Equity Extraction and Mortgage Default

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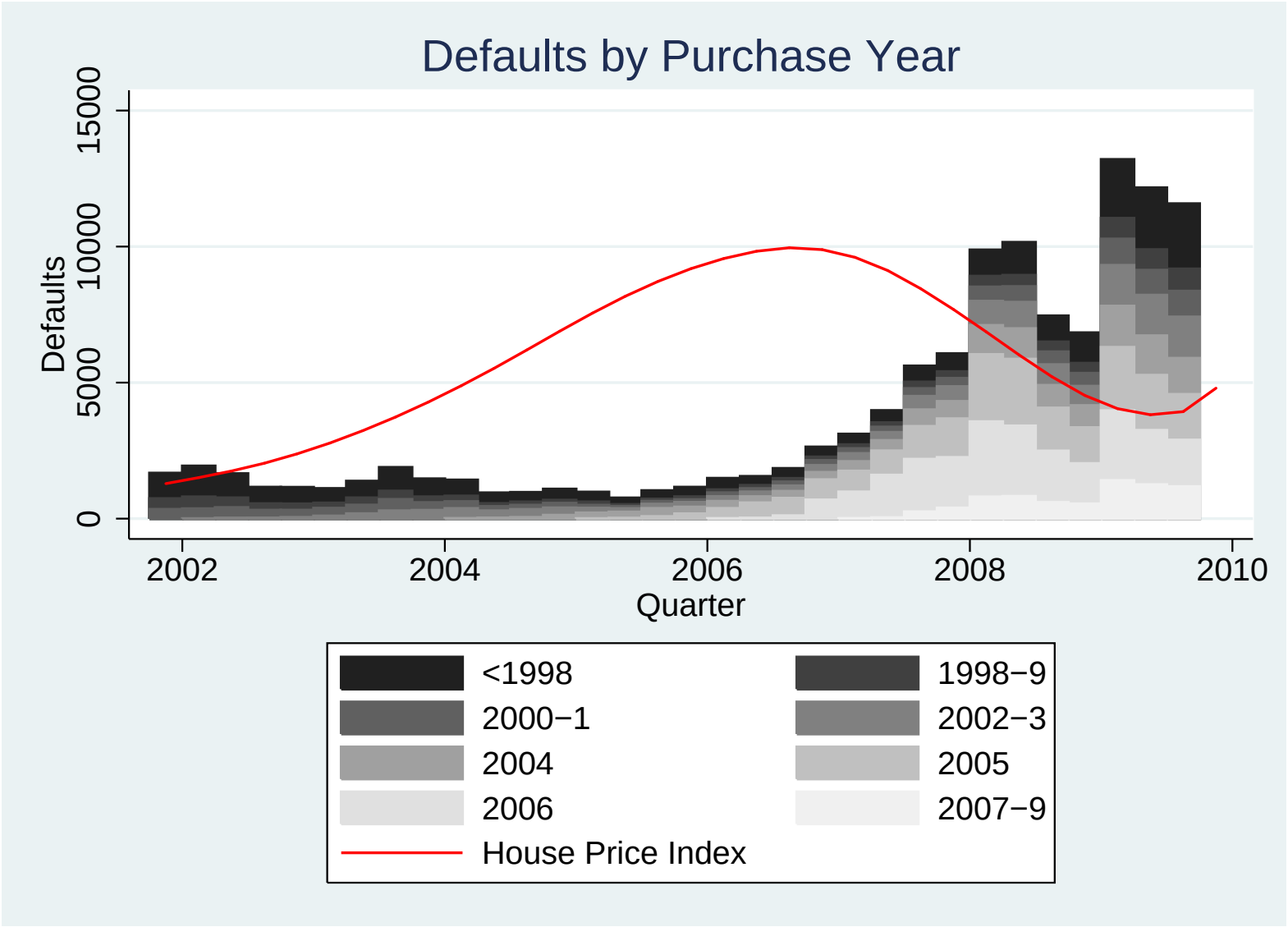
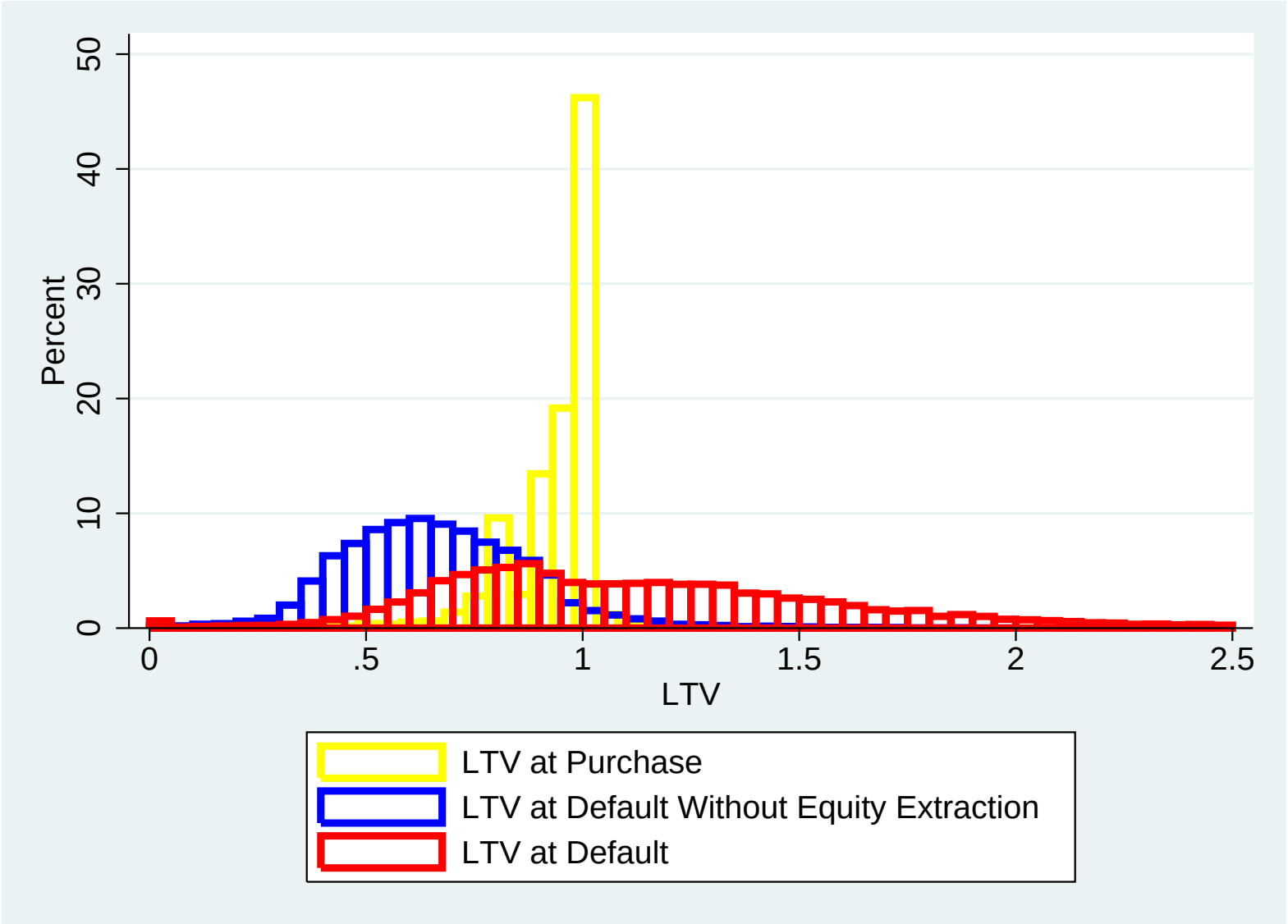
Motivation: Defaults by Purchase Year

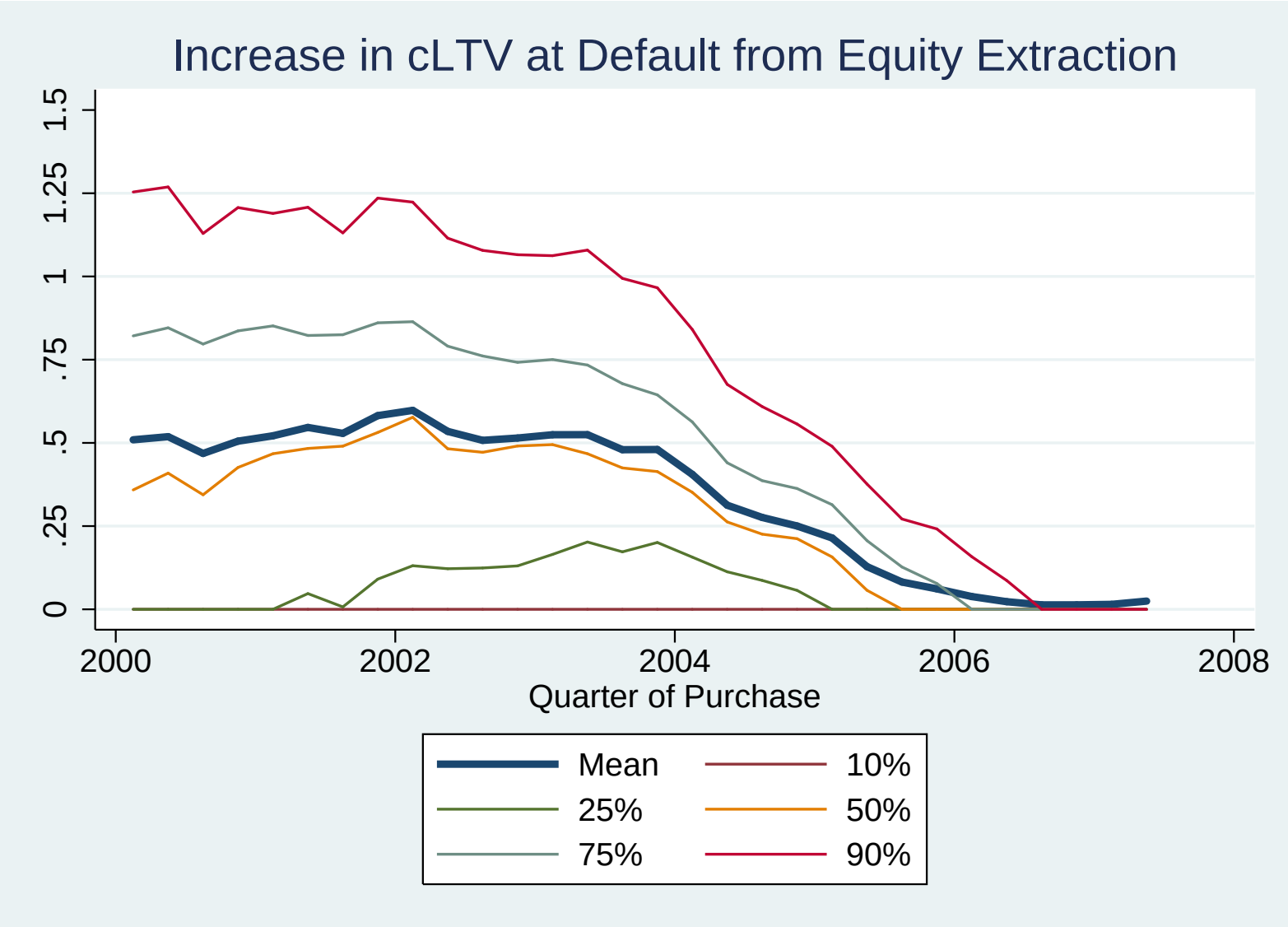


Motivation: Equity Extraction and LTV at Default

LTV ratios of defaulters who purchased their houses during 2000-2003



Motivation: LTV at Default



Questions

Why did these homeowners take out equity and then default?

1. House prices: Homeowners borrowed in response to rising prices. After prices fall, default because of negative equity. (Direct effect)
2. Income shocks: Homeowners with few liquid assets use equity extraction to smooth consumption. Liquidity constrained homeowners with negative equity default when hit by income shock. (Selection effect)

Questions

Why did these homeowners take out equity and then default?

1. House prices: Homeowners borrowed in response to rising prices. After prices fall, default because of negative equity. (Direct effect)
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What would have been the effects of a policy that limited refinancing to 80% of the house value?

Approach

- Build model of equity extraction and default with large shocks in income process and boom/bust cycles of house prices.
- Use property-level mortgage data set where can observe equity extraction.
- Use other data sources for information on income, assets.
- Estimate parameters of model to match rates of equity extraction, sales, default.
- Run counterfactual policy experiment within estimated model.

Model

- Model of homeowners.
- Income shocks including large shocks that look like unemployment.
- House price shocks including persistent "boom" and "bust" periods.
- Household choices:
  1. Consumption and savings
  2. Mortgage balances and housing equity
  3. Sale, Default

Model

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- Household choices:
  1. Consumption and savings
  2. Mortgage balances and housing equity
  3. Sale, Default
- Households withdraw equity to finance additional spending when they deplete savings.
- Households default when
  1. they can't afford mortgage payments because of bad income realizations
  2. when they're underwater and it's optimal to do so (for a variety of reasons)

Data: Mortgages

Open Lien Search from CoreLogic

- Los Angeles County, California. Single Family Homes. 1.2-1.3M properties
- Quarterly observations 2000Q1-2009Q4
- Full property address
- Purchase information: date, value
- All open mortgages on property: origination date, original balance, interest rate, sub-prime lender, current balance
- Defaults: Filings of notice of default, notice of trustee sale

Data: Income

- Mortgage data does not have income.
- American Community Survey
  - Annual Survey by US Census starting 2000
  - Unemployment data by congressional district, age/race group: annual local unemployment rate
- Panel Study of Income Dynamics (PSID)
  - Annual observations of household income
  - Housing information: house value, mortgage balance, interest rates, move-in date
  - Distribution of income, assets among new homeowners

Data: House Prices

- Use observations from liens data to calculate repeat-sales house price index (HPI) for each zip-code.
- Estimate of house value using purchase price/date and zip-code HPI. Construct estimated LTV each quarter.
- Use prices of repeat sales to measure distribution of "true" house values around estimated values.

Model Estimation

Estimate model parameters with method of simulated moments.

