Goverment Policies, Residential Mortgage Defaults, and the Boom and Bust Cycle of Housing Prices

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Agenda

- Research Motivation
- The Simulation Model
- Parameter Calibration
- Subprime Default Contagion
- Policy Analysis
- Conclusion

Research Motivation

- The current financial crises has caused unimaginable wealth losses to households, because wealth of the majority of the U.S. population is concentrated in their home equity.
- Last couple years, there has been much written about the still-unfolding financial crises. General agreement in both popular press and academic literature is the burst of the housing bubble
- Easy access to cheap credit is claimed to be the source of the current crises. Some are:

- Lax mortgage underwriting standards coupled with goverment policies increase the demand for housing causing unprecedented increase in prices.
- In 1995, the GSEs receive gov't tax incentives for purchasing MBS
- From 2000 to 2003, fed fund rate from 6.5% to 1%.
- In 2003, the American Dream Development Act become law and provided financing for low income families.
- We address how easy credit fueled the bubble in prices through the contamination of subprime virus.


Case Shiller Composite Indices SA (Nominal)
Composite 10
Composite 20
Case-Shiller Index
250
200
150
100
50
0
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
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Jan-01
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Jan-07
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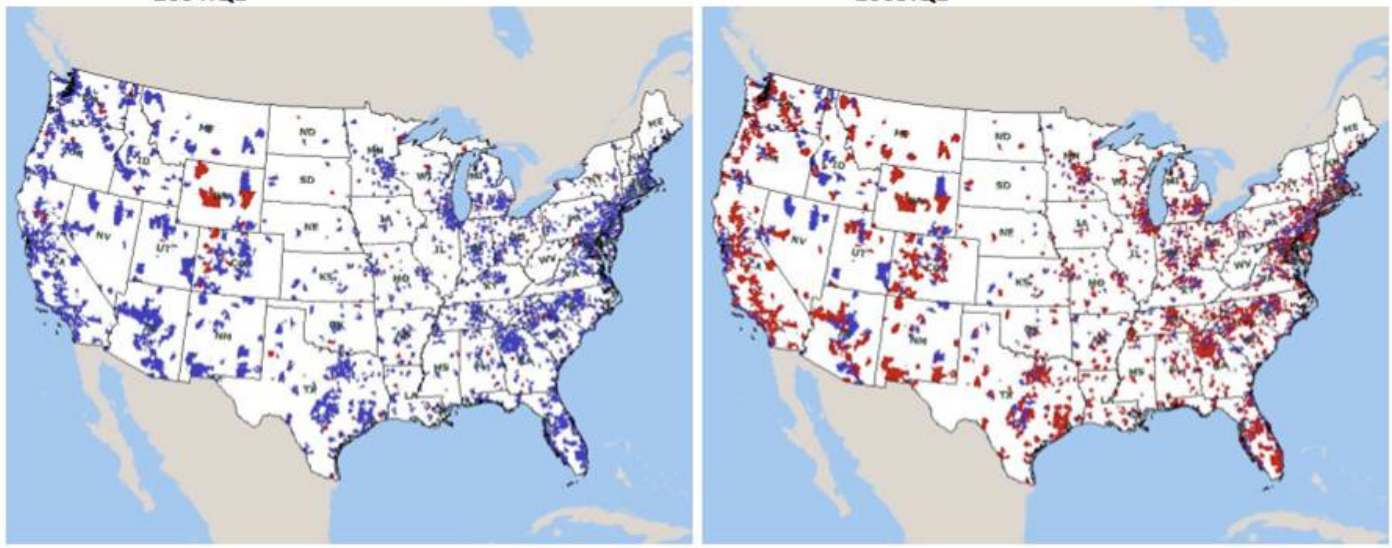
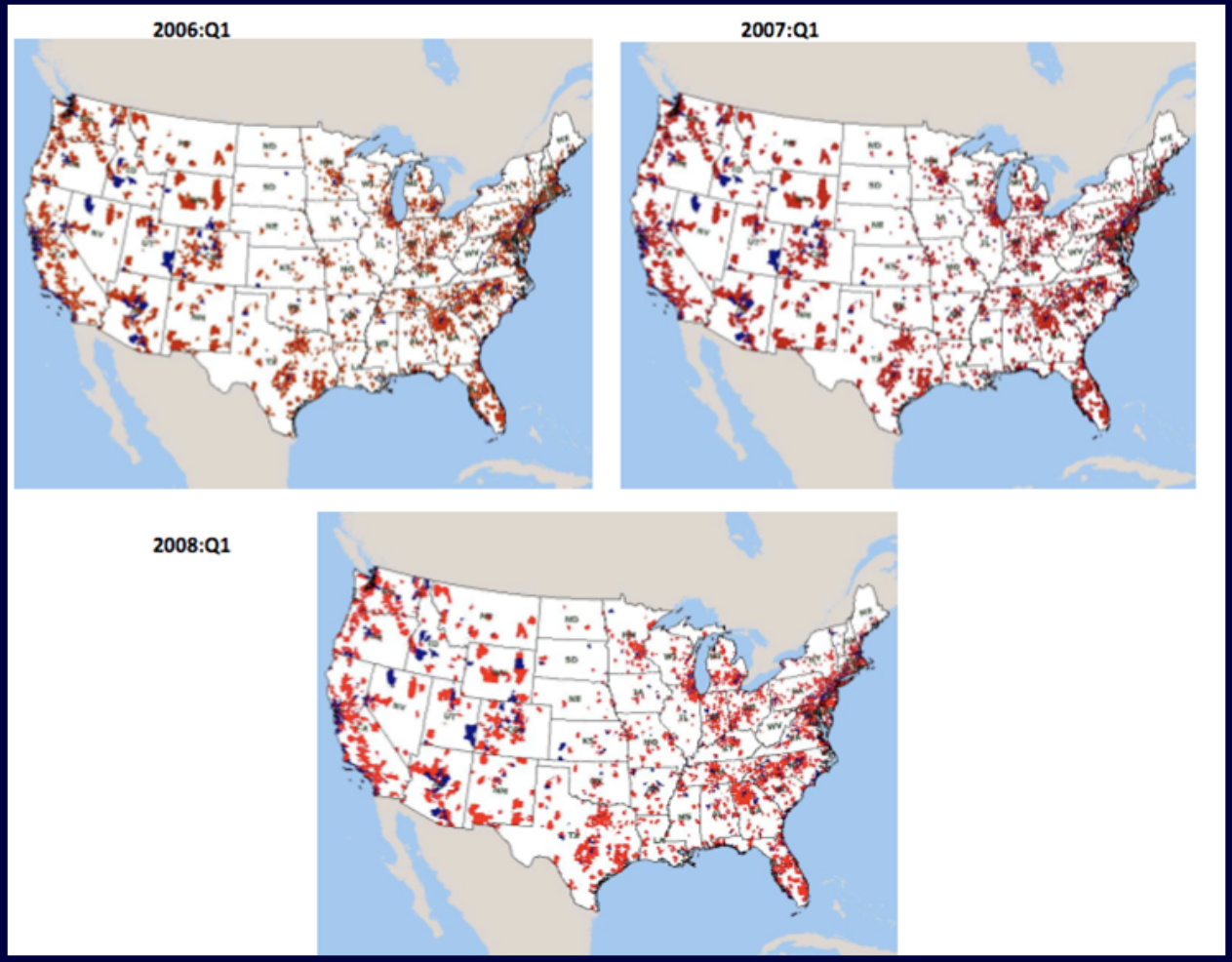
Jan-12
http://www.calculatedriskblog.com/

Figure 1: Maps of Subprime And Prime Areas in our Analysis: 2004-2008

2004:Q1 **2005:Q1**




2006:Q1
2007:Q1
2008:Q1

- A realistic model for housing critically depends on the
  - ⋆ market interest rate,
  - ⋆ household's wealth and
  - ⋆ house price evolution in addition to incorporating significant negative suprises.

- The negative shock in the economy will build up default contagion in aggregate wealth shifting the wealth downward and forcing the borrowers to default, and causing the house prices decline.

