Mortgage defaults

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Outline

1. **The model**: we incorporate **house price risk and mortgages** into a standard incomplete market (**SIM**) **model**.
2. **Calibration**: **Empirically based estimations of house price risk for the U.S**.
3. **Model predictions**: Down payments, default, and ownership
4. **Self-insurance**: Earning and house price risk (Kaplan and Violante, AEJ 2010; Li and Yao, JMCB 2007)
5. Effects of **minimum down payment requirements** and **garnishment of defaulters' income** (Feldstein, 2008; GFSR 2011; MBA, 2011; etc.)

1. The model

- Three building blocks:

  1. **Standard incomplete market** model (Kaplan and Violante AEJ 2010) but with housing and mortgages

  2. **Housing and house-price risk** (Campbell and Cocco QJE 2003) but with endogenous debt levels and interest rates

  3. Defaultable debt, **endogenous debt levels** and interest rates (Chatterjee et al. Econometrica 2007) but debt is long-term, collateralized, and refinanceable

Housing

- As in Campbell and Cocco (QJE 2003):
  - The agent must live in a house.
  - There is a cost of buying a house ($\xi_B p_t$) and a cost of selling a house ($\xi_S p_t$)
  - The agent cannot own more than one house.
  - All houses deliver the same housing services and have the same price, p_t.
  - p_t evolves stochastically over time.
  - If the agent owns a house, he must live in the house he owns.

- The agent may rent. There is a constant renting cost (r), and a disutility from renting (θ).

Earning and house-price stochastic processes

$$log(p_{t+1}) = (1 - \rho_p)log(\bar{p}) + \rho_p log(p_t) + \nu_t$$

$$y_t = \exp(z_t + f(a) + \varepsilon_t),$$

$$z_t = \rho_z z_{t-1} + e_t,$$

- e_t and ν_t are jointly normally distributed with correlation $\rho_{e,\nu}$
- The agent lives up to T periods and works until age $W \leq T$.
- Social security schedule in Storesletten et al. (JME 2004) but as a function of z_W

Preferences

- Mortality risk

$$E_t\left[\sum_{s=0}^{T-t}\beta^s\zeta_{t,t+s}\left(\frac{C_{t+s}^{1-\gamma}}{1-\gamma}-I_{t+s}\theta\right)\right]$$