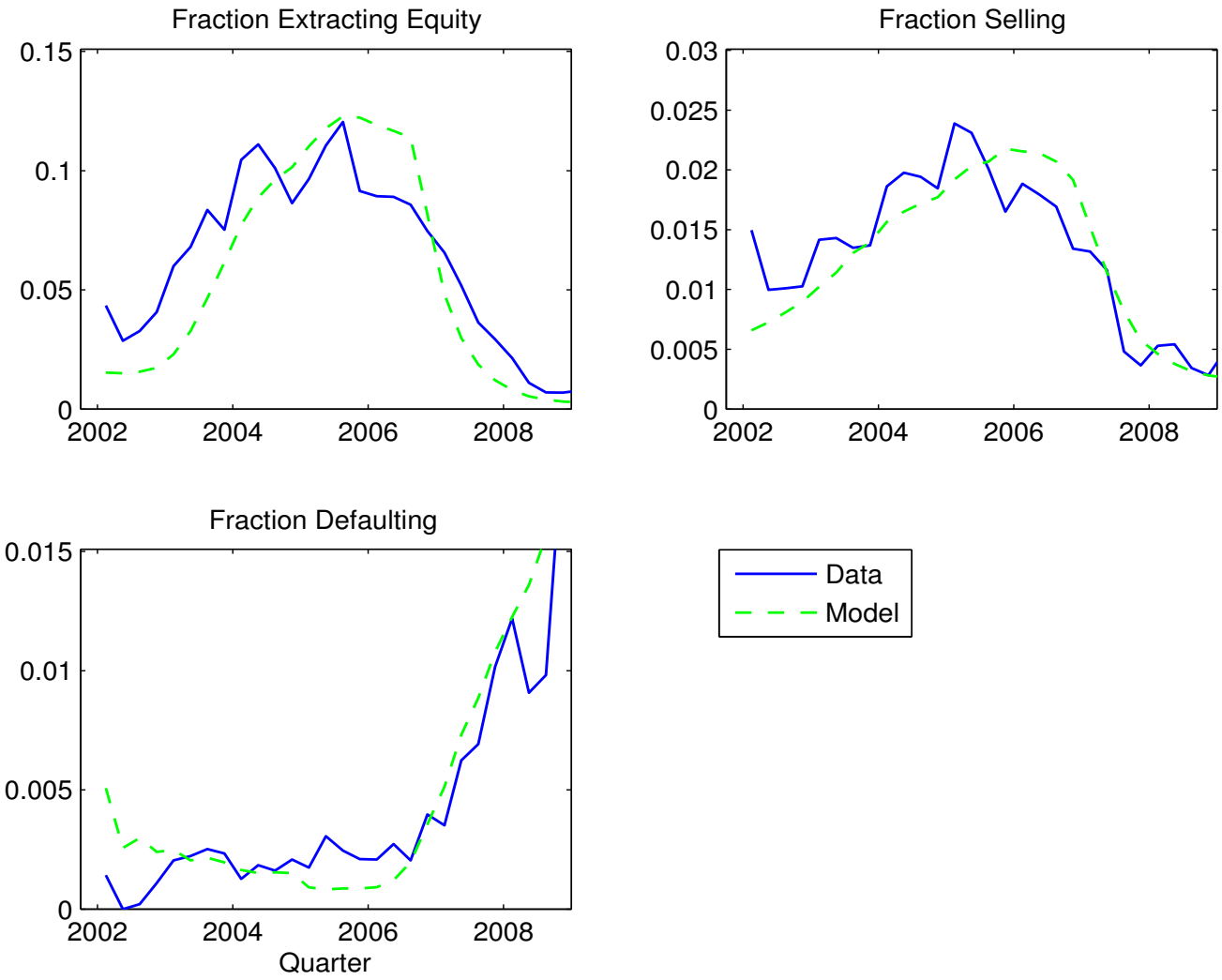
- Sample of 2002-2004 buyers
- Begin with observed LTV, income and assets to match distribution for new buyers from PSID
- Simulate income to match observed values of unemployment rate and median income growth, house prices to match observed regional house prices
- Find model parameters so that simulations match data: rates of default, moving, equity extraction, asset and income moments from PSID

Estimation: Key Parameter Estimates

What parameters values are needed for the model to match the data?

- Homeowners are very impatient, spend down savings quickly (quarterly discount factor $\beta = .94$)
- Homeowners act as if they face a harsh penalty for default (equivalent to sacrificing to 51% of future consumption)

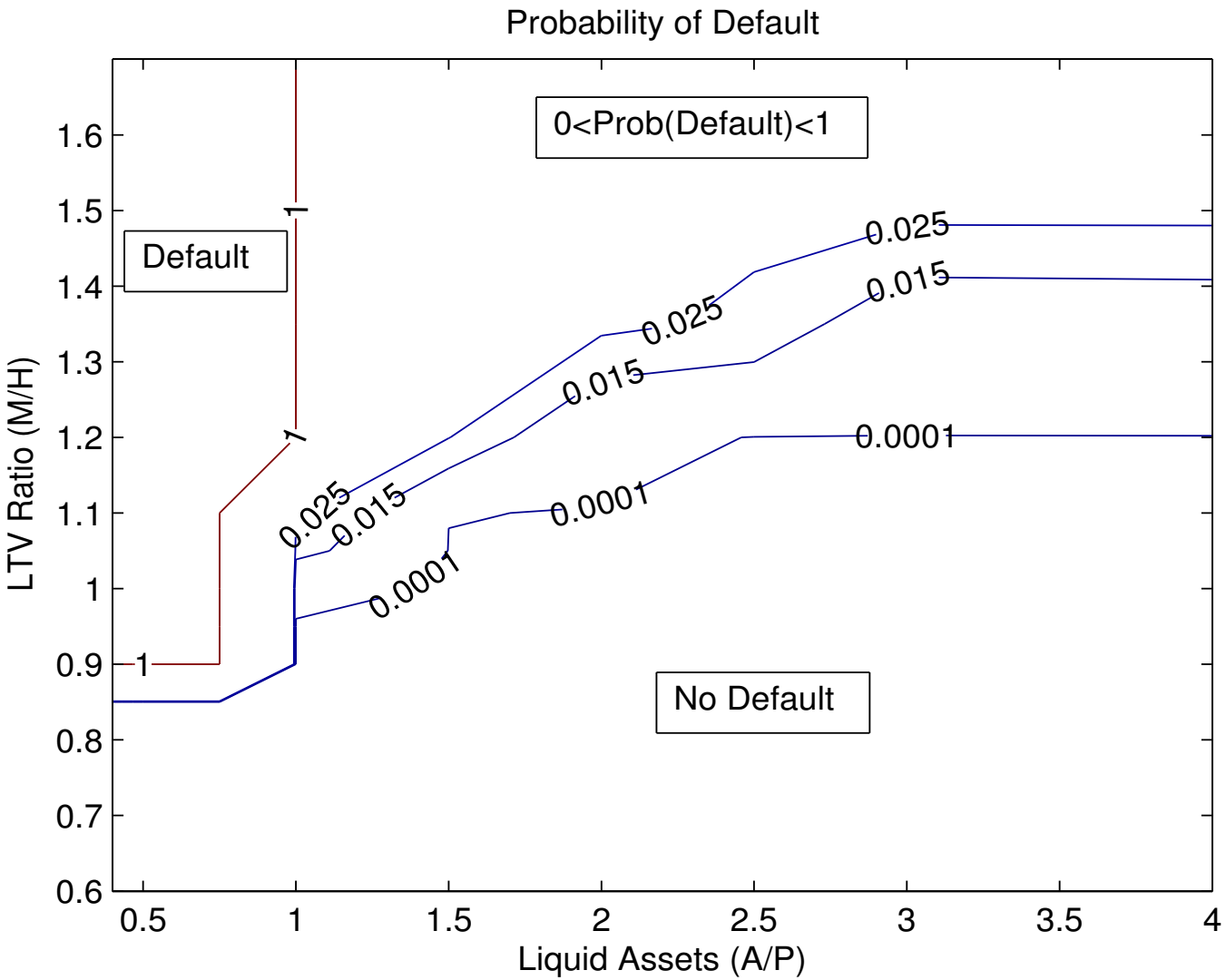
Results: Aggregate Rates



Results: Equity Extraction and Default

Purchase Year	Outcome	New Mortgages/Year Data	Model
2002	Stay	.25	.29
	Sell	.36	.34
	Default	.47	.50
2003	Stay	.25	.25
	Sell	.36	.30
	Default	.47	.46
2004	Stay	.21	.16
	Sell	.29	.23
	Default	.35	.30

Model Discussion: Default



Model Discussion: Causes of Equity Extraction and Default

Equity Extraction 2002-2005

- Without unemployment shocks, equity extraction is 2% lower.
- Without rising house prices, equity extraction is 92% lower.
- Without the *expectation* of rising house prices, equity extraction is 20% lower.

Default 2006-2009

- Liquidity constraints, income shocks account for 30% of defaults.
- Negative equity plus non-income shocks account for remaining 70%.
- Without unemployment shocks, 9% fewer defaults.
- Without falling house prices, 49% fewer defaults.
- Without the *expectation* of falling house prices, 34% fewer defaults.

Policy Experiment - 80% Refinancing Limit

Impose limit that total LTV of new loan cannot exceed 80%

- Similar to a provision of the Texas A6 refinancing laws
- Prices adjust to clear the housing market: Everyone buys the same house as in the baseline

Policy Experiment - 80% Refinancing Limit

Solve and simulate model with 80% LTV limit on refinances.

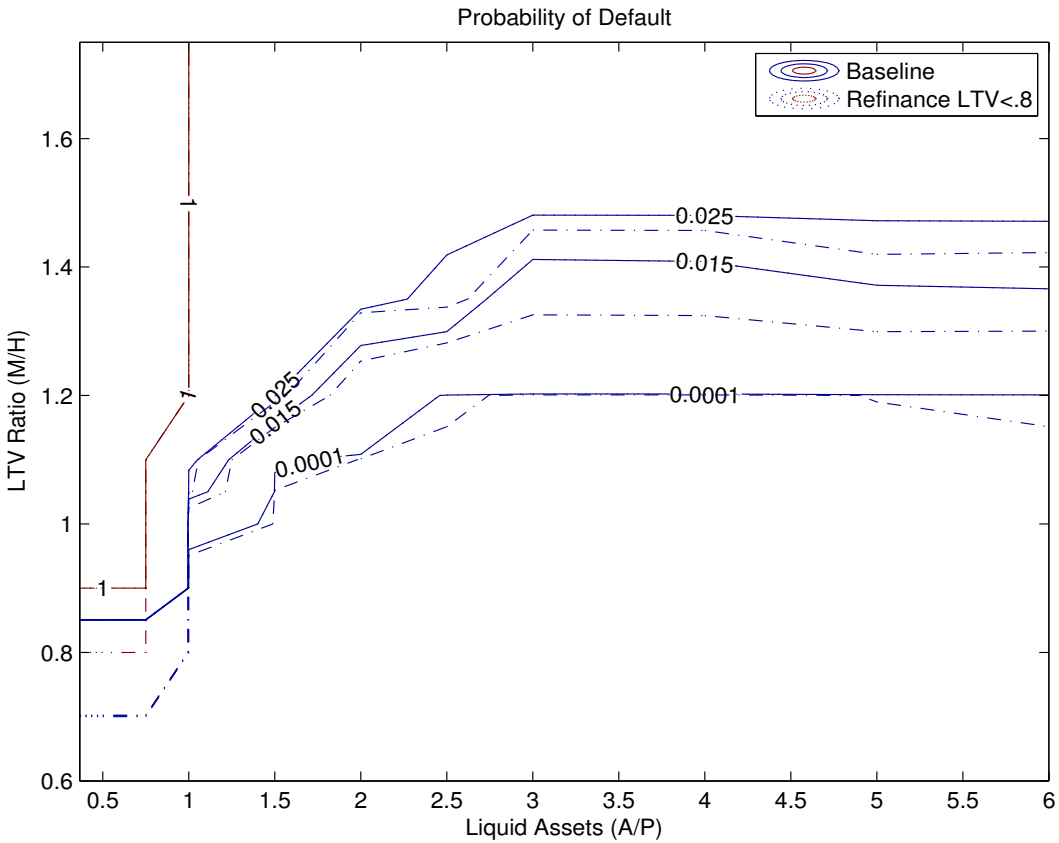
- House prices are 14% lower because of lower value of housing as collateral.
- Equity extraction is 23% lower and defaults are 28% lower because of smaller house values and lower mortgage balances.
- At given LTV ratio, probability of default is actually higher.
- Overall, new homeowners are better off because of lower house prices. (Welfare gain equivalent to 3% of consumption)

Policy Experiment - 80% Refinancing Limit

Distribution of outcomes in counter-factual for each outcome in baseline model

Baseline Outcome	Outcome with Refinance LTV$<$.8		
	Stay	Sell	Default
Stay (62.7%)	93.8%	4.6%	1.6%
Sell (26.7%)	0.9%	97.5%	1.6%
Default (10.6%)	24.8%	16.4%	58.8%
Total	61.7%	30.7%	7.6%

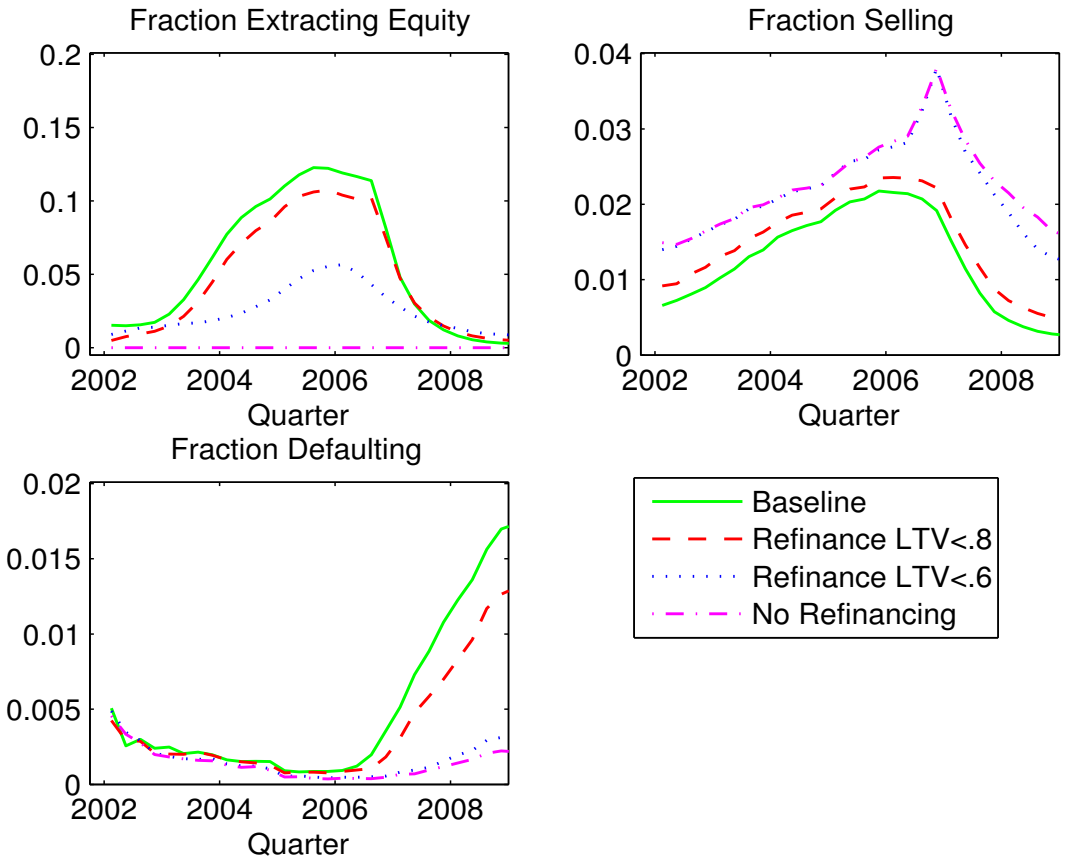
Policy Experiment - 80% Refinancing Limit: New Defaults



Two new groups of defaulters:

1. Liquidity constrained with small amounts of positive equity
2. Negative equity, lower value of staying because of future equity extraction

Policy Experiment - Other Refinancing Limits



- Without any equity extraction, the default rate of homeowners who had purchased before 2004 would have been 80% lower.
- This decrease represents 30% of total defaults.

