A Structural Model of Continuous Workout Mortgages (Preliminary–Do not cite)

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OBJECTIVES

- The goal of this paper is to assess the potential impact of introducing alternative mortgage designs, which *share house price risk between the borrower and lender*, using an estimated structural model of the mortgage and housing market

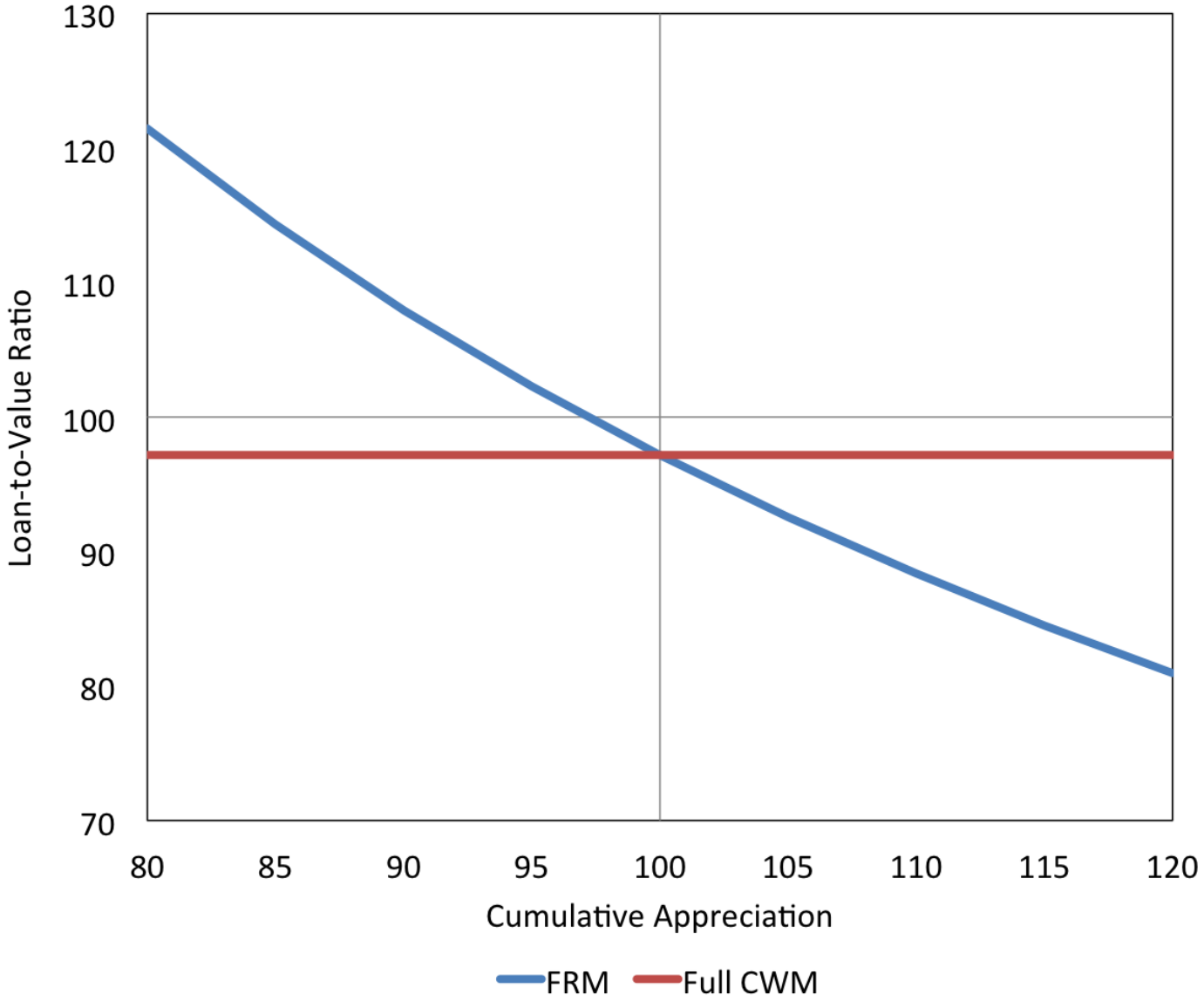
Housing Crisis

- Crisis revealed weaknesses in the way Americans currently finance home purchases
- In particular, nominal mortgage debt is fixed, but house prices fluctuate
- Great when house prices appreciate rapidly, bad when house prices collapse
- Inefficiencies associated with underwater mortgages
  - Costly defaults
  - Labor market consequences
  - Effects on consumption through balance sheets

Alternative Mortgage Designs

- Mortgage contracts that share house price risk between borrower and lender
- Mortgage terms explicitly indexed to house prices
  - Insurance to borrower on downside
  - Lender shares in capital gains on upside
- Shared appreciation mortgages / Continuous Workout Mortgages (Shiller)
- Many reasons to think they'd benefit homeowners
  - Housing is a large share of homeowners' wealth portfolio
  - Homeowners more exposed to local spatial risks
  - Can be designed to eliminate negative equity

Figure 1: Risk Sharing vs. FRM Loan-to-Value



Questions Addressed

- What would be the interest rate of a risk sharing mortgage in competitive equilibrium?
- What would be the takeup rate of risk sharing mortgages if they were introduced as an option?
- What are the welfare impacts of introducing risk sharing mortgages?
- What effect would introducing risk sharing mortgages have on default rates?