The Simulation Model

Household:

- We assume an area with K different households with mortgages.
- Each borrower purchases their home using a fixed rate mortgage.
- There are two types of borrowers, prime and subprime, characterized by their credit score (quality) at time t, denoted by Φ_t^i where $\Phi_t^i = 1$ if the i^{th} household is a prime borrower and 0 if a subprime borrower.
- We let the i^{th} home be financed with a 30 year $\textit{fixed rate mortgage}$. If the home is purchased at time t, there is an initial down payment of $C(\Phi_t^i)H_t^i$ dollars where $C(\Phi_t^i)$ is the initial deposit to value ratio depending on the borrower's credit score.

- We assume that the i^{th} borrower's disposable income evolves through time according to a mean-reverting process:

$$dY_t^i = Y_t^i \left[\kappa_Y \left(\ln \left(R(\Phi_t^i) \bar{Y}_t \right) - \ln \left(Y_t^i \right) \right) dt + \sigma_Y dW_t^{Y,i} \right]$$

where $\left\{ W_t^{Y,i} \right\}_t$, $i = 1, .., K$, are independent Brownian motions and R is a deterministic function of the credit quality (prime or subprime) modeling the income difference between subprime and prime households.

- Indivual house prices move according to the following stochastic jump process

$$dH_t^i = H_t^i \left[\kappa_H (\ln(\bar{H}_t) - \ln(H_t^i)) dt + \sigma_H dW_t^{H,i} - L_H dU_t^i \right]$$

where $\left\{W_t^{H,i}\right\}_t$, $i = 1, .., K$, are independent Brownian motions and mean reverts around the average house price level, $\bar{H}_t$.

- The process $\left\{U_t^i\right\}_t$ counts the number of defaults related to house i. Thus the cumulative defaults process U_t is defined by $U_t = \sum_{i=1}^{K} U_t^i$.

Aggregate Economy:

- To capture the fluctuations in the aggregate economy, three macroeconomic variables are introduced: short rate r_t, disposable income level $\bar{Y}_t$ (e.g. aggregate wealth process for the economy) and average house price level $\bar{H}_t$.

$$dr_t = \kappa_r \left(\bar{r} - r_t\right) dt + \sigma_r dW_t^r,$$

$$d\bar{Y}_t d = \bar{Y}_t \left[\mu_Y dt + \bar{\sigma}_Y \left(\rho_{Yr} dW_t^r + \sqrt{1-\rho_{Yr}^2} dW_t^Y\right) - \eta \mathrm{d}N_t\right]$$

$$d\bar{H}_t = \bar{H}_t \left[\mu_H dt + \bar{\sigma}_H \left(\rho_{Hr} dW_t^r + \hat{\rho}_{HY} dW_t^Y + \hat{\rho}_H dW_t^H\right) - \bar{L_H} dU_t\right]$$

where $\{W_t^r\}_t$, $\left\{W_t^Y\right\}_t$ and $\left\{W_t^H\right\}_t$ are correlated Brownian motions.

- To incorporate the impact of a loss in wealth (i.e. economic income declines) to those homeowners who do not have mortgages when mortgage defaults occur in the economy, we add the jump component $(-\eta dN_t)$ to the change in average income where N_t is a Poisson-process with time-varying intensity β_t. The jump intensity process β_t is given by

$$d\beta_t = \kappa_\beta \left(\bar{\beta} - \beta_t\right) dt + L_\beta dU_t$$

Default:

- We have two conditions for default to happend:
  - ⋆ household's monthly income (e.g. wealth) is not enough to cover the mortgage payments; and
  - ⋆ he doesn't have enough equity on the house to borrow more.
- (income$<$pmt) and (enough equity): We assume borrowers do not refinance optimaly and allow no refinancing (in general) outside of financial distress.

Parameter Calibration

Type of Parameter	Parameter	Value
Short Rate r_t	Initial Value r_0	5.104%
	Mean Reversion Level $\bar{r}$	5.104%
	Mean Reversion Speed κ_r	0.14213
	Volatility σ_r	0.00781
Average House Price $\bar{H}_t$	Initial Value H_0	100
	Drift μ_H	0.043325
	Volatility $\bar{\sigma}_H$	0.015243
	Loss given Default $\bar{L}_H$	0.005
Income Level $\bar{Y}_t$	Initial Value Y_0	42.64
	Drift μ_Y	0.0598
	Volatility $\bar{\sigma}_Y$	0.02224
	Jump Size η	0.0121
Correlations	Real Estate - Income, ρHY	0.5723
	Real Estate - Short Rate, ρHr	0.65
	Income - Short Rate, ρYr	0

Table 1: Macro-Economic Parameters.