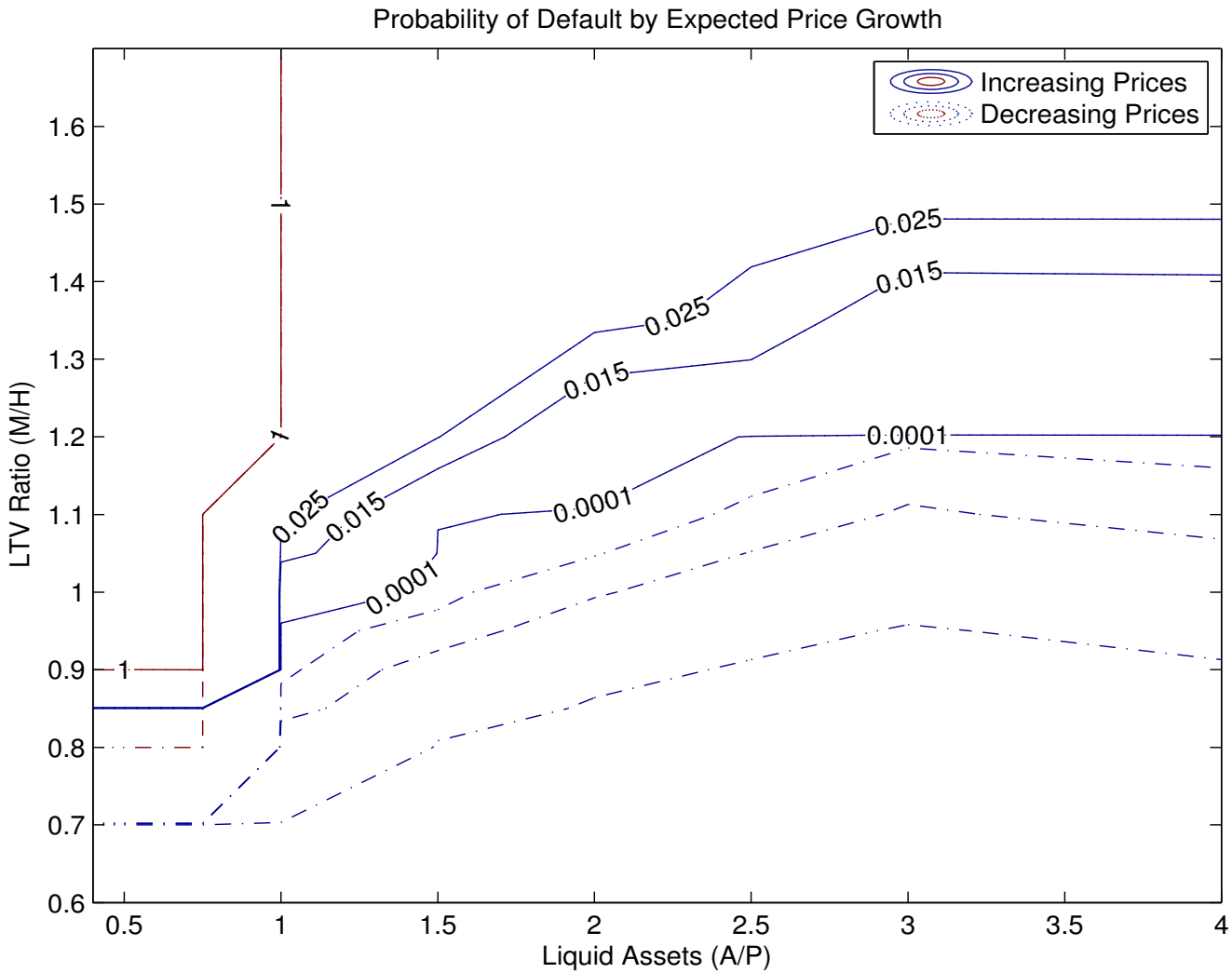
Conclusion

- Equity extraction explains negative equity and 80% of default among earlier buyers, which is about 30% of total defaults.
- Equity extraction driven largely by high spending in response to rising house prices.
- In the model, post-2006 defaults caused mostly by high LTV ratios, 30% income shocks hitting liquidity-constrained households.
- Limiting refinances to 80% of house value would reduce house prices, equity extraction and default, result in welfare increase for new homeowners.

Related Literature

- Equity Extraction: Hurst and Stafford (2004), Greenspan and Kennedy (2007)
- Empirical studies of default: Bajari, Chu and Park (2008), Elul *et al.* (2010), Bhutta, Dokko, and Shan (2010)
- Empirical studies of equity extraction and default
  - Holmes and LaCour-Little (2013): Study California foreclosures in 2006-2008. Half were underwater because of equity extraction rather than fall in prices.
  - Mian and Sufi (2011): Regional correlations between price growth in 2002-2005 and defaults in 2006-2008 explain 35% of defaults.
- Micro structural models with default: Campbell and Cocco (2003,2011). Yao and Zhang (2008).

Model Discussion: Expectations and Default



Summary of Results

Findings

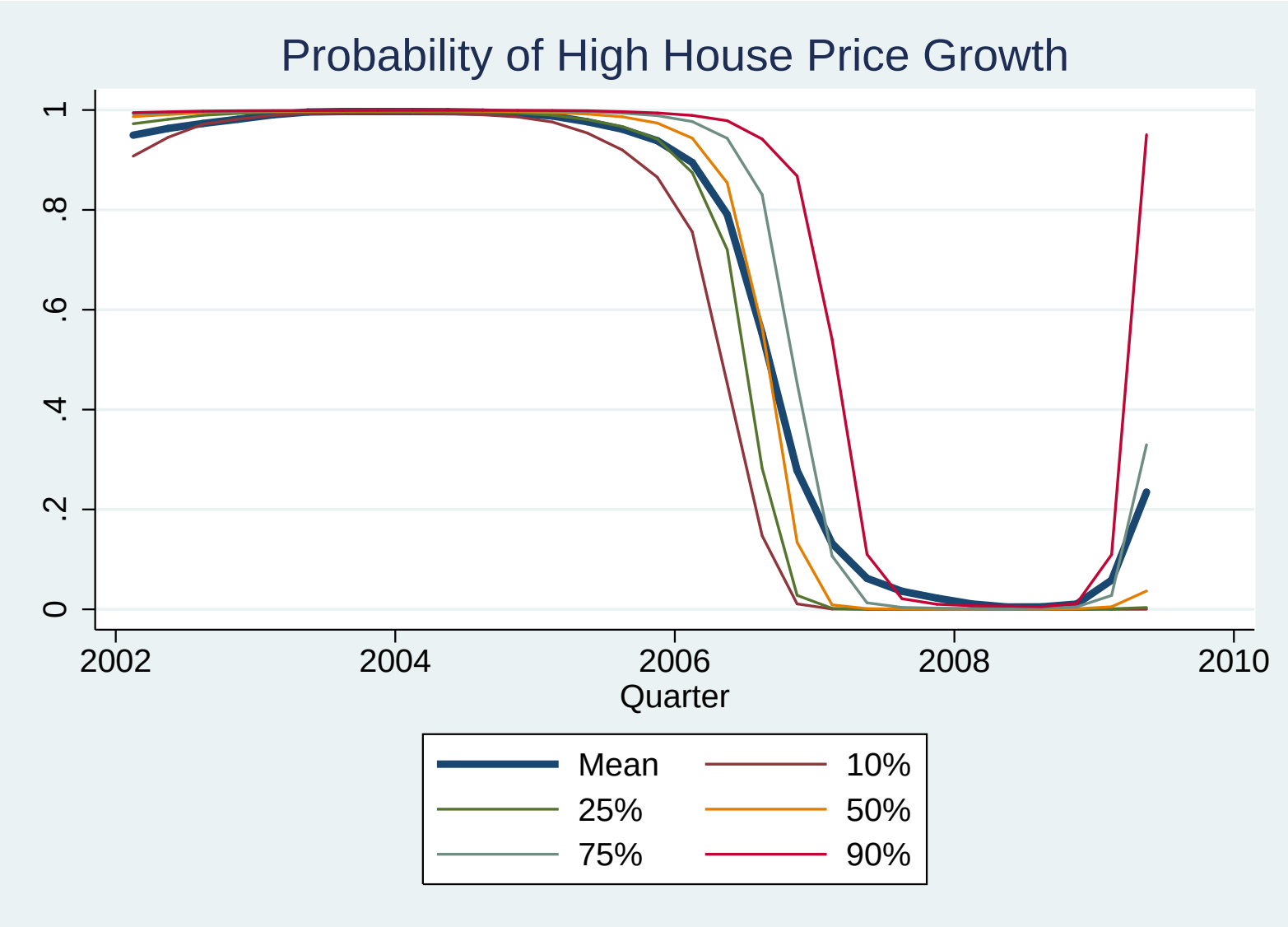
- Extract equity when liquidity constrained. Liquidity constraints bind because of high spending rather than income shocks. High spending because of house price growth.
- Rise in defaults driven by high loan-to-value ratios (LTV). Income shocks account for only 30% of defaults after crash.
- Limiting refinances to 80% of house value decreases prices, lowers defaults and increases the welfare for new homeowners.
- Without any equity extraction, 80% of defaulting homeowners who had purchased before 2004 (30% of total) would not have defaulted.

Estimation: Housing Prices

Regional Housing Prices: MLE of two-state Markov switching process on zip-code level house prices

- Booms:
  - Expected price growth is 15% per year.
  - Expected duration is 22 quarters.
- Busts:
  - Expected price decline is 7% per year.
  - Expected duration is 11 quarters.

House Price Expectations



Model: Income

- Permanent and transitory components

$$Y_t = P_t \varepsilon_t$$

- Permanent component

$$P_t = P_{t-1} \nu_t \qquad \ln \nu_t \sim \mathcal{N}(\mu_\nu, \sigma_\nu^2)$$

- Transitory component

$$\varepsilon_t = e_t \cdot \varepsilon_t^0$$

- Unemployment shock

$$e_t \in \{\delta, 1\} \qquad Prob(e_{1,t+1} = e' | e_t = e) = \Pi^E_{e',e}$$

- Continuous i.i.d. transitory shock

$$\ln \varepsilon_t^0 \sim \mathcal{N}(\mu_\varepsilon, \sigma_\varepsilon^2) \qquad E(\log \varepsilon_t) = 0$$

Model: Housing

- House i in region j has price p_{ijt}

$$\Delta \log p_{ijt} = \mu_{jt} + \eta_{jt} + \zeta_{it}.$$

  - Expected house price appreciation

$$\mu_{jt} \in \{\mu_1, \mu_2\}, \qquad Prob(\mu_{j,t+1} = \mu' | \mu_{jt} = \mu) = \Pi^H_{\mu,\mu'}$$

  - Regional house price shock

$$\eta_{jt} \sim \mathcal{N}(0, \sigma^2_\eta)$$

    Observe regional house price growth $\mu_{jt} + \eta_{jt}$. Don't observe μ_{jt} but observe history of prices in region j and filter price series to get distribution $f_{jt}(\mu)$:

$$f_{jt}(\mu_2) = Prob(\mu_{jt} = \mu_2).$$

  - Idiosyncratic shock

$$\zeta_{jt} \sim \mathcal{N}(0, \sigma^2_\zeta)$$

- Per-period maintenance cost $\chi p_t h_t$.
- Selling cost $\theta_0 P_t + \theta_1 p_t h_t$ if $h_{t+1} \neq h_t$, dis-utility from moving θ_u

Model: Mortgages

- Mortgage of size M_t requires interest payments $r^m M_t$ but no principal payments.
- All borrowers, mortgages have same constant interest rate.
- Owners can take out new mortgage up to fraction $\phi(f_{jt}(\mu_2))$ of current house value.
- No borrowing limits on existing mortgages. LTV ratio may rise above one if prices fall.
- Limit on debt-to-income ratio: Mortgages must satisfy $r^m M_t < \psi_i P_t$. (i=Purchase or Refinance)
- Mortgage costs

$$K(M_{t+1}) = k_0 P_t + (k_1 + k_2 \cdot \mathbf{1}(M_{t+1} > \overline{m} p_t h_t)) M_{t+1}$$

Model: Default

- Defaulters permanently enter a frictionless rental market with housing services available at price ρp_t.
- Incentives to Default:
  1. Defaulters do not pay mortgage/housing costs in period of default.
  2. Lose value of house and obligation to repay mortgage. (Wealth increases by $M_t - p_t h_t$)
- Default if can't afford mortgage payment.
- Default as an optimal decision even if can afford payments.