Questions Not Addressed

- What would be the general equilibrium effect of introducing risk sharing mortgages on house price dynamics?
- Why are risk sharing mortgages not prevalent in the U.S. mortgage market?
- What is the optimal mortgage design in the face of house price risk?

Model Overview

- Local housing and mortgage market populated by consumers and a representative, risk neutral, competitive lender
- Consumers have a quantity of housing they with to buy, and decide how much to borrow (and, if applicable, what kind of mortgage contract to use)
- In subsequent periods, consumers face house price risk, unemployment risk, and an exogenous probability of having to move
- Consumers can choose to pay down mortgage or default in each period
- Defaulting is costly to both consumer and lender, results in immediate foreclosure, and forces consumer into rental market

Data and Estimation Overview

- Data on L.A. ownership histories from 1993 to 2008
- Observe initial purchase and loan decision, then follow owner until time of sale or default
- Use observed default behavior to estimate parameters of the consumer's decision problem
- Use estimated default and prepayment risks to calculate lender's expected returns in each period
- Estimated parameters and lender's expected returns are used in the counterfactual

Overview of Results

- Risk sharing mortgages are:
  - Less expensive during periods of expected house price growth
  - More expensive during periods of expected house price decline
- Take up rates are:
  - High during periods of expected house price growth
  - Low during periods of expected house price decline
- Welfare gains from introducing risk sharing mortgages from 1993 to 2008 averaged a consumption equivalent of about $3,000 per household per year
- Default rates would have been much lower during the crisis period

Model–Households

- Households indexed by i, born at time s, with decision horizon of T periods
- Endowed with deterministic and constant (except for unemployment) real income stream Y_i and initial wealth W_{is}
- In initial period, exogenously purchases H_i units of housing at unit price P_s
- Household decides the amount of down payment D_{is} and the loan is therefore

$$L_{is} = P_s H_i - D_{is}$$

Model–Households

- Households care about consumption of a numeraire good and total wealth at the time of a move
- Household moves with probability τ in each period $t = s+1, \ldots, s+T-1$
- Households move with probability 1 in period $t = s+T$
- Household that moves at time t evaluates consumption flows $\{C_{ij}\}_{j=s}^{t-1}$ and final wealth W_{it} according to:

$$E_s \sum_{j=s}^{t-1} \beta^{j-s} \frac{C_{ij}^{1-\gamma}}{1-\gamma} + \beta^{t-s} \frac{W_{it}^{1-\gamma}}{1-\gamma}$$

Model–Housing and House Prices

- Housing is treated as a perfectly divisible and homogeneous good
- Price of one quality unit at time t is P_t
- One-period appreciation $\pi_t = \log P_t - \log P_{t-1}$ moves according to:

$$\pi_t = (1 - \phi^\pi)\,\bar{\pi} + \phi^\pi \pi_{t-1} + \nu_t^\pi$$

where ν_t^π is iid normal with mean 0 and variance σ_π^2

Model–Mortgage Contracts

- Households finance their home purchase using fixed rate mortgages with maturity T, and can finance up to 100% of the purchase
- The P&I payment for an FRM is:

$$M = \frac{r^f \left(1 + r^f\right)^T}{(1 + r^f)^T - 1} L_0$$

- And the balance evolves according to:

$$L_{t+1} = \left(1 + r^f\right) L_t - M$$

Model–Savings

- Households can save at a one-period risk free rate of r but cannot borrow (except initially to finance a home purchase)
- Households can therefore only consume out of savings and income, but not out of housing wealth
- Budget constraint:

$$C_{it} + \frac{1}{1+r} S_{i,t+1} + M_{it} = S_{it} + Y_{it}$$

Model–Staying, Selling and Defaulting

- Household is required to move with probability τ in each period (probability 1 in final period)
- If the household moves it can either sell the house or default.
- If it sells, its final wealth is:

$$P_t H_i - L_{it} + S_{it}$$

- If it defaults, it pays a linear utility cost $c + \epsilon_{it}$, and final wealth is simply:

$$S_{it}$$

- ϵ_{it} is type-1 extreme value, and reflects idiosyncratic reasons for wanting to default

