t}$  from owning,  $\omega_{i,t}^B \stackrel{iid}{\sim} \Gamma_{\omega,B}$ 
  - Interpretation: life cycle, preferences, credit score, down payment
- Landlords: Benefit  $\omega_{i,t}^L \text{rent}_t H_{i,t}$  from owning,  $\omega_{i,t}^L \stackrel{iid}{\sim} \Gamma_{\omega,L}$ 
  - Interpretation: Variation in rental suitability
  - Implicit assumption: New construction has same dist as existing stock
- Housing allocated to best suited agents  $\rightarrow$  cutoffs  $\bar{\omega}_t^B$  and  $\bar{\omega}_t^L$ 
  - Optimality conditions will include  $\bar{\omega}$ s. These adjust to clear housing quantities and satisfy

$$H_t^{\text{rent}} + H_t^{\text{own}} = H_t^{\text{tot}}$$

- Construction sector determines  $H_t^{\text{tot}}$ .

## Greenwald-Guren: Heterogeneity and Optimality

- Key optimality conditions are Eulers for landlords (supply) and borrowers (demand):

$$p_t^{supply} = E_t \left\{ \Lambda_{t+1}^L \left[ \underbrace{\bar{\omega}_t^L + rent_{t+1}}_{\text{Housing Services}} + \underbrace{(1 - \delta) p_{t+1}}_{\text{Continuation Value}} \right] \right\}$$

$$p_t^{demand} = \underbrace{(1 - C_t)^{-1}}_{\text{Credit Conditions}} E_t \left\{ \Lambda_{t+1}^B \left[ \underbrace{\bar{\omega}_t^B + rent_{t+1}}_{\text{Housing Services}} + \underbrace{(1 - \delta - (1 - \rho_{t+1}) C_t) p_{t+1}}_{\text{Continuation Value}} \right] \right\}$$

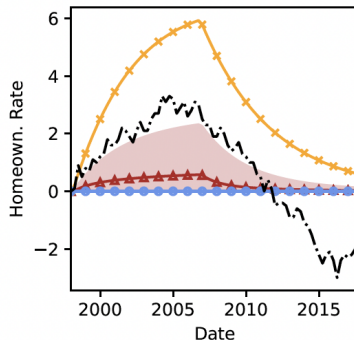
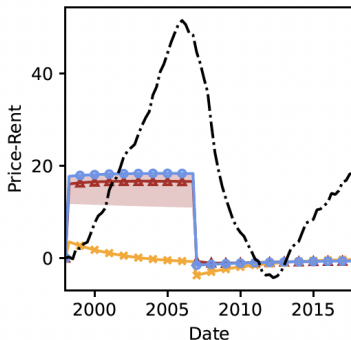
- Standard asset pricing conditions:  $p = E[SDF \times \text{payoff}]$
- These correspond to inverse supply and demand in prior pictures, slope affected by densities of  $\Gamma$  dists at margin
  - Payoffs are period housing services plus resale value next period
  - $C_t$  reflects shadow value of credit that can be collateralized by dollar of housing, shows up multiplying Euler and shifting inverse demand curve for housing

## Greenwald-Guren: Calibration

- Most parameters standard
- Borrower heterogeneity (demand slope): Match evidence on uptake of first time homebuyer tax credit
- Borrower patience controls extent to which demand shifts when credit changes
  - Calibrate using private mortgage insurance pricing
  - This is where I think not having a full heterogeneous agent model matters most...
  - But KMV find credit moves HOR, expectations price. This implies flat supply curve, not dampened shift in demand (which would not move HOR), is driving results
- Landlord heterogeneity (supply slope): Match empirics
  - Most of the way towards full segmentation (FLVN), but still important HOR response
- Boom-bust from two MIT shocks in 1997 and 2006 (LTV 85%  $\rightarrow$  99%, PTI 36%  $\rightarrow$  65%; PTI does most of work)