Model: Preference Shocks

- Every period with probability λ, the household receives a preference shock of strength ω_t,

$$\omega_t \sim \mathcal{N}(\mu_\omega, \sigma_\omega^2)$$

- If move (sell or default) in response to shock, get utility

$$\Omega_t = \omega_t P_t^{1-\gamma} p_t^{(1-\alpha)(\gamma-1)}$$

Estimation: Income & Housing Prices

- Period is a quarter. All quantities are nominal.
- Discrete income shock: Match to unemployment

$$\delta = 0.5 \quad \Pi^{E}_{e \to u} = .020 \quad \Pi^{E}_{u \to e} = .60 (u = .034)$$

- Continuous income shocks: Match moments of household income for homeowners from PSID

$$\mu_\nu = .008 \quad \sigma_\nu = .096 \quad \sigma_\varepsilon = .233$$

- Regional Housing Prices: MLE of two-state Markov switching process on zip-code level HPI's

$$\{\mu_1, \mu_2\} = \{-.018, .038\}, \quad \Pi_{\mu_1,\mu_1} = .908 \quad \Pi_{\mu_2,\mu_2} = .954 \quad \sigma_\eta = .028$$

- Idiosyncratic house price shock from variance of residuals of repeat sales observations

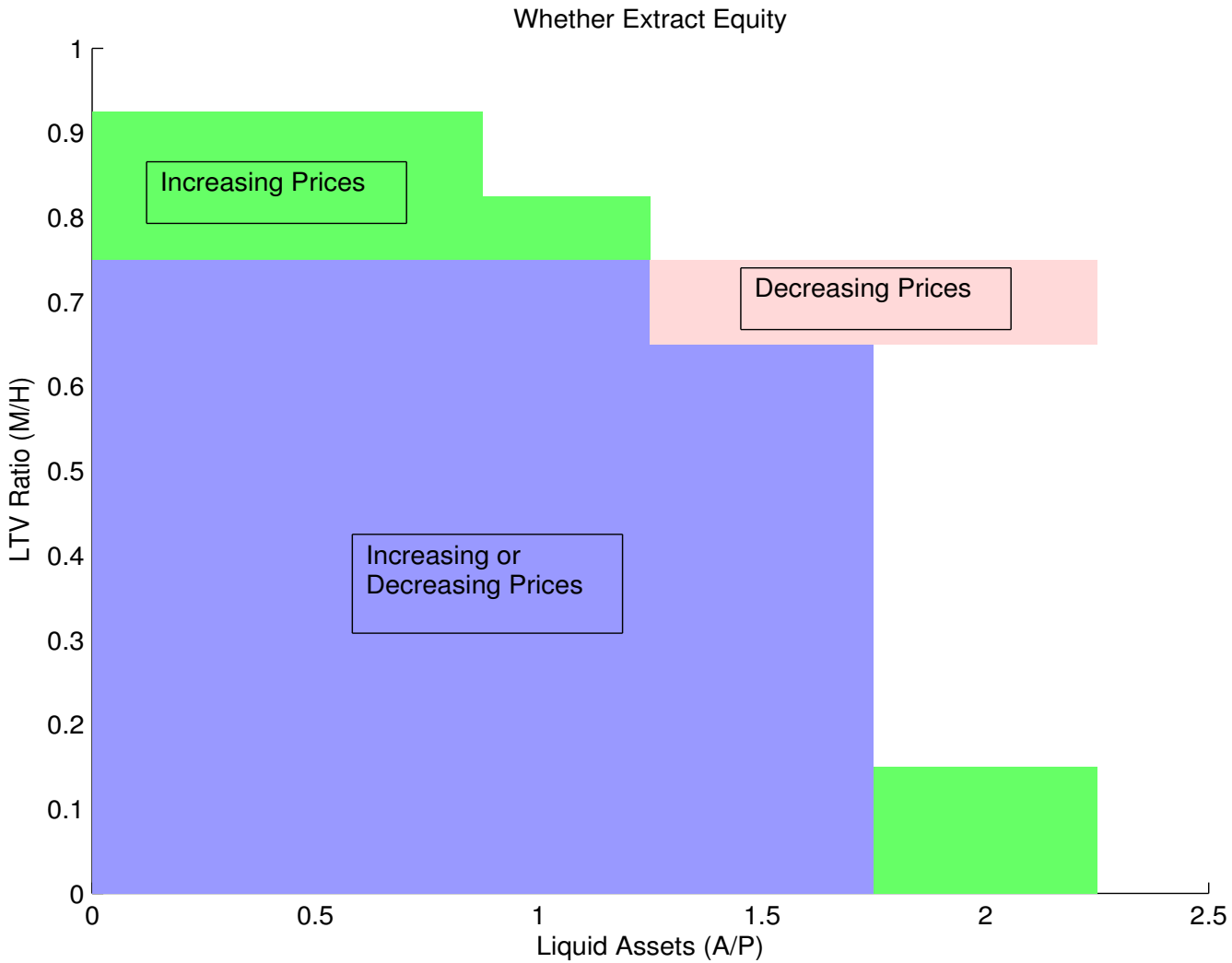
$$\sigma_\zeta = .017$$

Estimation: MSM

Estimate model with method of simulated moments.

- Sample of 2002-2004 buyers.
- Begin with observed LTV, income and assets to match distribution for new buyers from PSID.
- Simulate income to match observed values of unemployment rate, median income growth. Observed regional house prices plus idiosyncratic shock.
- Target 190 moments: rates of default, moving, equity extraction plus interactions with observed variables. Asset and income moments from Michigan Panel Study of Income Dynamics (PSID).

Model Discussion: Equity Extraction



Policy Experiment - Recourse

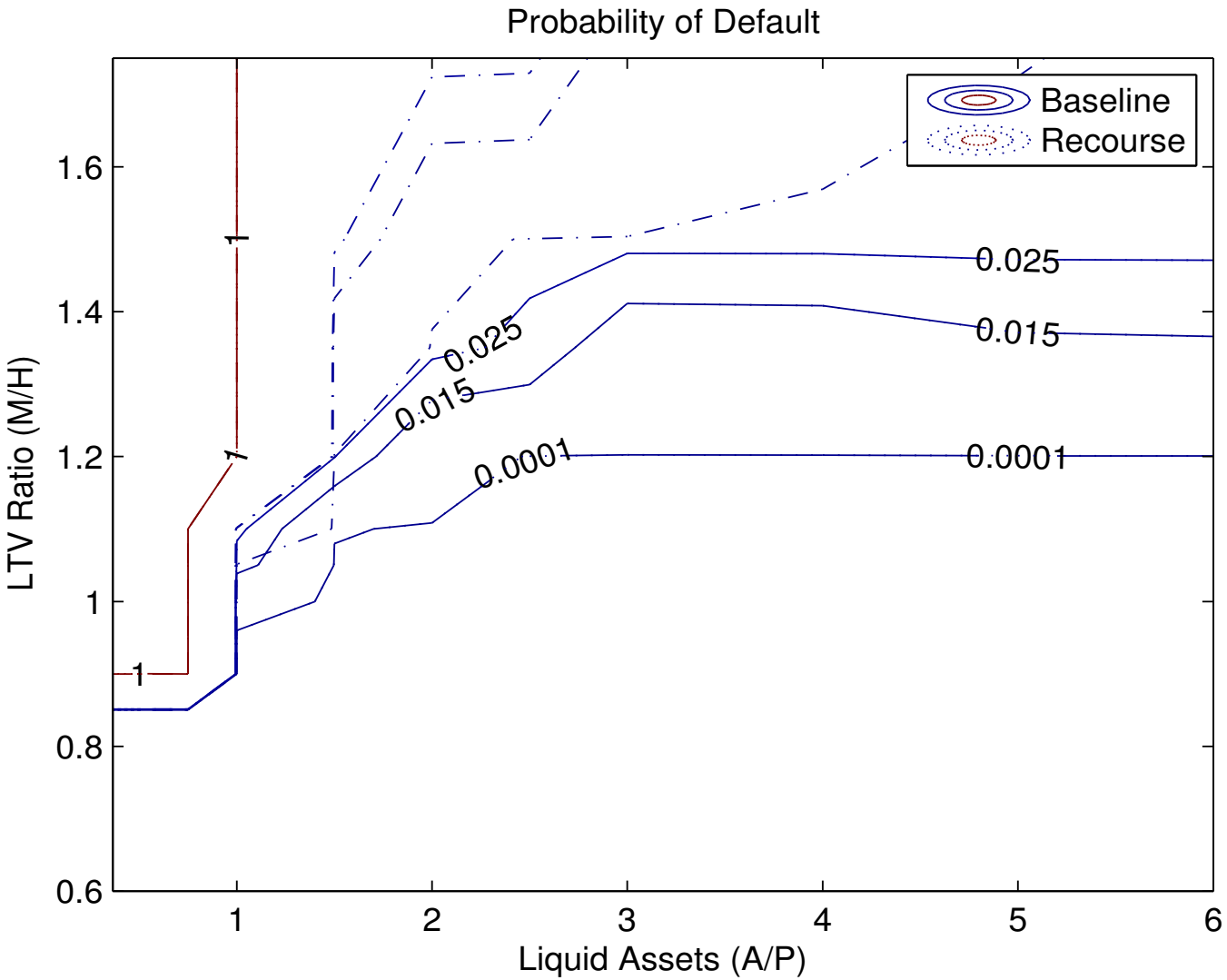
Grant lenders full recourse. Convert un-paid balance of mortgages into un-collateralized debt upon default.

- Same interest rate $r_m = .017$.
- Can't discharge debt through bankruptcy.

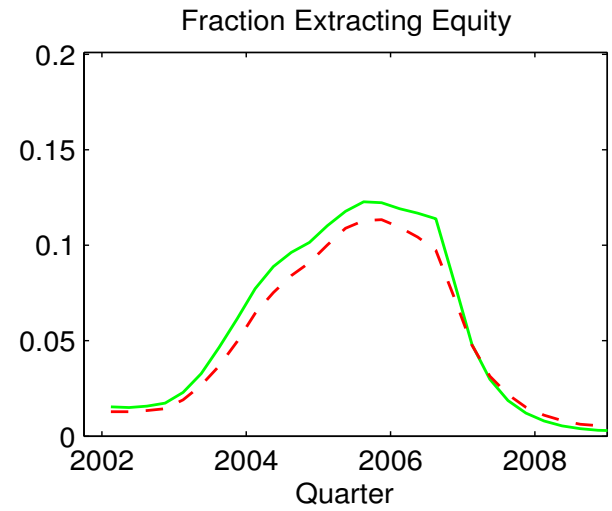
Will decrease default rate. Two effects:

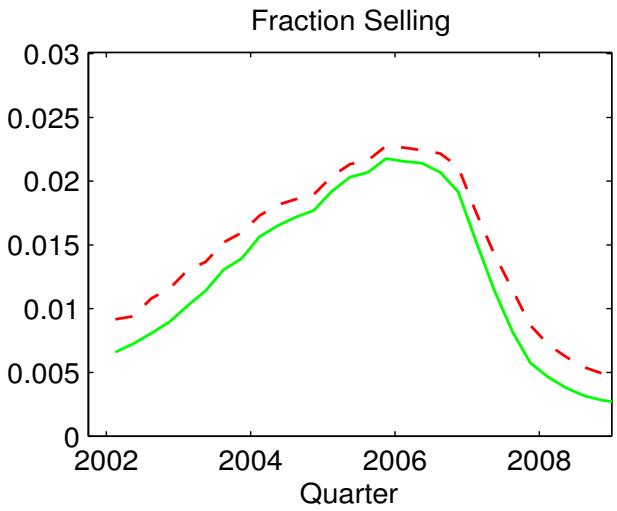
1. Decrease in likelihood of default for given LTV.
2. Decrease in borrowing $\rightarrow$ lower LTV.

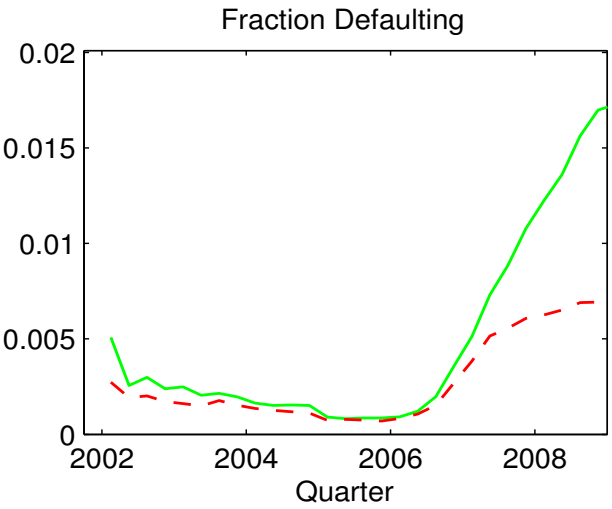
Policy Experiment - Recourse: Default

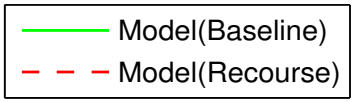


Policy Experiment - Recourse









Policy Experiment - Recourse

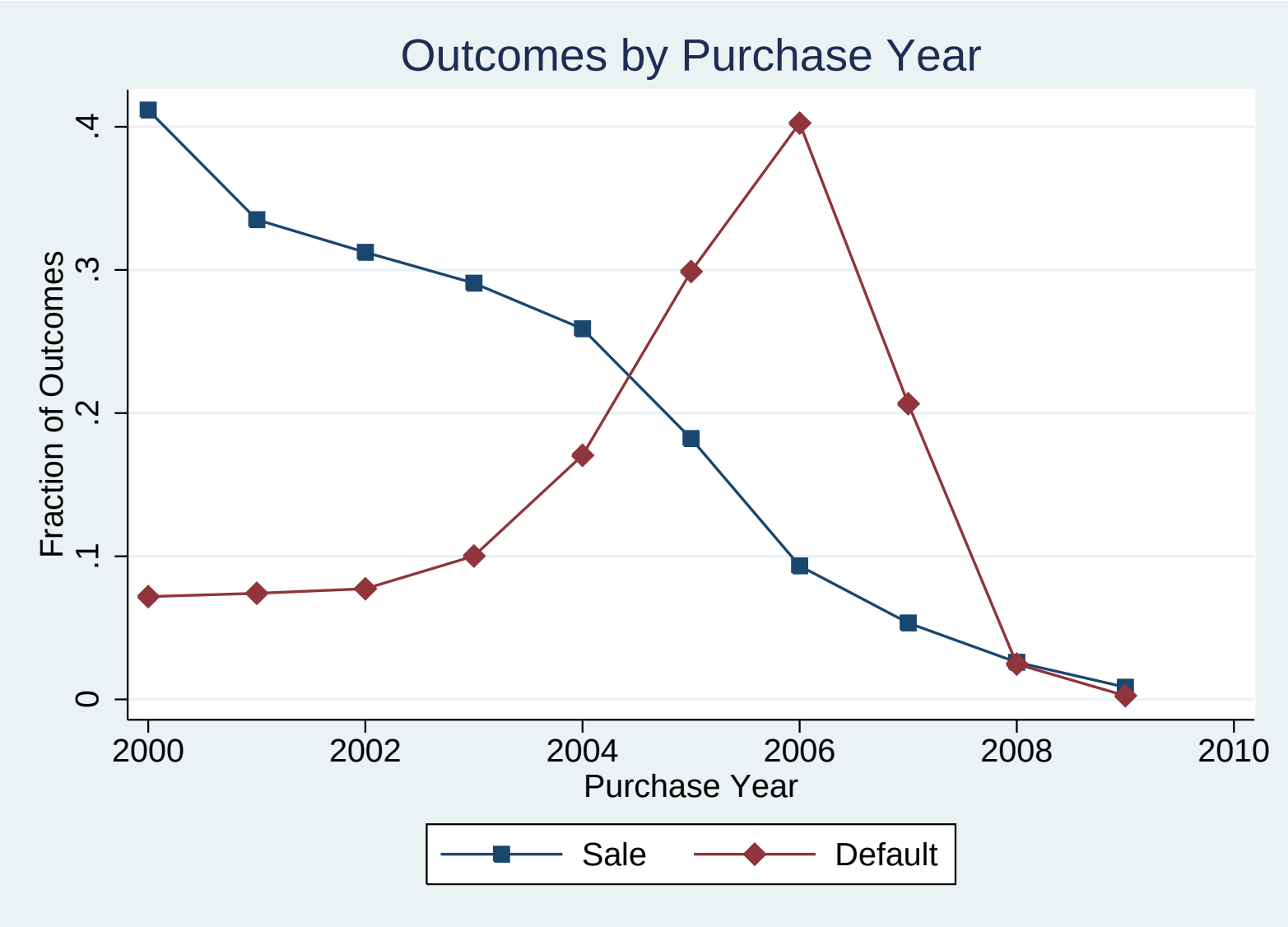
Distribution of outcomes in counter-factual for each outcome in baseline model.