Model–Saying, Selling and Defaulting

- Households are assumed to only sell when required to move
- If not required to move, the household either pays down the mortgage or defaults
- The value function for paying down the mortgage is:

$$V_{it}^{pay} = \max_{S_{i,t+1}} E_t \left[\frac{\left(Y_{it} + S_{it} - \frac{1}{1+r} S_{i,t+1} - M_{it} \right)^{1-\gamma}}{1-\gamma} + \beta V_{i,t+1}^{o} \right]$$

- The value function for defaulting is:

$$V_{it}^{default} = \max_{S_{i,t+1}} \left[\frac{\left(Y_{it} + S_{it} - \frac{1}{1+r} S_{i,t+1} - R_t H_i \right)^{1-\gamma}}{1-\gamma} + \beta V_{i,t+1}^{r} \right] + c + \epsilon_{it}$$

LENDERS

- In each period s, a competitive lender provides mortgages to the entire set of buyers in that period

- The lender holds onto the mortgage portfolio until time $s + T$, re-investing any flows of receipts at a riskless return r

- Expected value of an active mortgage at time t is:

$$\begin{aligned}\Pi_{it} &= P^{default}\theta P_t H_i + \tau P^{sell} L_{it} + \\ &\quad (1-\tau)P^{stay}\left[M_{it} + \frac{1}{1+r}E\Pi_{i,t+1}\right]\end{aligned}$$

- The time s lender requires an annualized premium ρ_s in order to participate in the mortgage market. The following zero-profit condition is therefore satisfied in equilibrium:

$$\frac{\sum \Pi_{is}}{\sum L_{is}} = (1+\rho_s)^{1/T}$$

DATA

- The data used for estimation is a random sample of 100,000 ownership histories from the L.A. metro area
- Ownership histories are constructed from DataQuick transactions data merged with HMDA loan application data
- Ownership histories allow us to see borrower's income, initial borrowing amount and down payment, and subsequent sale and default decisions

Data Availability

- We observe:

$$\{Y_i, H_i, L_{is}, D_{is}, s_i, d_i\}_{i=1}^{i=100,000}$$

$$\left\{P_t, r_t^f\right\}_{t=1993}^{t=2009}$$

- What is not observed:

$$W_{is}, S_{it}$$

ESTIMATION

- Parameters to be estimated are:
  - Parameters affecting consumer choice problem: γ, τ, c
  - Unobserved initial wealth: W_{is}
  - Lender returns in each period ρ_t
- W_{is} is identified off variation in down payment for observably identical individuals
- (γ, τ, c) are identified off observed stay/sell/default probabilities
- ρ_t are computed directly from estimated stay/sell/default probabilities and observed loan amounts

Table 5: Parameter Estimates

Parameter	Description	Estimate
ϕ^{π}	Serial correlation of price process	0.7595
$\bar{\pi}$	Long run mean of price process	0.0050
σ_{π}	Standard deviation of price process	0.0618
γ	Coefficient of relative risk aversion	1.0940
τ	Per period probability of moving	0.0980
c	Utility cost to defaulting	-1.4152