Type of Parameter	Parameter	Value
House Price H_t^i	Mean Reversion Speed κ_H	0.94811
	Volatility Parameter σ_H	0.0805
	Loss given Default L_H	0.27
Disposable Income Y_t^i	Mean Reversion Speed κ_Y	0.5372
	Volatility Parameter σ_Y	0.22
	Prime Income Reduction $R(1)$	0.2582
	Subprime Income Reduction $R(2)$	0.2323

Table 2: Micro-Economic Parameters.

Type of Parameter	Parameter	Value
Loan-To-Value Ratio $C(\Phi_t^i)$	Prime LTV C(1)	80%
	Subprime LTV C(0)	85.9%
Spread $s(\Phi_t^i)$	Prime Spread $s(1)$	0.011256
	Subprime Spread $s(0)$	0.026635

Table 3: Credit-Related Parameters.

Parameter	Value
Intial Value β_0	1.0
Mean Reversion Speed κ_β	1.0
Mean Reversion Level $\bar{\beta}$	1.0
Jump Size L_β	0.20

Table 4: Income Jump Intensity β_t Parameters.

Subprime Default Contagion

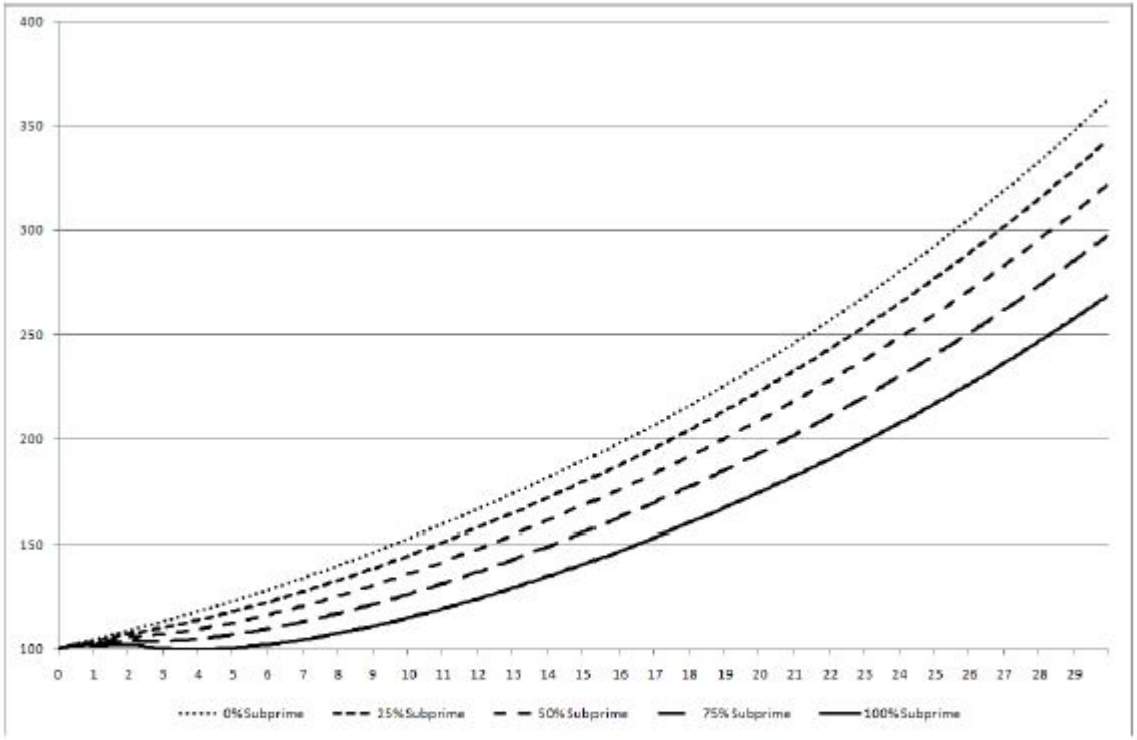


Figure 1: Average House Price in Each Month for Different Populations.