Baseline Outcome	Outcome with Recourse		
	Stay	Sell	Default
Stay (62.7%)	94.9%	4.1%	1.0%
Sell (26.7%)	1.1%	97.7%	1.3%
Default (10.6%)	40.9%	13.1%	46.0%
Total	64.1%	30.1%	5.8%

Policy Experiment - Recourse

- House prices are 12% lower because of lower value of housing as collateral.
- Equity extraction is 18% lower and defaults are 45% lower because of smaller house values and restrictions on borrowing.
- Welfare gain for new homeowners equivalent to 2.7% of consumption because of lower house prices.

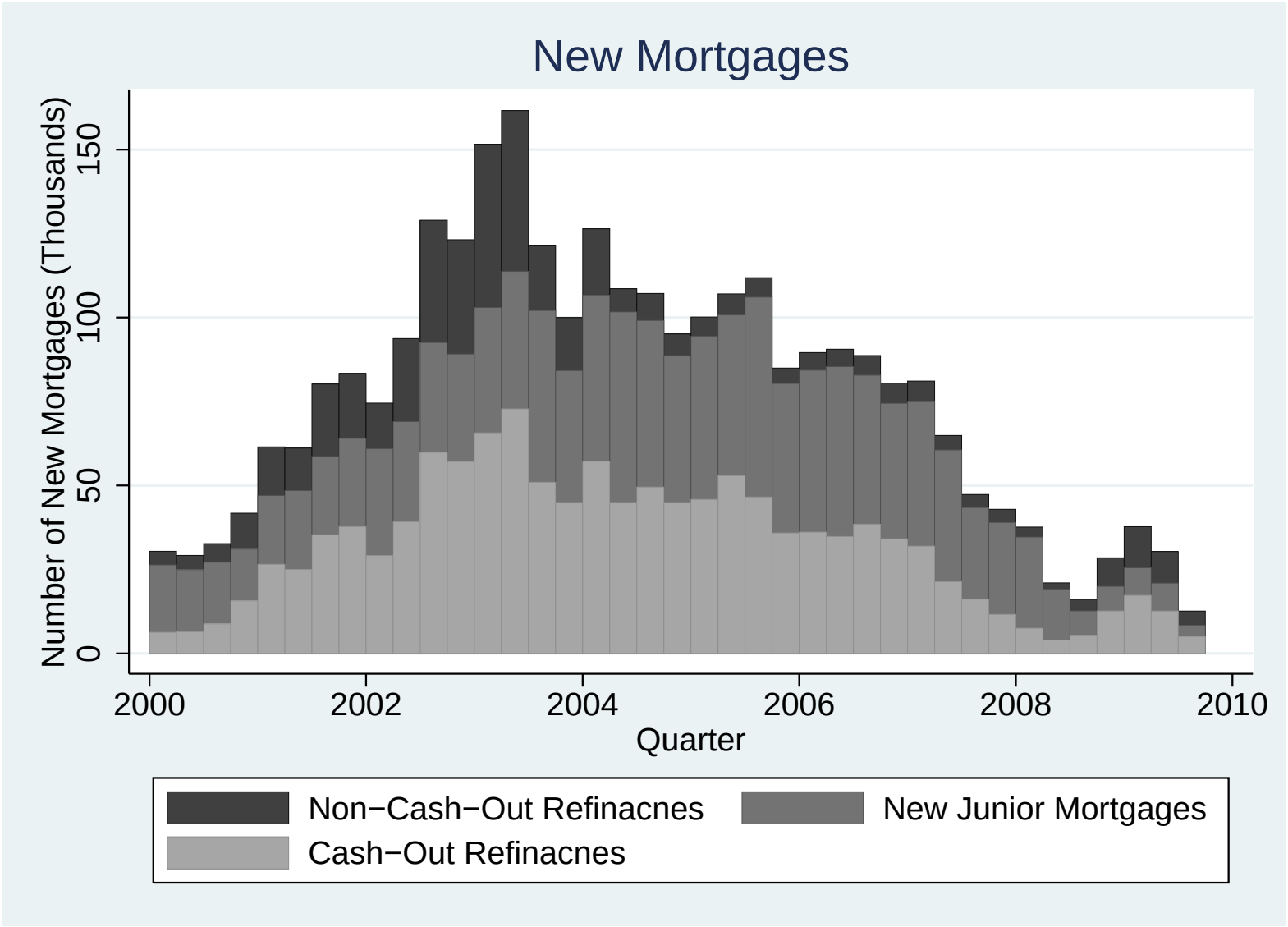
Data: Outcomes by Purchase Year



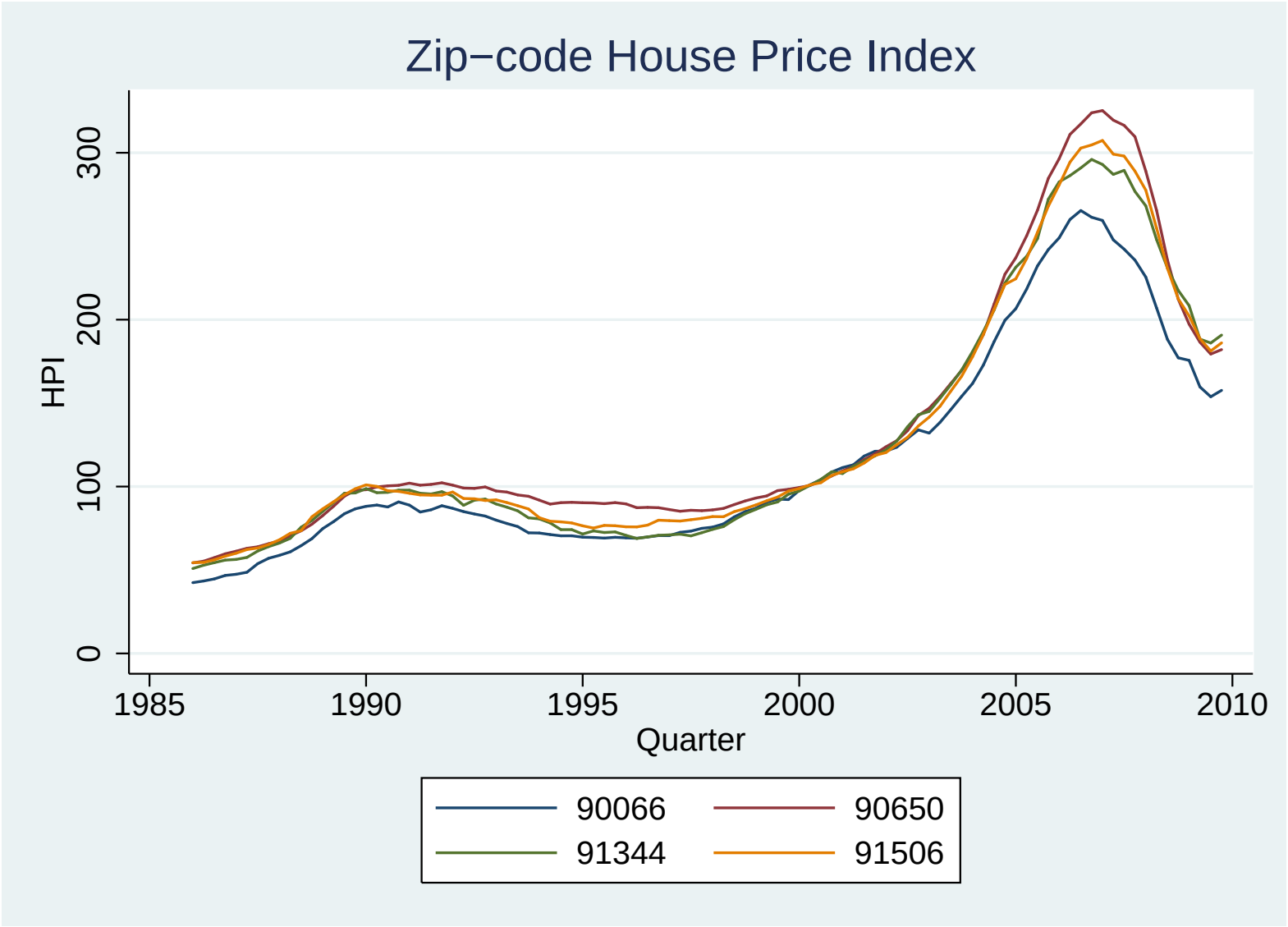
Data: Purchases

Purchase Year	N (1000)	Mean cLTV	Median cLTV	Subprime	Default
2000	103	.87	.90	.40	.07
2001	88	.87	.90	.14	.08
2002	94	.86	.90	.18	.08
2003	94	.86	.90	.25	.11
2004	91	.87	.90	.29	.19
2005	88	.88	.91	.28	.32
2006	72	.90	1.00	.22	.42
2007	53	.85	.90	.05	.19