Model Fit: Default Rate by Purchase Year

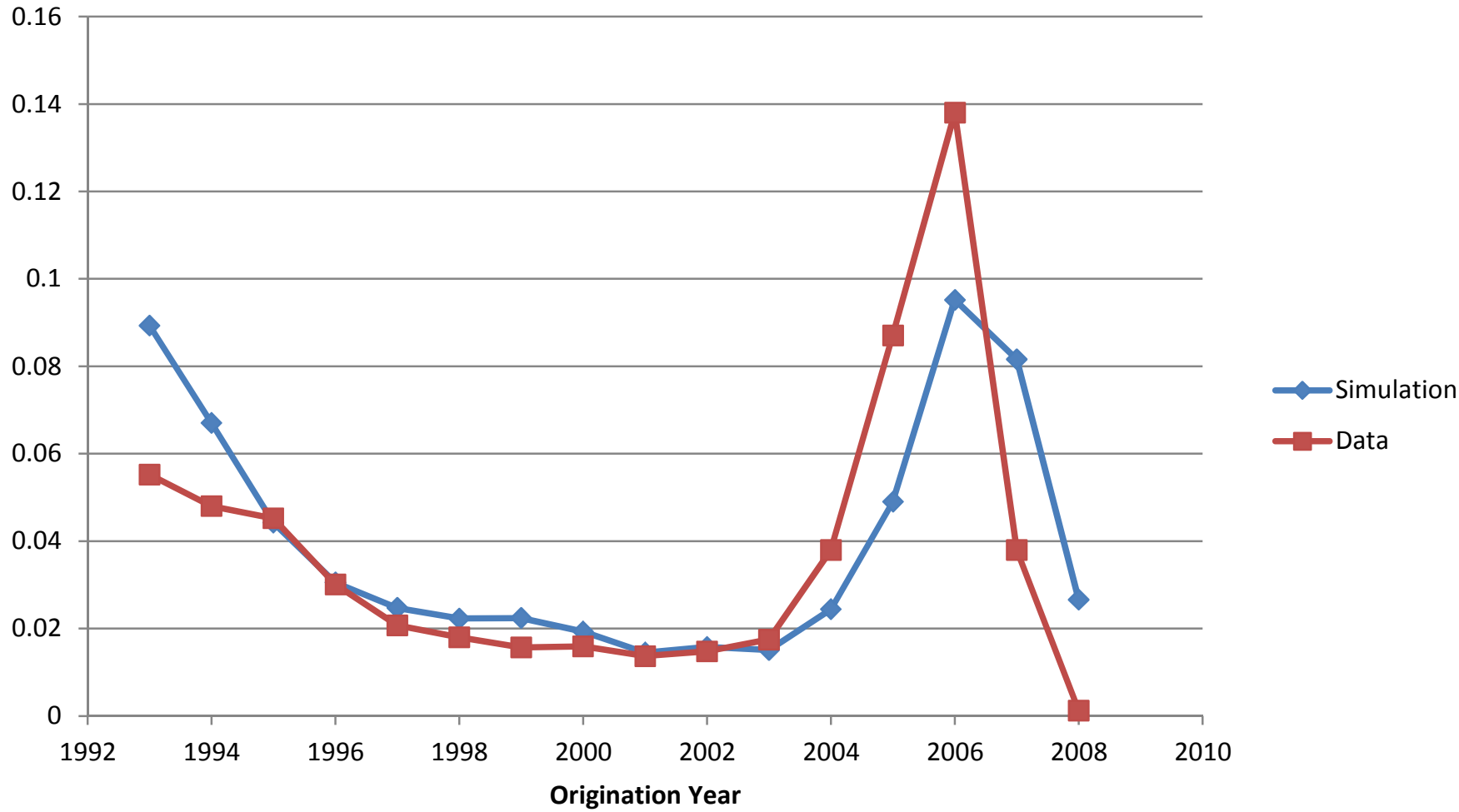


Table 6: Initial Wealth and Lender's Premium Estimates

Year	Average Initial Wealth	Lender's Premium (basis points)
1993	126,000	65
1994	97,000	78
1995	104,000	72
1996	95,000	80
1997	91,000	87
1998	130,000	69
1999	143,000	56
2000	129,000	74
2001	136,000	75
2002	180,000	55
2003	214,000	26
2004	257,000	0
2005	276,000	0
2006	262,000	14
2007	283,000	0
2008	144,000	72