	Prime	Subprime
SP0	1.25%	–
SP25	1.40%	22.09%
SP50	1.62%	24.91%
SP75	2.07%	27.67%
SP100	–	31.92%

Table 5: Probability to Default on Original Credit for Different Populations.

Policy Analysis

- We like to analyze different policies and their impact on creating and bursting bubbles.

- The following six policies are compared:

  ⋆ Monetary Policy (MP). This policy reduces the initial spot rate of interest from $r_0 = 0.05104$ to $r_0 = 0.005$. Note that the mean reversion level of the spot rate process is not changed.

  ⋆ Moderate Monetary Policy which reduces the initial spot rate of interest to $r_0 = 0.03$.

  ⋆ Restrictive Credits (RC). This policy forces homeowners to have an initial down payment equal to 20% of the initial house value. In this policy both prime and subprime borrowers have the same initial down payment.

- ⋆ Easy Credit (EC). Subprime borrowers are subsidized to the extent that they can borrow at the prime borrowers' spread, if their loan is originated in the first five years.
- ⋆ Tax Rebate (TR).The policy expires after five years.
- ⋆ Distress Relief (DR). If a borrower cannot make his fixed rate mortgage payments, then he receives a relief of 15% of the outstanding loan balance (e.g. loan modification).

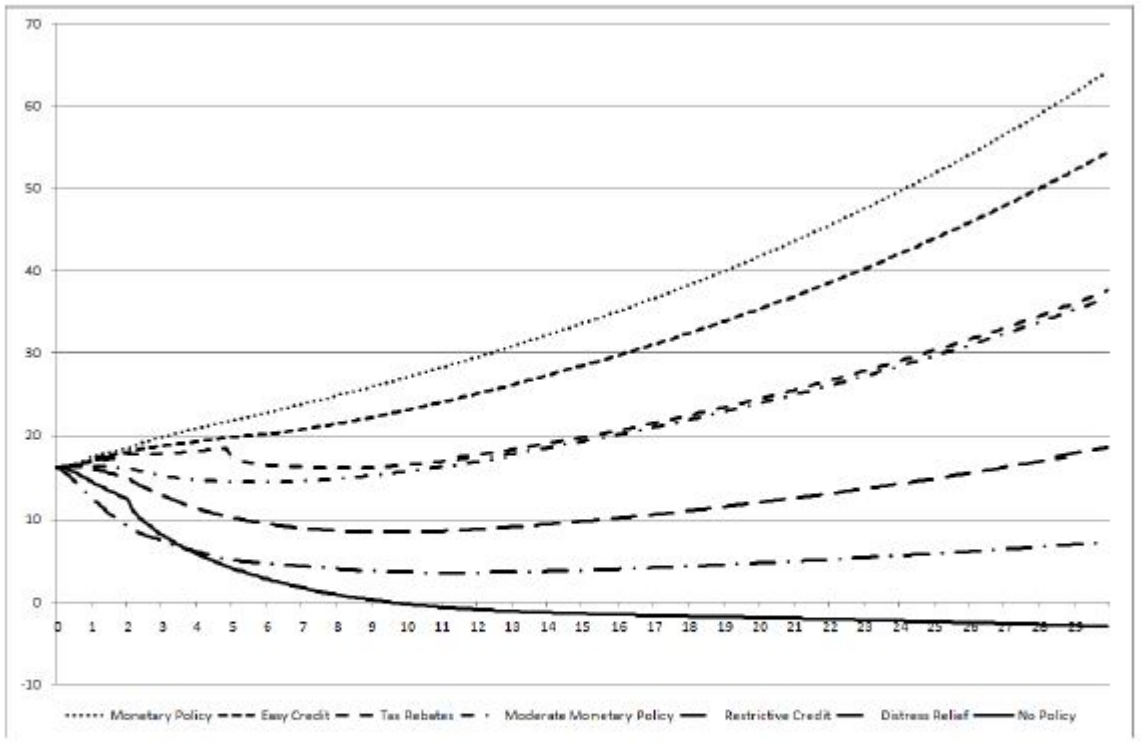


Figure 2: Average Increase in House Price over the Base Scenario in Each Month for Different Policies applied to the Bubble Scenario.