Data: New Mortgages



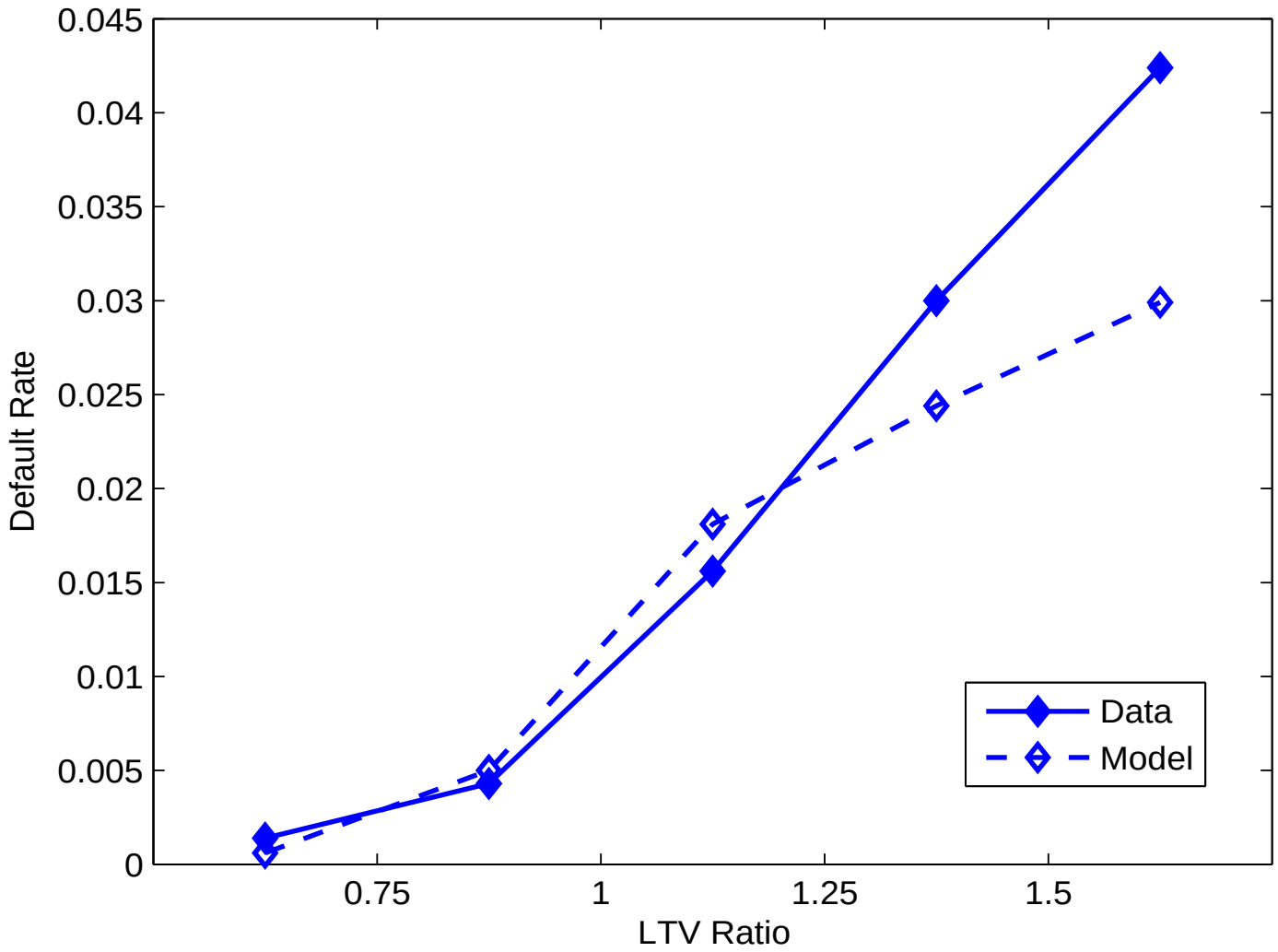
Data: Zip-code HPI's



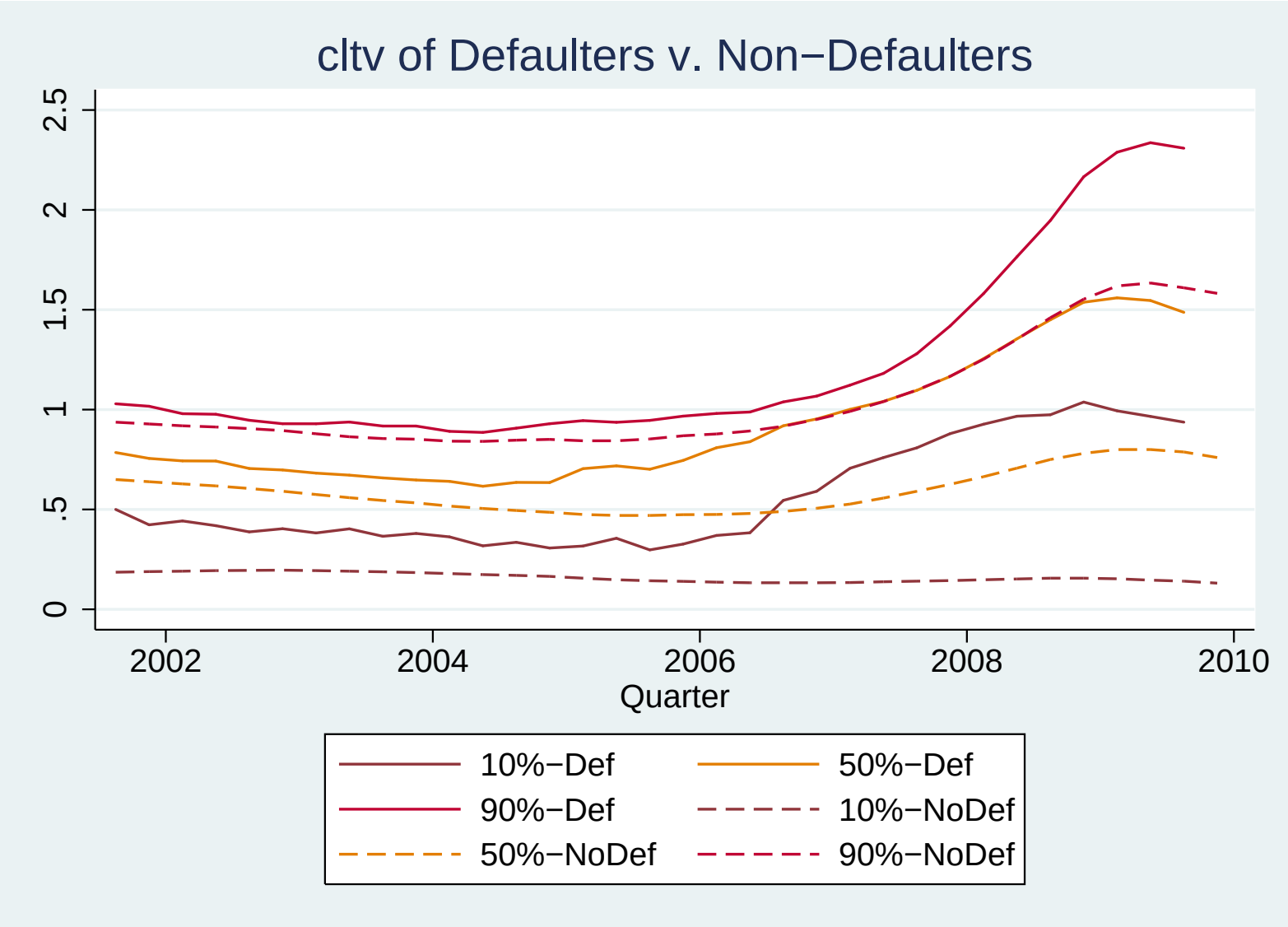
Estimation: Parameter Estimates

discount factor	β	.942	(.001)
weight on non-housing consumption	α	.636	(.010)
risk aversion	γ	1.89	(.073)
mortgage cost (fraction of income)	k_0	.116	(.022)
mortgage cost (fraction of mortgage balance)	k_1	.014	(.001)
mortgage cost (for LTV$>$.8)	k_2	.080	(.004)
repayment cost	κ	4.17	(.561)
mortgage payment/income limit (purchase)	ψ_p	.372	(.160)
mortgage payment/income limit (refinance)	ψ_r	>1	(-)
moving cost (fraction of income)	θ_0	2.86	(.228)
moving cost (fraction of house value)	θ_1	.177	(.011)
moving cost (utility)	θ_u	2.41	(.276)
default rent-price ratio	ρ	.177	(.017)
probability of preference shock	λ	.026	(.001)
mean of preference shock	μ_v	10.62	(.897)
variance of preference shock	σ_v	.403	(.235)
job separation rate	$\Pi^E_{e\to u}$	.018	(.002)

Results: Defaults by LTV



Data: LTV at Default



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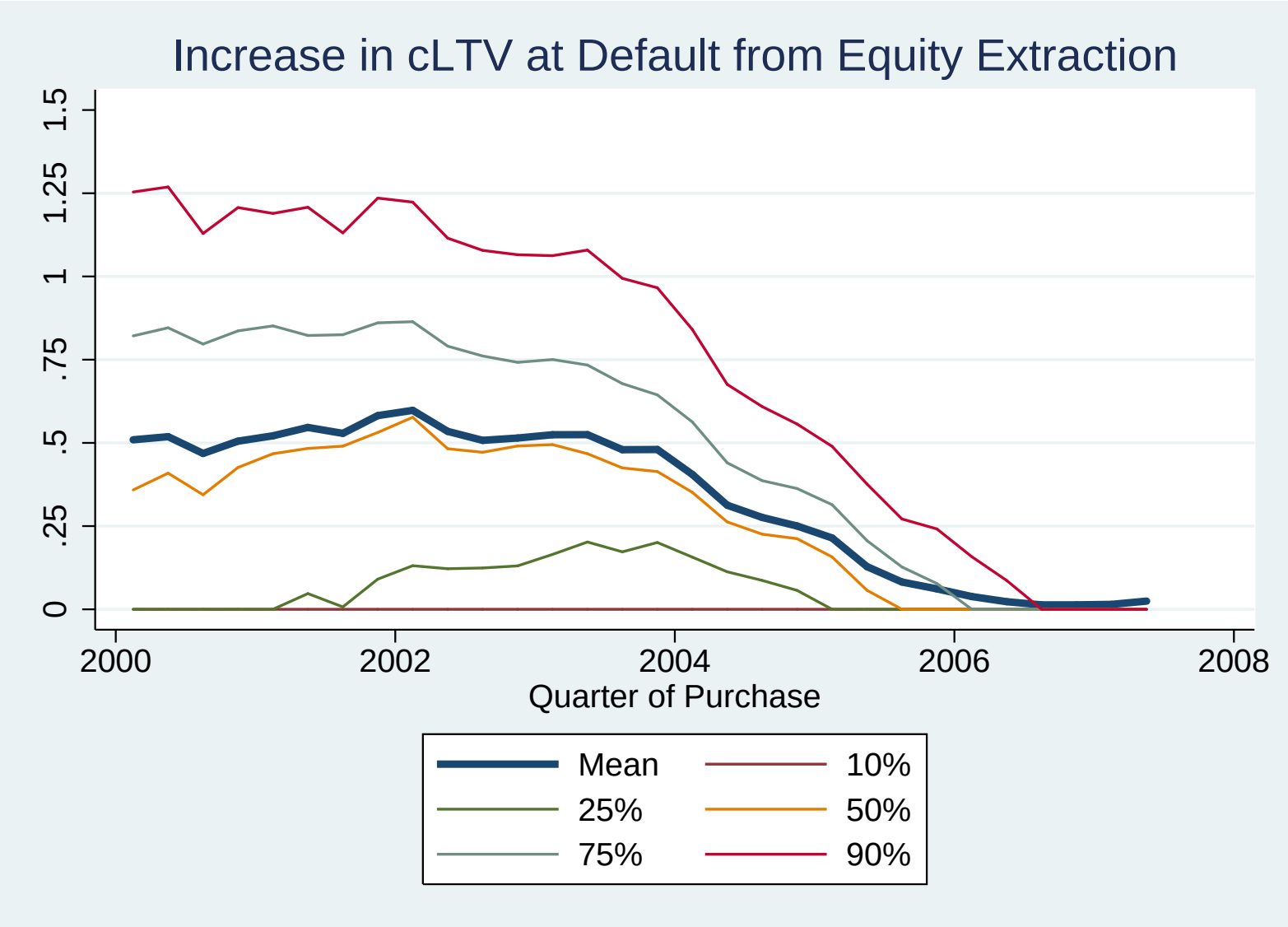

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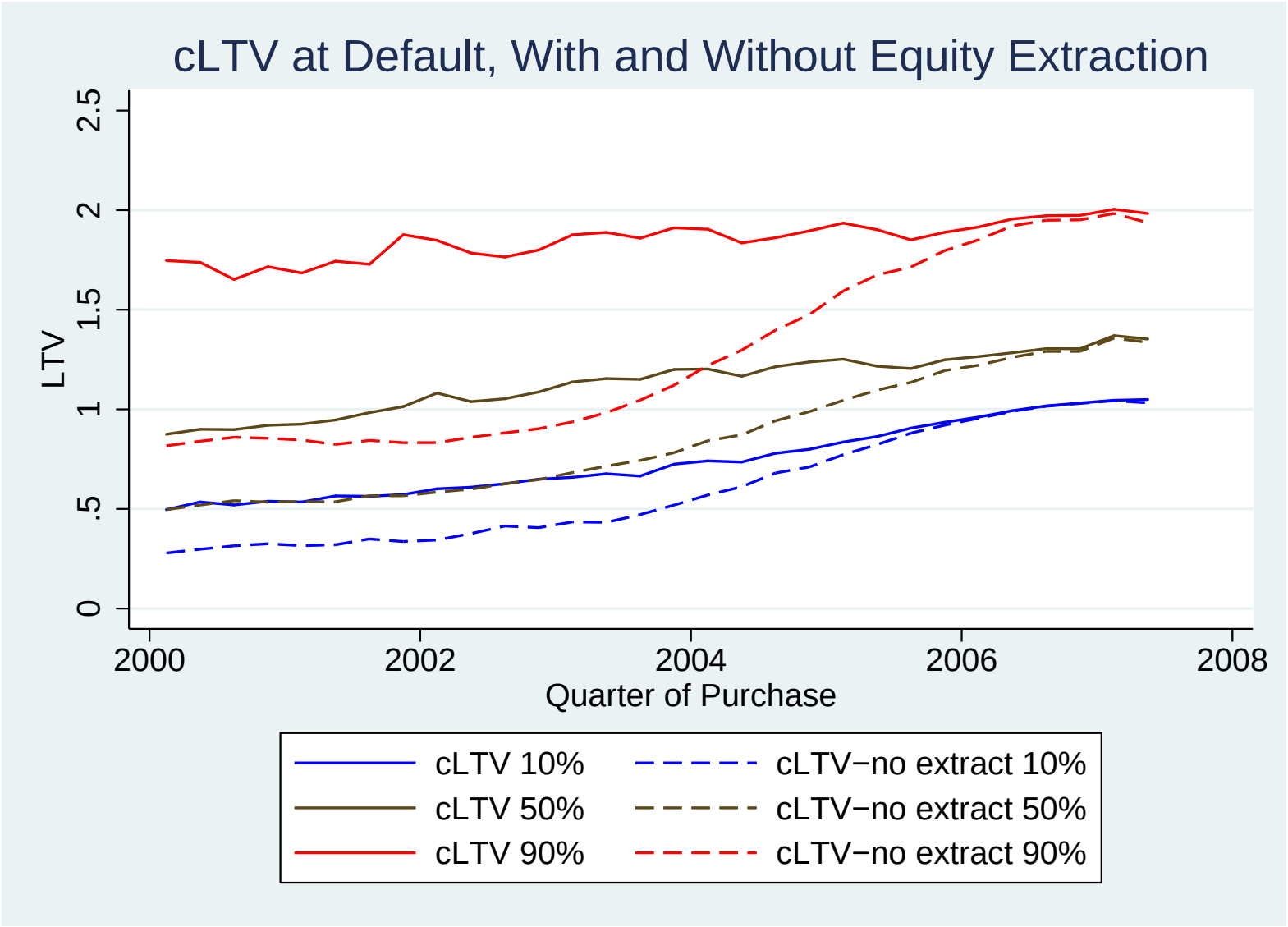