Risk Sharing Mortgage

- Fixed rate mortgage

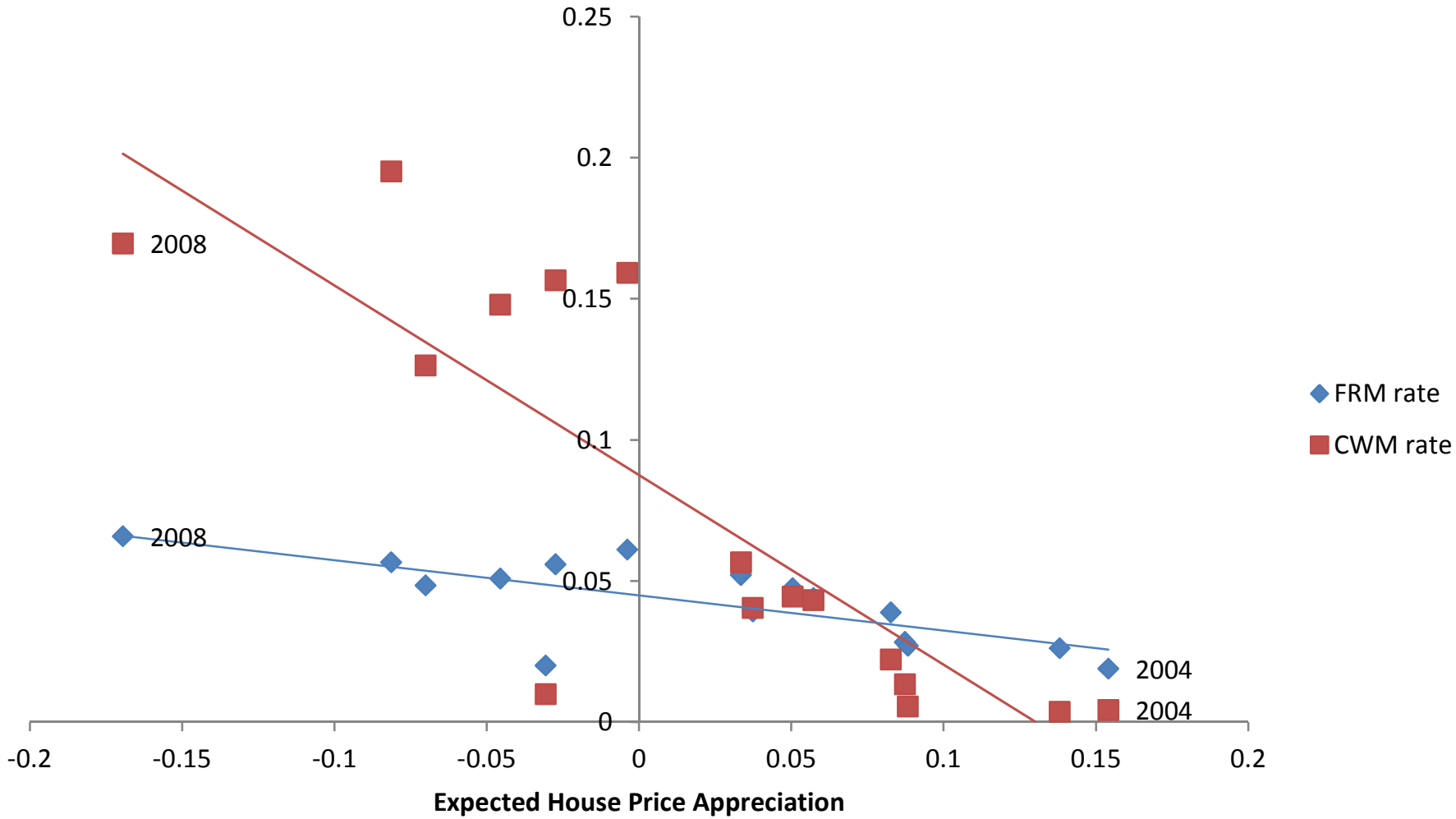
$$M = \frac{r(1+r)^T}{(1+r)^T - 1} \qquad L_{t+1} = (1+r)L_t - M$$