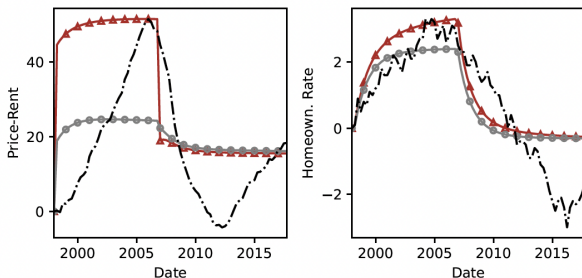
## Greenwald-Guren: Credit Only

- Start with only credit changes
  - **Benchmark**: 32% of PRR increase (shaded shows CI of our new moment)
  - **Perfect rental markets**: -2% of PRR increase
  - **Complete segmentation**: 36% of PRR increase



## Greenwald-Guren: Credit in Full Boom Model

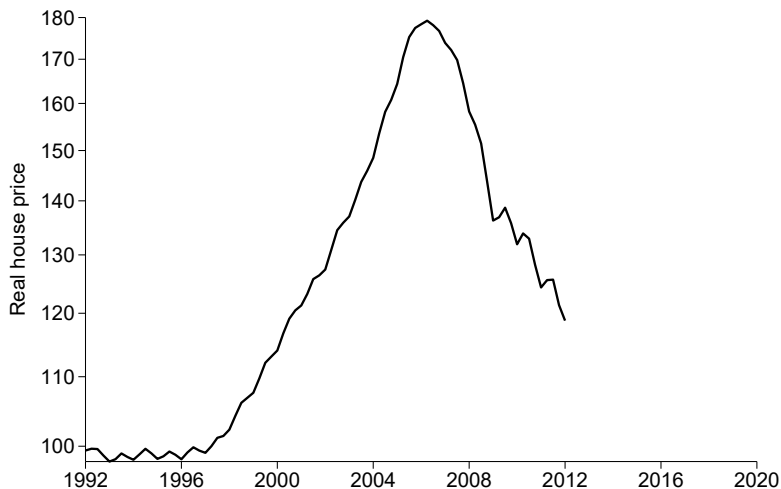
- Full Boom model: Add 2% drop in mortgage rates, use demand and supply shocks (shift in  $\Gamma$  means) to exactly explain PRR and HOR in boom
- Compare **full boom** with full boom removing credit
  - Removing kills 53% of boom in PRR, relative to 3% if do full boom exercise with no segmentation model
  - Larger than credit only because of interactions between credit and expectations-driven demand shocks



## Foreclosure Policy Implications

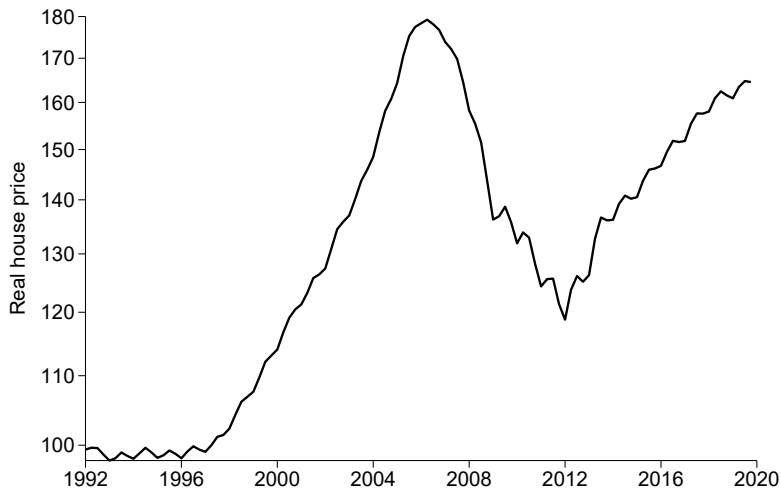
- Also implies that foreclosures have price impact and foreclosure policy affects prices
  - KMV: Flat supply curve means foreclosures ( $\downarrow$  demand due to shut out borrowers as in Guren-McQuade) has no effect
  - Also implies no price-foreclosure spiral!
- Places with bigger booms had disproportionately larger busts, which Guren-McQuade (2020) argue is consistent with significant city-level price impacts of foreclosures
  - GM: Ruined credit accounts for 25% of decline in non-distressed prices, lender losses contracting credit 23%
  - Consistent with quasi-experimental evidence on foreclosures at market level (e.g. Mian-Sufi-Trebbi, 2015)
- Matters for macroprudential and foreclosure policy (next class)