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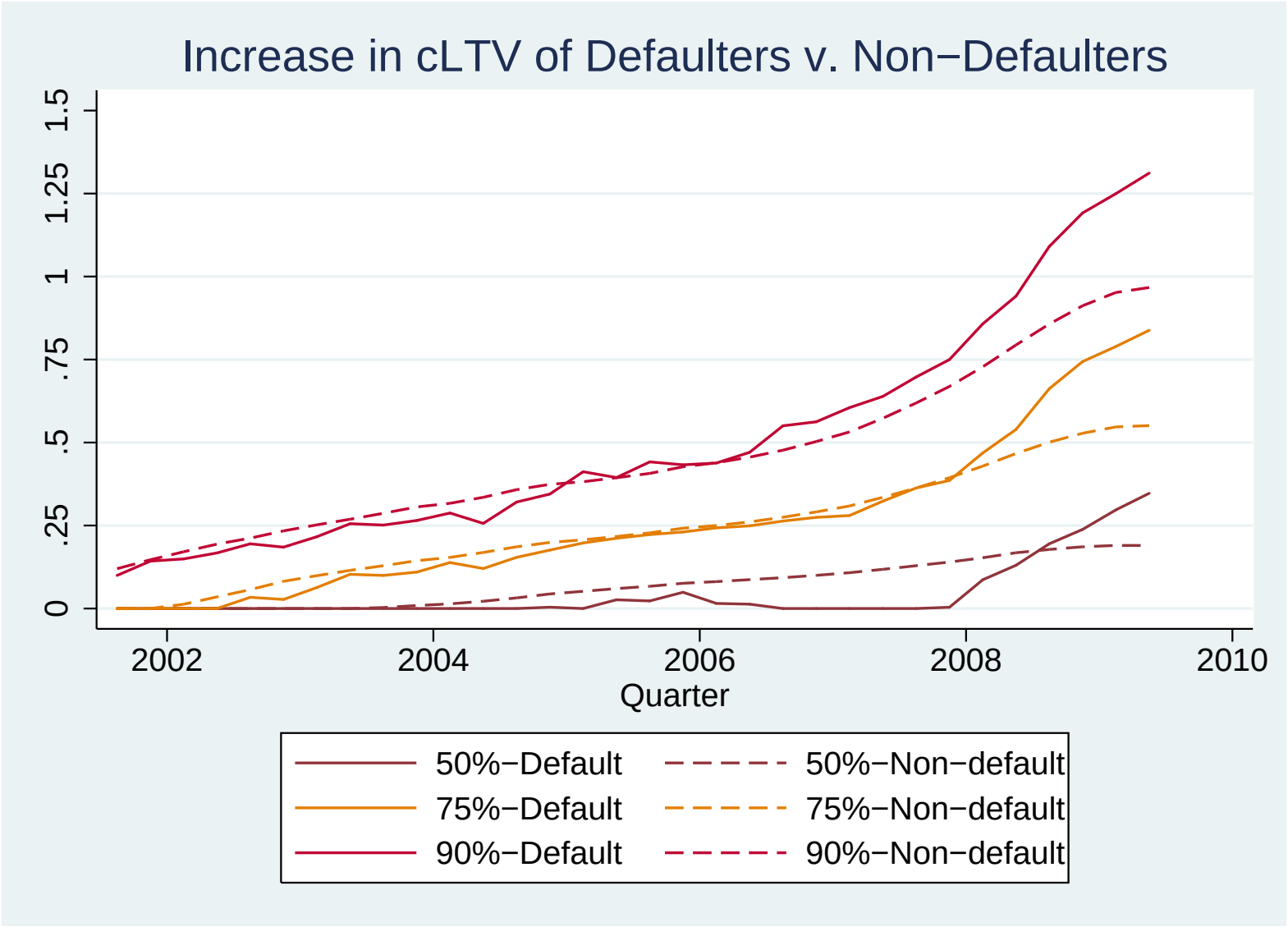
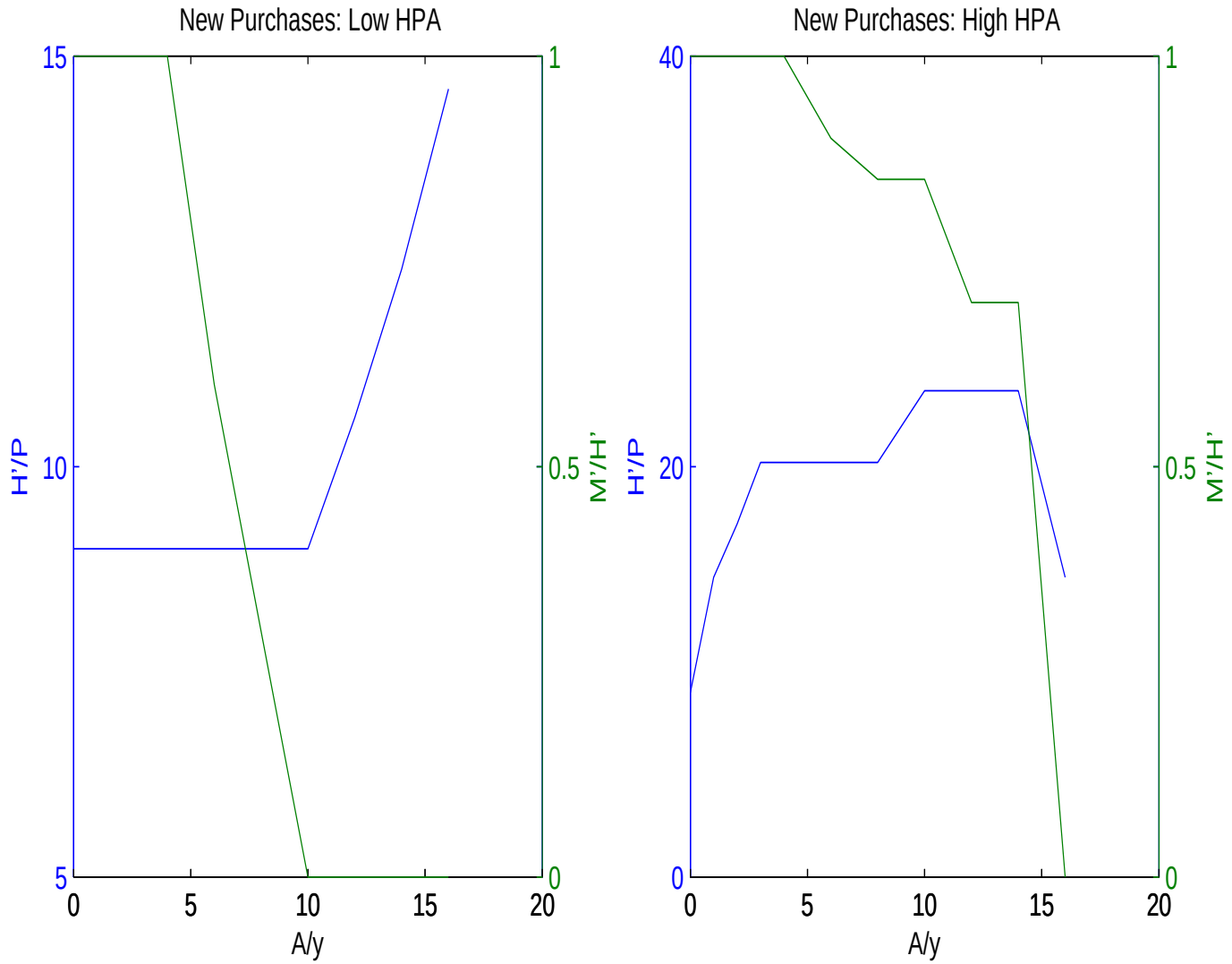
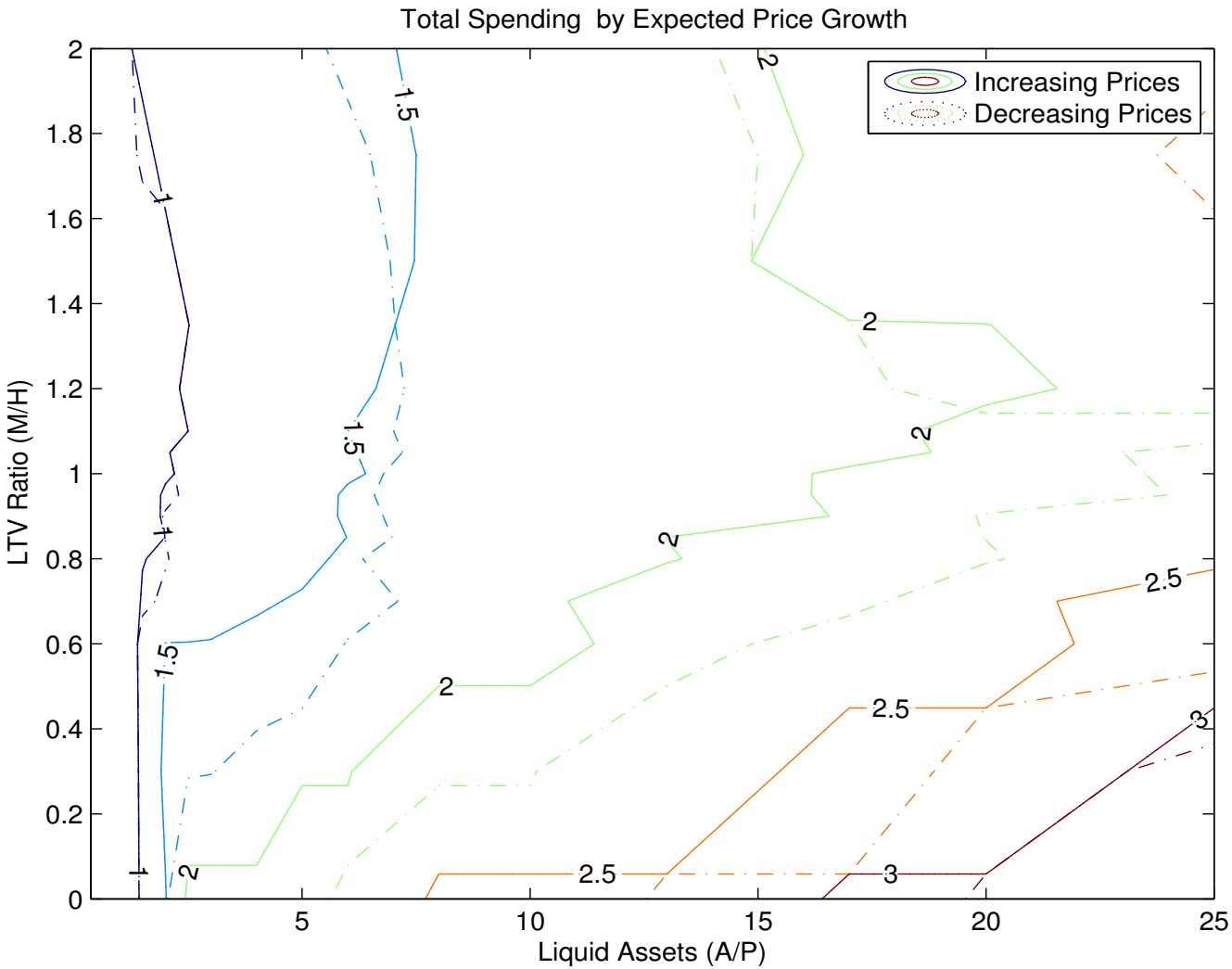