- Continuous workout mortgage

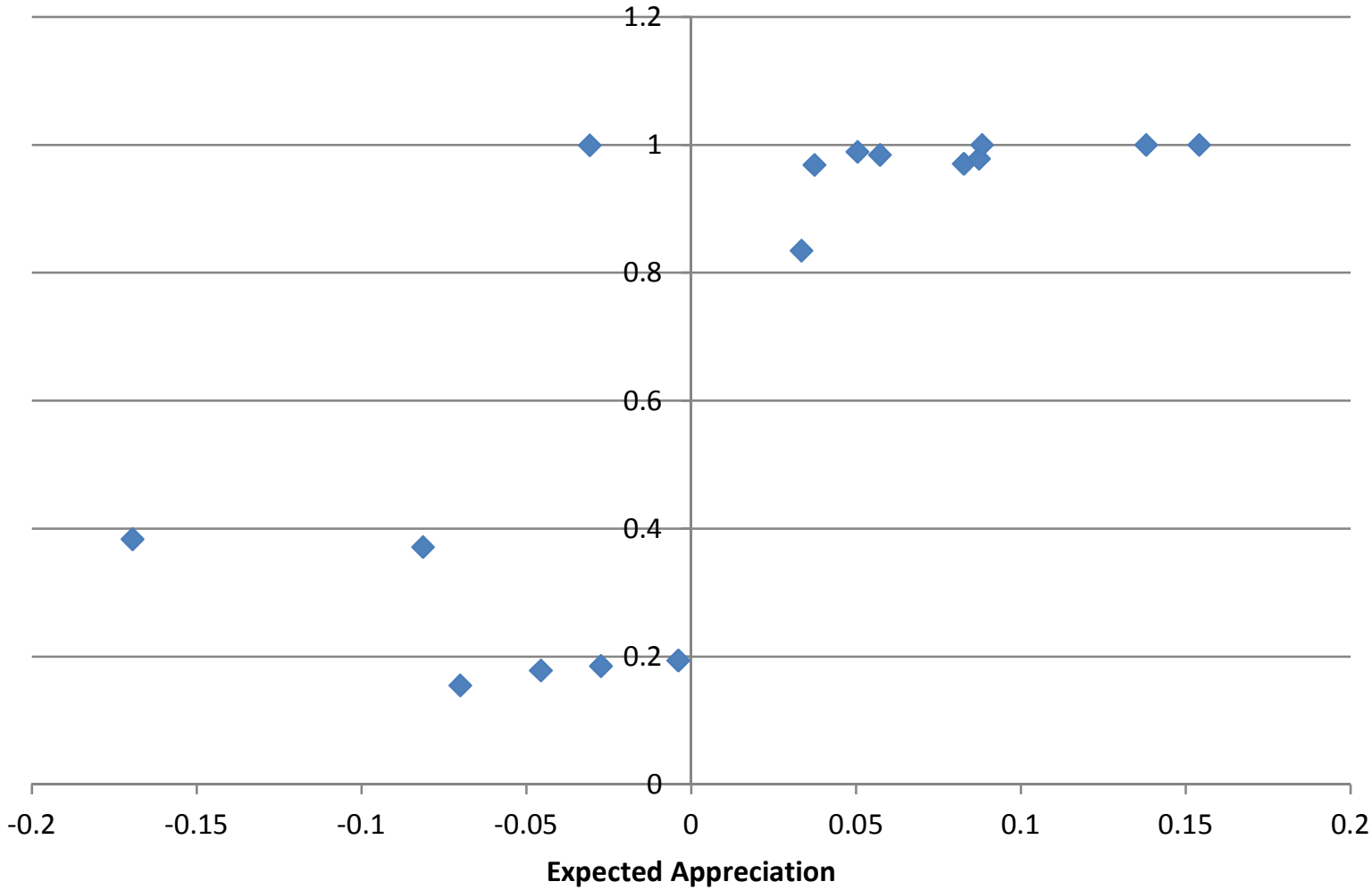
$$M = \frac{r(1+r)^T}{(1+r)^T - 1} \qquad L_{t+1} = (1+r)\,\frac{P_{t+1}}{P_t} L_t - M$$