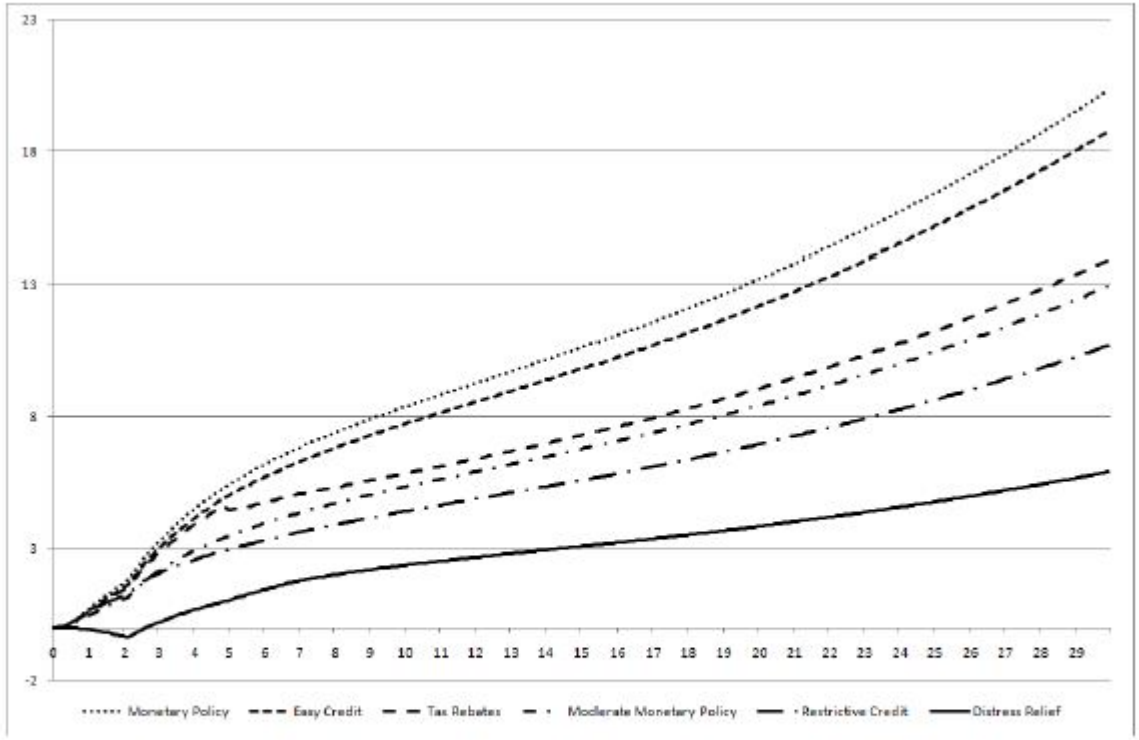


Figure 3: Average Increase in House Price over the Base Scenario in Each Month for Different Policies applied to the Base Scenario.

Policy	Base Scenario		Bubble Scenario	
	Prime	Subprime	Prime	Subprime
Easy Credit	0.38%	4.57%	3.13%	19.00%
Restrictive Credit	1.31%	10.85%	8.86%	40.01%
Distress Relief	1.88%	14.60%	11.42%	44.89%
Tax Rebates	0.30%	10.21%	2.96%	36.85%
Monetary Policy	0.08%	3.76%	0.74%	16.30%
Moderate Monetary Policy	0.42%	10.96%	3.29%	36.72%
No Policy	1.40%	22.91%	10.17%	60.39%

Table 7: Probability to Default of Original Owners for Different Policies.