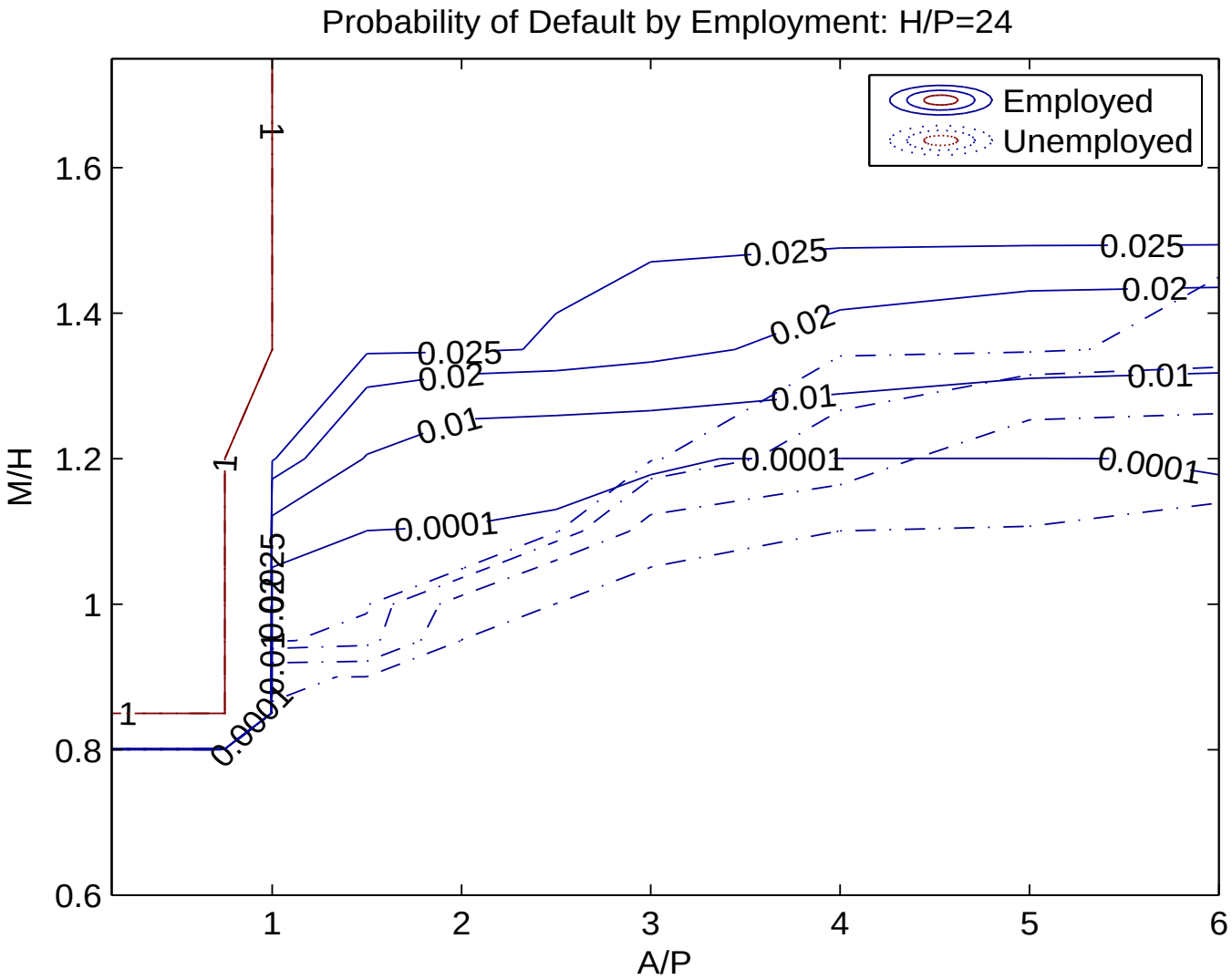
Purchase Policies



Model Discussion: Spending



Model Discussion: Unemployment and Default



California Mortgages

Sample of homeowners is from Los Angeles County, California

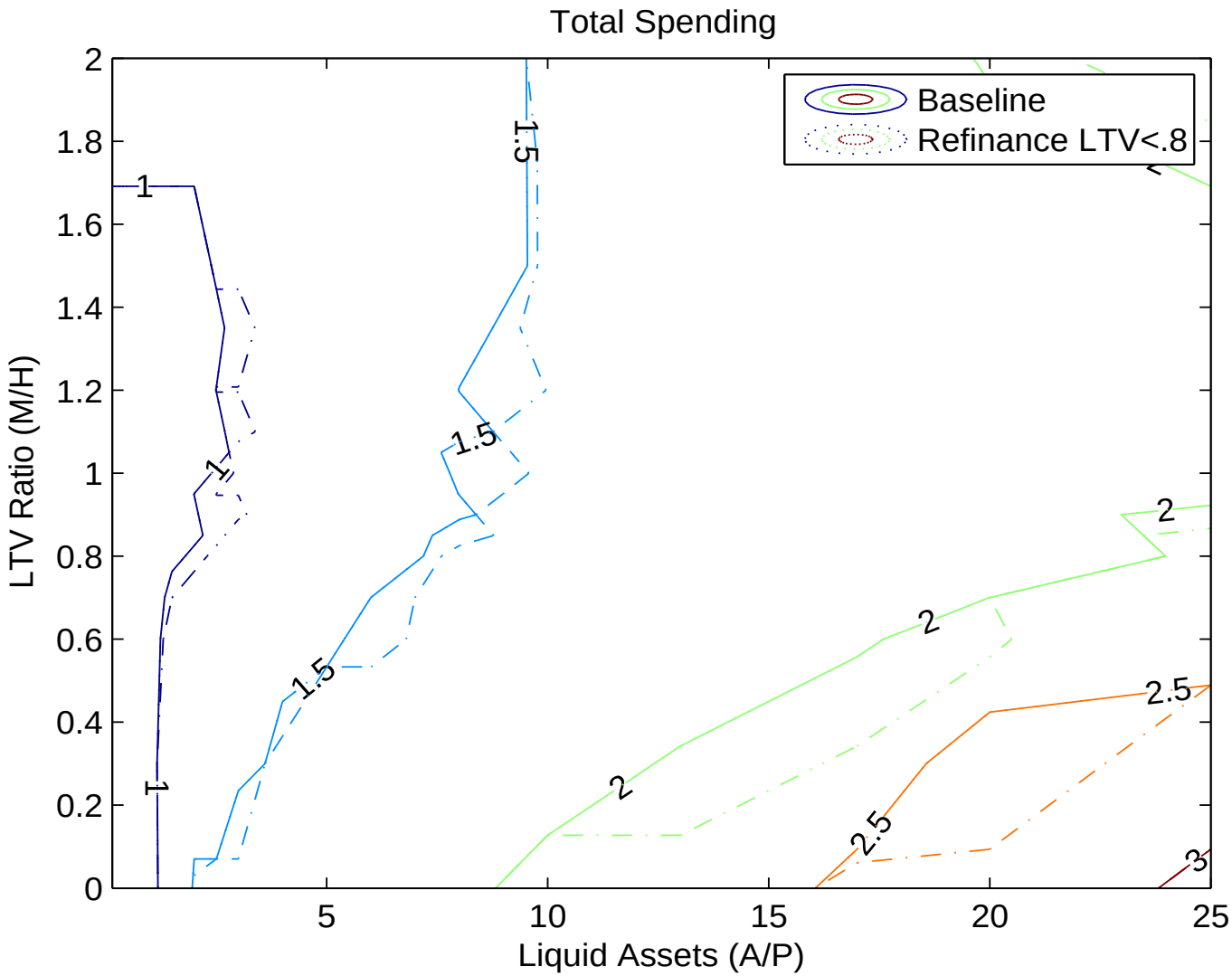
- California is one of nine non-recourse states.
- Allows both judicial and non-judicial foreclosures (judicial foreclosures are rare)
- Laws on different types of loans
  - No deficiency judgements on purchase-money loans
  - Deficiency judgements on refinances (before 2013), second mortgages, cash-out, but only in judicial foreclosures.

Texas Refinancing Laws

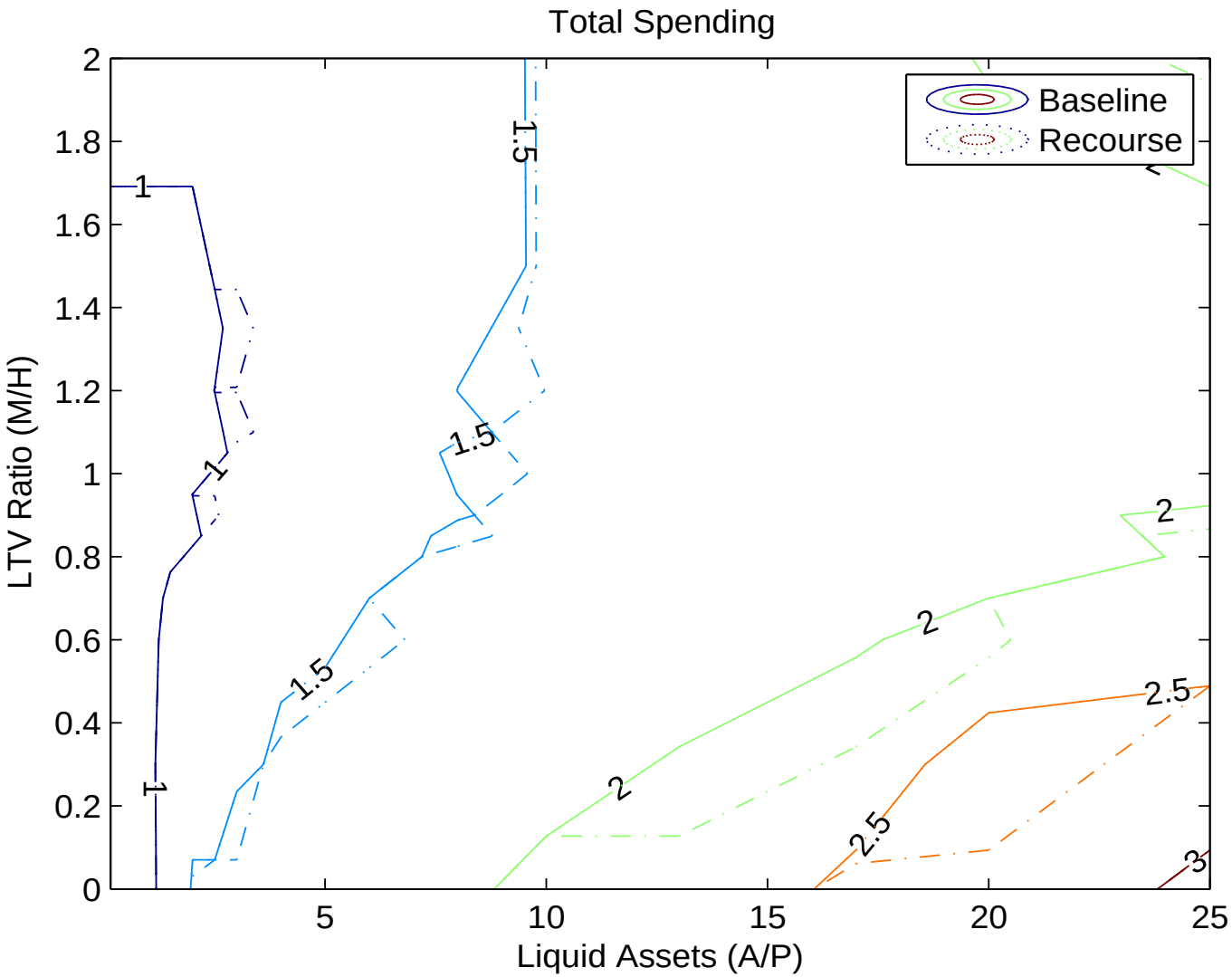
Homestead Act of 1997, Article A, Section 6 permits cash-out refinances: Texas A6 Home Equity Loans

- Applies to any cash-out refinance or new loan on primary residence, or any refinance of existing A6 loan.
- Does not apply if cash is entirely for home-improvement or back taxes
- Borrower protections: 12-day review period, maximum 3% closing costs, no pre-payment penalties, judicial foreclosures.
- No refinancing within first 12 months.
- Total LTV when take out new A6 loan cannot exceed 80%.

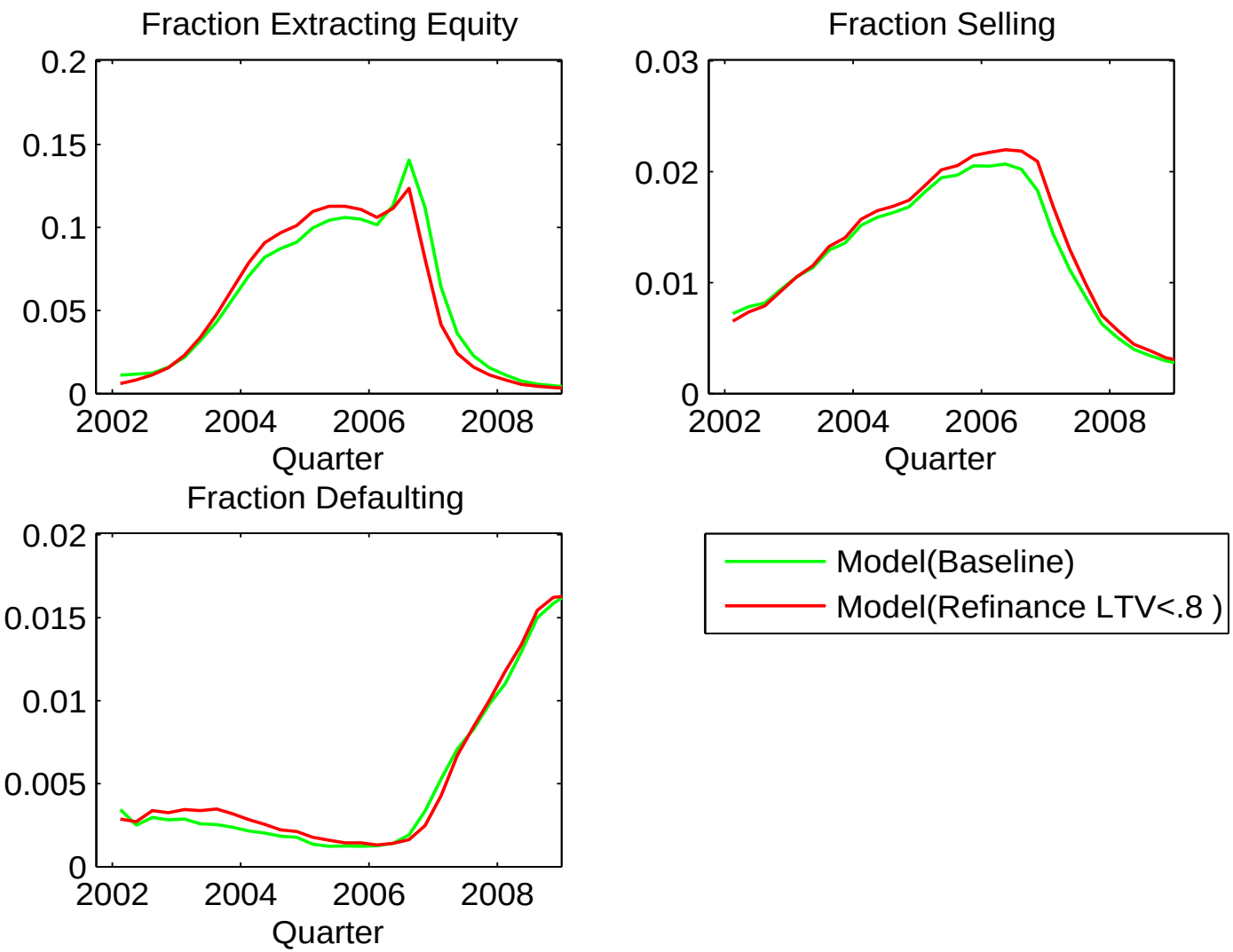
Policy Experiment - Texas Refinancing: Spending



Policy Experiment - Recourse: Spending



Policy Experiment - Texas Refinancing



Data: Empirical Results

	Extract Equity	Sell	Default
Subprime	.043***	-.015	.133***
Purchase LTV	.029***	.056***	-.047
Purchase cLTV	.142***	-.002	.191***
Purchase Rate	.061***	.071***	.106***
Current Rate	.089***	.061***	.759***
ΔHPI - 1yr	.395***	.261***	.095*
ΔHPI - last mort.	.035***	.127***	-.296***
$cLTV > 1$	.169*	.062	.576***
$cLTV \times (cLTV > 1)$	-.190***	-.037	.185***
Δ med. inc.	.030***	-.002	-.023
Unemp.	.015**	-.007	.085**
$(cLTV > 1) \times$ unemp	-.095**	.061	-.175***
$(cLTV > 1) \times$ rate	-.107*	-.053	-.256***
2000 Unemp.	-.017**	.014	.023
2000 Frac Young	-.000	.120***	-.067*
2000 Frac. College	.064***	.168***	-.176***

* 5%, ** 1%, ***0.1%, Pseudo-R^2=.052

Model: Solution

- Write problem recursively, solve for

$$V(P, \tilde{a}, h, e, p, M, v, f)$$

$$\tilde{a} = a + P\varepsilon$$

- Each period, household has four options.
  1. Continue to pay mortgage. (V^0)
  2. Refinance into new mortgage (V^R)
  3. Sell and buy a new house (V^S)
  4. Default (V^D)
- $V = \max(V^0, V^R, V^S, V^D)$

Model: Household Problem

1. Continue to pay the mortgage.

$$V^0(P, \tilde{a}, h, e, p, M, v, f) = \max_c u(c, h) + \beta \mathbf{E} V(P', \tilde{a}', h, e', p', M, v', f')$$

$$a' = (1 + r^s) \cdot (\tilde{a} - \chi p h - r^m M - c), \quad a' \geq 0$$

2. Refinance into a new mortgage of size $M' \neq M$ with $M' < \phi p h$

$$V^R(P, \tilde{a}, h, e, p, M, v, f) = \max_{c, M'} u(c, h) + \beta \mathbf{E} V(P', \tilde{a}', e', h, p', M', v', f')$$

$$a' = (1 + r^s) \cdot (\tilde{a} + (M' - M) - r^m M - \chi p h - K(M') - c), \quad a' \geq 0$$

Model: Household Problem (cont)

3. Move to a new house of size $h' \neq h$ with a new mortgage $M' < \phi p h'$.

$$V^M(P, \tilde{a}, h, e, p, M, v, f) = \max_{c, h', M'} u(c, h) + \beta \mathbf{E} V(vP', \tilde{a}', e', h', p', M', v', f')$$

$$a' = (1 + r^s) \cdot (\tilde{a} + (1 - \theta_1 - \chi) p h - \theta_0 P - (1 + r^m) M - p h' + M' -$$
$$\kappa((1 - \theta_1) p h - M) \cdot \mathbf{1}((1 - \theta_1) p h < M) - c), \; a' \geq 0$$

4. Default

$$V^D(P, \tilde{a}, h, e, p, M, v, f) = \max_c u(c, h) + \beta \mathbf{E} V^{rent}(vP, \tilde{a}', e')$$

$$a' = (1 + r^s) \cdot (\tilde{a} - c), \quad a' \geq 0$$

Equity Extraction and Default

Issues connecting equity extraction and default decisions

1. Extracting Equity increases LTV-ratio
   - Creates financial incentive to default if bank has no recourse beyond repossession of house: "Strategic Default."
   - Makes it more difficult to pay off mortgage from value of house if want to move.
2. Extracting equity provides liquidity. May allow owner to keep up mortgage payments
3. Selection issue. Liquidity constraints can induce both equity withdrawal and default. High-risk borrowers have less access to credit.

Future Work

- Endogenous maintenance decisions
  - During the boom, extracted equity used for home improvements.
  - During the bust, debt overhang causes lower maintenance.
- Preference shocks as job offers that require relocation. Interaction between housing and labor markets.
- More flexible model of beliefs about house prices, fit to survey data on house price expectations.