- Two important features:
  - Loan-to-value ratio will never rise above 100%
  - Mortgage may not be paid off after T periods, but may also be paid off early

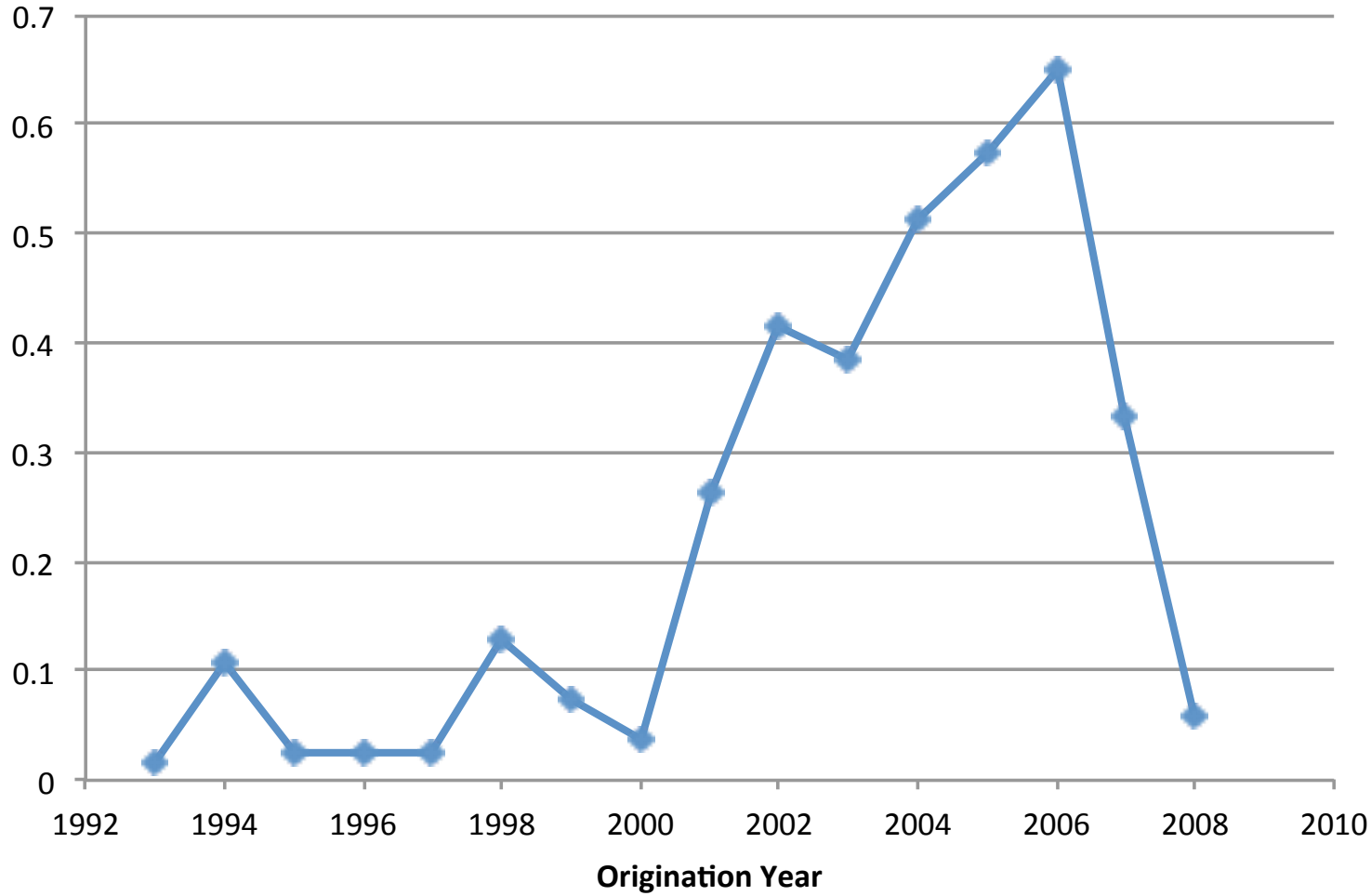
Counterfactual: Mortgage Interest Rates



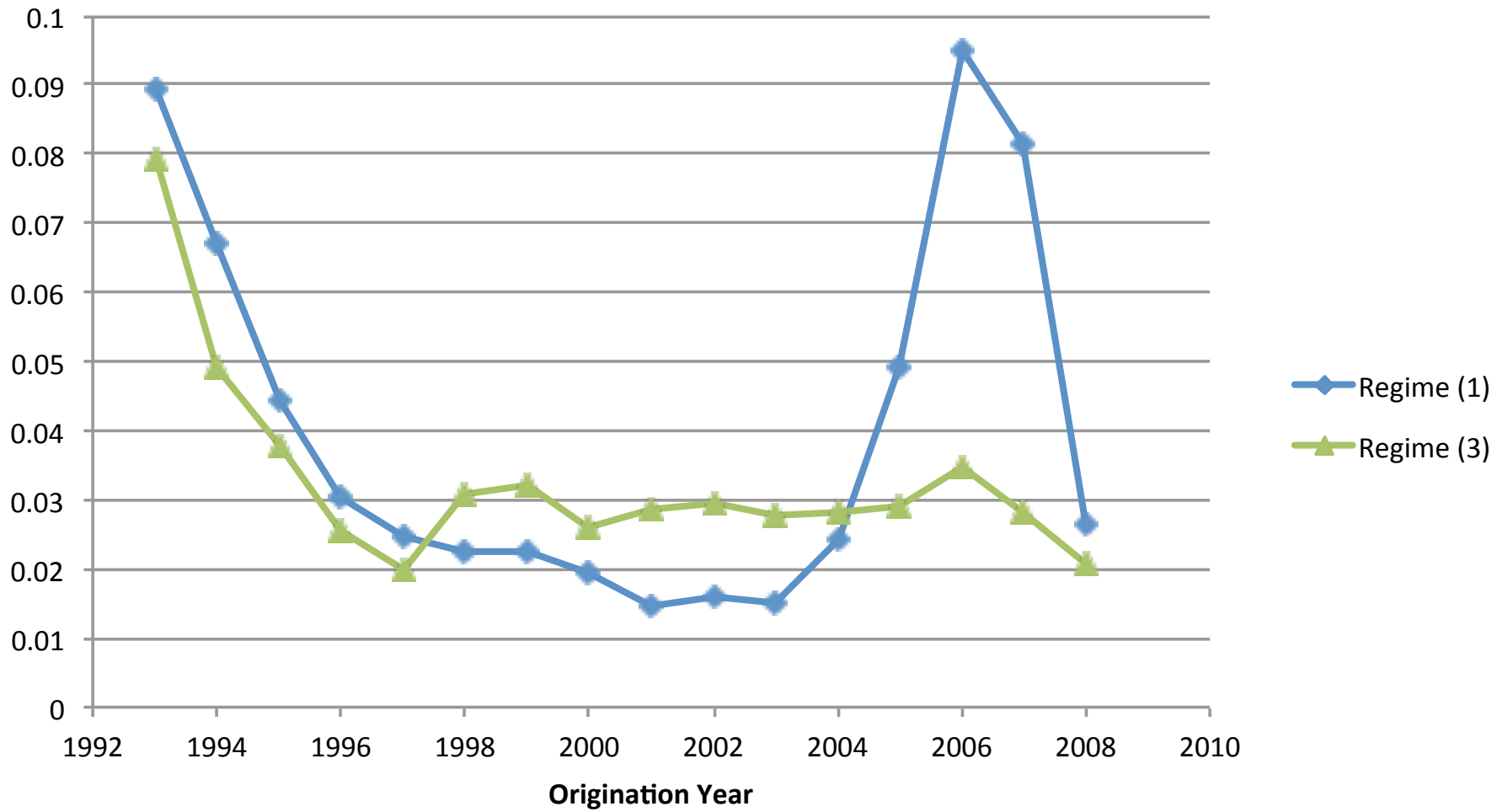
Counterfactual: Takeup Rates



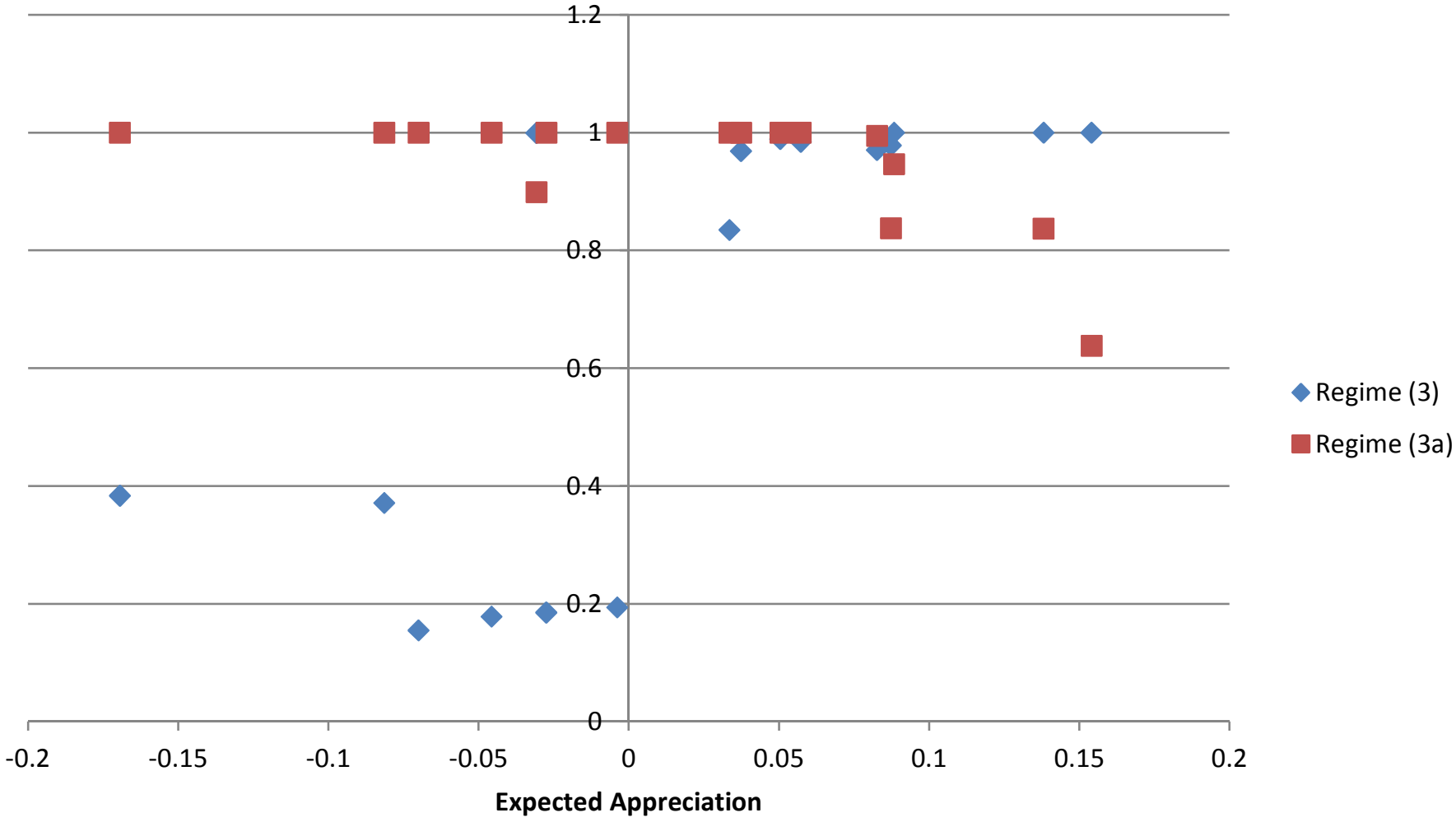
Counterfactual: Consumption Equivalent (in $10,000 1993 dollars)



Counterfactual: Default Rate by Purchase Year



Counterfactual Takeup Rates (High Mobility)



Conclusion

- In a competitive mortgage market, risk sharing mortgages will have to be priced appropriately
- More expensive in periods of expected decline; less expensive in periods of expected growth
- Homewoners appear to care more about cash flows than housing equity
- Benefits may currently be understated due to not endogenizing house prices and not modeling consumption externalities
- Benefits could be overstated due to note capturing basis risk / moral hazard