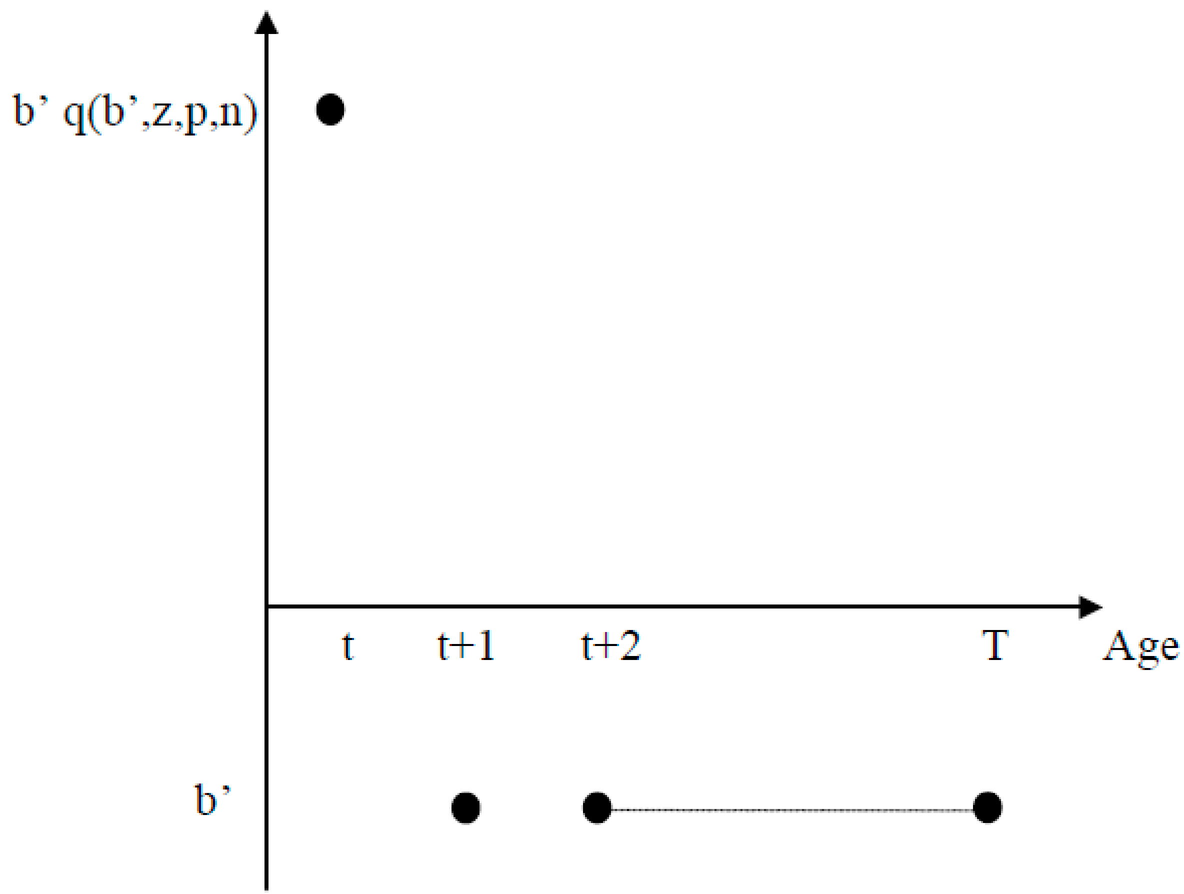
Mortgages (1)

- A homeowner can have **up to one mortgage**
- Mortgage loans are the **only loans** available to the agent who can borrow up to p_t
- A mortgage for an agent of age t is a promise to make **constant payments of** $b > 0$ **for next** $n = T - t$ **years**, or to **prepay** his debt by paying

$$\sum_{j=1}^{n} \left(\frac{b}{1+\bar{r}} \right)^{j}$$

- b **is chosen by the agent**

Mortgages (2)



Mortgages (3)

- A homeowner annuitizes his home equity.
  - If the homeowner dies, the financial intermediary who contracted with the homeowner receives the house, sells it, and cancels the mortgage.
- The agent may **refinance** (and thus adjust his equity position) by prepaying his current mortgage and taking a new one
- Equilibrium **interest rates**: Risk-neutral lenders make zero profits in expectation and have an opportunity cost of lending given by the interest rate $\bar{r}$.

Savings

- If the agent does not have a mortgage, he can save using one-period annuities.
- If the agent has a mortgage, he can only save by accumulating home equity.

Defaults

- If the agent chooses to default **he hands in his house** to his lender who sells it at $p_t(1 - \overline{\xi}_S)$, with $0 \leq \overline{\xi}_S \leq 1$.

- The agent **must rent in the period in which he defaults**.

Agent's decisions

- At the beginning of the period, an agent **observes the realization of his earning and house-price shocks**.
- **A renter** can become a homeowner or stay as a renter.
- **A homeowner with a mortgage** can (i) make his current-period mortgage payment; (ii) default; (iii) sell the house, prepay his mortgage, rent, and save; and (iv) prepay and change his financial position.
- **A homeowner without a mortgage** chooses whether (i) to stay on his house or (ii) sell his house, and then he chooses his next-period financial position.

2. Calibration

- All but three parameter values are taken from **previous estimations**.