## CRGM: National Boom, Bust





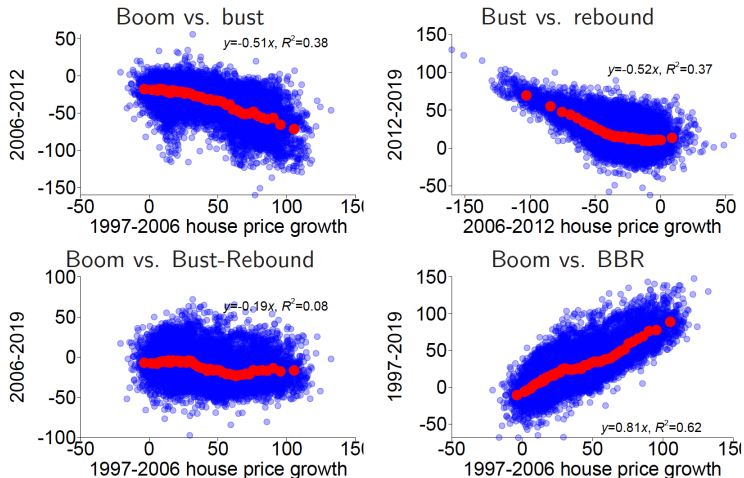
## CRGM: National Boom, Bust, and Rebound



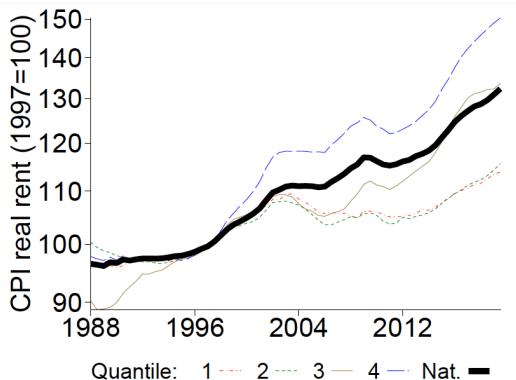
## CRGM: 2020 Hindsight

- Chodorow-Reich, Guren, and McQuade (2024) re-evaluate narrative of 2000s as “bubble” and bust
  - Was it really a “sunspot” expectation or credit shock that exogenously reversed?
- 1. **National BBR**: Price rebound nearly as large as bust
- 2. **X-Section BBR**: Areas with big booms and busts had big rebounds
- 3. **Empirical Analysis of Urban Fundamentals**
  - Long run city price growth corr with long-run fundamentals
  - Higher long-run **fundamentals** → **larger boom-bust-rebound**
- 4. Neo-Kindlebergerian view of **fundamentally-rooted BBR** from single shock in 1997:
  - **Boom**: **Overoptimism** about growth rate of fundamentals
  - **Bust**: Beliefs correct, exacerbated by **foreclosures**
  - **Rebound**: Converge to growth path at new drift rate
  - **Estimated model** fits cross-section of cities
  - **Role of structural factors and low discount rates**

# CRGM: Boom-Bust-Rebound at ZIP Level



## CRGM: Rent Break in Mid-1990s



- Rents more closely reflect dividends, not other factors like interest rates (but  $E[\Delta P]$  also matters through user cost)
- Additional support for fundamentally-rooted BBR

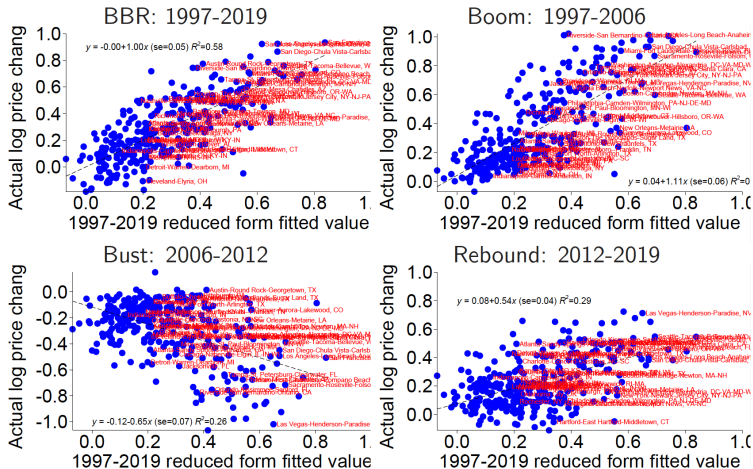
# CRGM

- **Structural supply equation** in growth rates extending Saiz:

$$p_{i,t} = c_0 + c_1 s_i + c_2 h_{i,t} + c_3 [s_i h_{i,t}] + c_4 [m_i h_{i,t}] + c_5 [m_i s_i h_{i,t}] + e_{i,t}$$