Policy Analysis in Different Economies

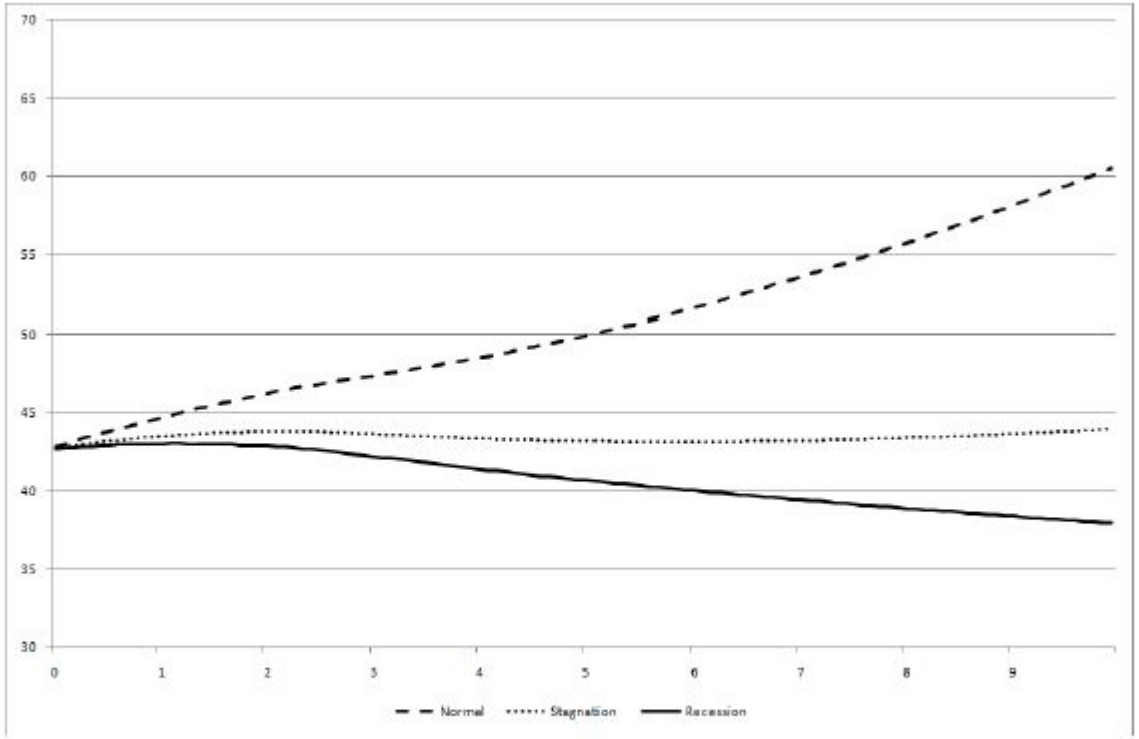


Figure 4: Income Level in the Bubble Scenario in each Month for different Economies.