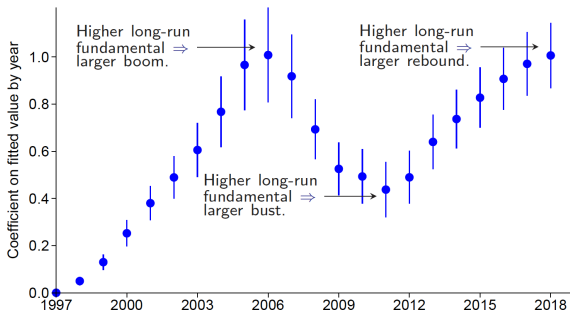
- $p_{i,t} = \Delta \log P_{i,t}$ ,  $s_i$  = land share of price,  $h_{i,t} = \Delta \log \text{Pop}_{i,t}$ ,  $m_i$  is regulation index
  - Unobserved cost shocks affect  $h_{i,t}$  and  $p_{i,t}$ , so OLS biased
- **Excluded instruments** from urban literature
  - Pop growth instruments:
    - Income: Share-shift in emp growth and wage growth
    - Amenities: Jan sunlight and temp, Jul humidity, restaurant emp
  - Land share instruments:
    - Saiz unavailability (Lutz and Sand, 2019), pop density
  - Regulation instruments: protective inspection/tax revenue, non-traditional Christian share
- Our “fundamental” is second-stage predicted value, which is a linear combo of these instruments and their interactions

# CRGM: Reduced-Form Fitted Values



## CRGM: Long-Run Fundamental Predicts BBR

- Long run fundamental  $\hat{p}_{i,1997,2019}$  is second-stage fitted value
- Coefficients  $\{\beta_{1,h}\}$  of house price growth since 1997 on fundamentals:  $p_{i,1997,1997+h} = \beta_{0,h} + \beta_{1,h}\hat{p}_{i,1997,2019} + v_{i,h}$



## CRGM: Model of Beliefs

- Agents learn about drift of dividend  $D_t$  to living in city by observing dividends

$$dD_t = \mu_t D_t dt + \sigma_D D_t dW_{D,t}$$

$$d\mu_t = \theta (\bar{\mu} - \mu_t) dt + \sigma_m dW_{\mu,t}$$

- At  $t = 0$ , long run mean  $\bar{\mu}$  shifts permanently to  $\mu_0 > \bar{\mu}$
- Rational learning:  $h_t(\mu_t | \mathcal{F}_t) \sim N(m_t, \sigma_m^2)$ ,  
 $dm_t = \theta (\bar{\mu} - m_t) dt + K dB_t$  by Kalman
- Replace with **Diagnostic expectations**, which over-weight recent news in nowcast of  $m_t$ :

$$\underbrace{h_t^\varphi(\mu_t)}_{\text{Diagnostic posterior}} \propto \underbrace{h_t(\mu_t | \mathcal{F}_t)}_{\text{Rational posterior}} \underbrace{\left[ \frac{h_t(\mu_t | \mathcal{F}_t)}{h_t(\mu_t | \mathcal{F}_{t-k})} \right]^\varphi}_{\text{Distortion}} \sim N \left( \underbrace{m_t}_{\text{Rat. mean}} + \varphi \underbrace{[m_t - \mathbb{E}_{t-k} m_t]}_{\text{Recent news}}, \sigma_m^2 \right)$$

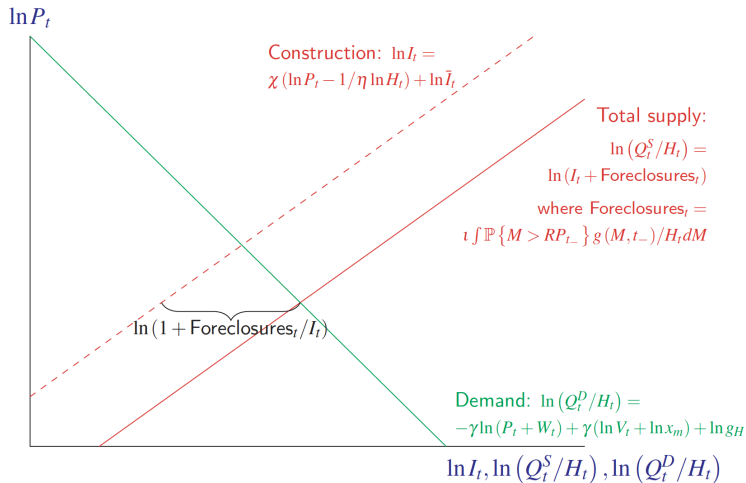
- Formalizes K-T representativeness heuristic
- Consistent with boom and bust length independent of size, beliefs fall slowly in bust



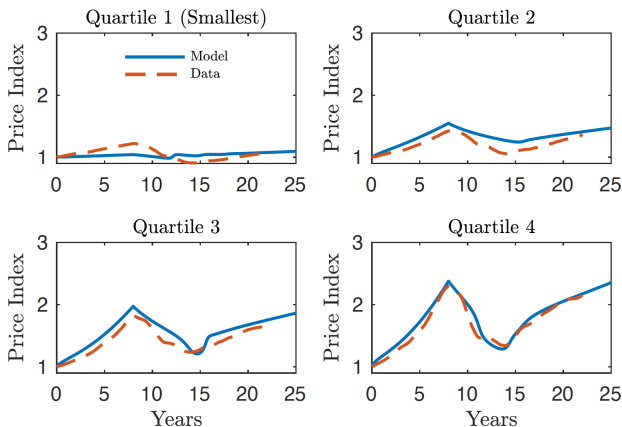
## CRGM: Rest of Model

- Potential entrants buy if  $\xi V_t > P_t + W_t$ 
  - $V_t$  is expected PDV of dividends *with diagnostic expectations*
  - $P_t$  purchase price,  $W_t$  mortgage cost in up-front points
  - $\xi$  idiosyncratic shock giving downward sloping demand
- Construction  $C_t = AH_t^{1/\eta} (I_t/\bar{I}_t)^{1/\chi}$ 
  - $\eta$  long-run supply elasticity,  $\chi$  short-run const elasticity in construction rate  $I_t = \dot{H}_t/H_t$  rel to trailing average  $\bar{I}_t$
- Mortgages and Double-Trigger Foreclosures:
  - Purchase mortgage at empirical dist of LTVs
  - Poisson liquidity shock  $\iota$  causes refi if above water, foreclosure if underwater. Foreclosures add to supply at date  $t_+$  and defaulters exit
  - Mortgage density evolves according to Kolmogorov forward eq

# CRGM: Graphical Depiction of Model



## CRGM: Model Fit By Quartile



- Calibrate to four quartiles of cities by long run price growth
- SMM to match 1997-2019 price growth, boom and bust expectations, bust length, role of foreclosures, etc.

# CRGM: Role of Structural Elements



- Need both diagnosticity and foreclosures
- Low interest rates  $\rightarrow V_t$  more sensitive to expected dividends further in future  $\rightarrow$  diagnostic cycles stronger

## Summary: My View of Boom-Bust

- **Both expectations and credit mattered**
  - Credit: Early boom in late 1990s, subprime in early 2000s, credit expansion in 2003
  - Expectations and speculation matter more in late boom
- Expectations were **overreaction to fundamental growth**
- **Price-foreclosure** spiral causes overshooting in bust
- Credit matters in two ways
  1. If long-run change, e.g. credit supply technology, could show up in long-run fundamental
  2. Otherwise credit is endogenous (over-optimistic beliefs of lenders), part of CRGM mechanism (through buyer entry margin and calibration of short-run supply elasticity)
- Market segmentation implies price-foreclosure spiral significant, scope for foreclosure mitigation policy to limit bust