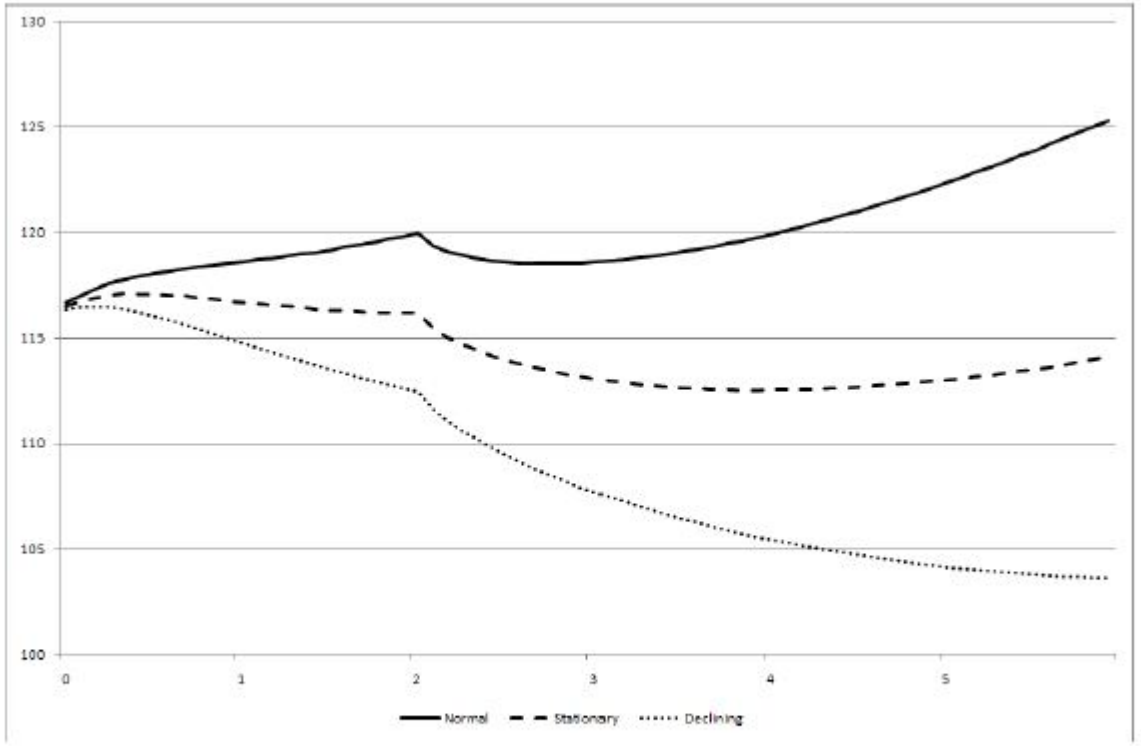


Figure 5: Average House Price $\bar{H}_t$ in the Bubble Scenario with different Drift $\bar{\mu_H}$.

Original Prime Households	Normal $\bar{H}_t$	Stationary $\bar{H}_t$	Declining $\bar{H}_t$
Easy Credit	3.13%	3.27%	3.46%
Restrictive Credit	8.86%	9.04%	9.38%
Distress Relief	11.42%	11.65%	11.99%
Tax Rebates	2.96%	3.10%	3.21%
Monetary Policy	0.74%	0.75%	0.76%
Moderate Monetary Policy	3.29%	3.38%	3.44%
No Policy	10.17%	10.46%	11.26%
Original Subprime Households	**Normal $\bar{H}_t$**	**Stationary $\bar{H}_t$**	**Declining $\bar{H}_t$**
Easy Credit	19.00%	19.69%	20.71%
Restrictive Credit	40.01%	40.31%	40.82%
Distress Relief	44.89%	45.11%	45.75%
Tax Rebates	36.85%	37.52%	38.67%
Monetary Policy	16.30%	16.73%	17.30%
Moderate Monetary Policy	36.72%	37.33%	38.18%
No Policy	60.39%	61.04%	62.41%

Table 9: Default Probability of Original Owners in the Bubble Scenario for Different Policies. Normal results are simulated with the calibrated parameters from Tables 1-4. Stationary $\bar{H}_t$ reduces $\bar{\mu}_H$ by 1.5%, declining $\bar{H}_t$ reduces $\bar{\mu}_H$ by 3.0%.

Original Prime Households	$\sigma_Y = 20\%$	$\sigma_Y = 22\%$	$\sigma_Y = 24\%$
Easy Credit	1.35%	3.13%	6.51%
Restrictive Credit	4.62%	8.86%	15.56%
Distress Relief	6.23%	11.42%	19.43%
Tax Rebates	1.23%	2.96%	6.38%
Monetary Policy	0.24%	0.74%	1.85%
Moderate Monetary Policy	1.41%	3.29%	6.76%
No Policy	5.32%	10.17%	17.81%
Original Subprime Households	$\sigma_Y = 20\%$	$\sigma_Y = 22\%$	$\sigma_Y = 24\%$
Easy Credit	13.16%	19.00%	26.60%
Restrictive Credit	30.93%	40.01%	50.55%
Distress Relief	34.02%	44.89%	56.78%
Tax Rebates	28.61%	36.85%	46.39%
Monetary Policy	10.61%	16.30%	23.56%
Moderate Monetary Policy	28.36%	36.72%	46.45%
No Policy	51.38%	60.39%	69.74%

Table 10: Default Probability of Original Owners in the Bubble Scenario with Varying Individual Income Volatility σ_Y.

Conclusion

- In this paper, we devoleped a dynamic simulation model for aggregate home prices that depends on the level of subprime and prime mortgage defaults in the economy.
- We show that subprime mortgage defaults, via their impact on aggregate housing prices and aggregate incomes, increase the incidence of prime mortgage defaults. There is a subprime default contagion.
- Secondly, we show the relative impact of various government fiscal and monetary policies for improving the housing market. Interestingly, fiscal policies relating to direct government rebates or a loosening of borrowing standards have less of an impact than does monetary policy.