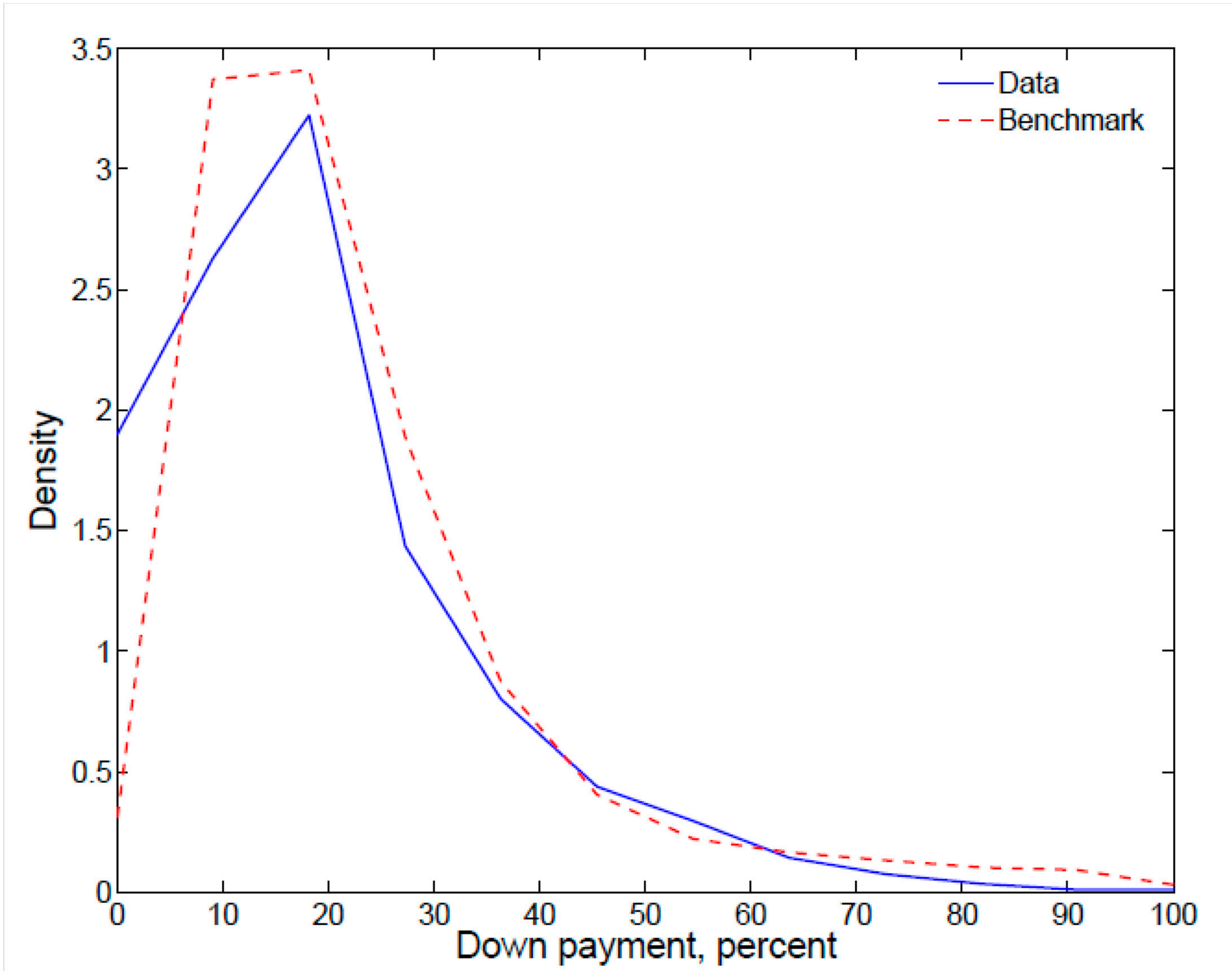
- We search over the **mean house price** $\bar{p}$, **discount factor** β, and **disutility cost of renting** θ.

- Criterion: Minimize distance to the **price/income ratio** of homeowners, the **median net-worth/income**, and the **home ownership rate**.

Targeted Moment

	Data SCF 2004	Model
Home ownership rate (%)	64.5	63.1
Mean Price-to-Income ratio	2.6	2.6
Median (net-worth / income)	1.4	1.4

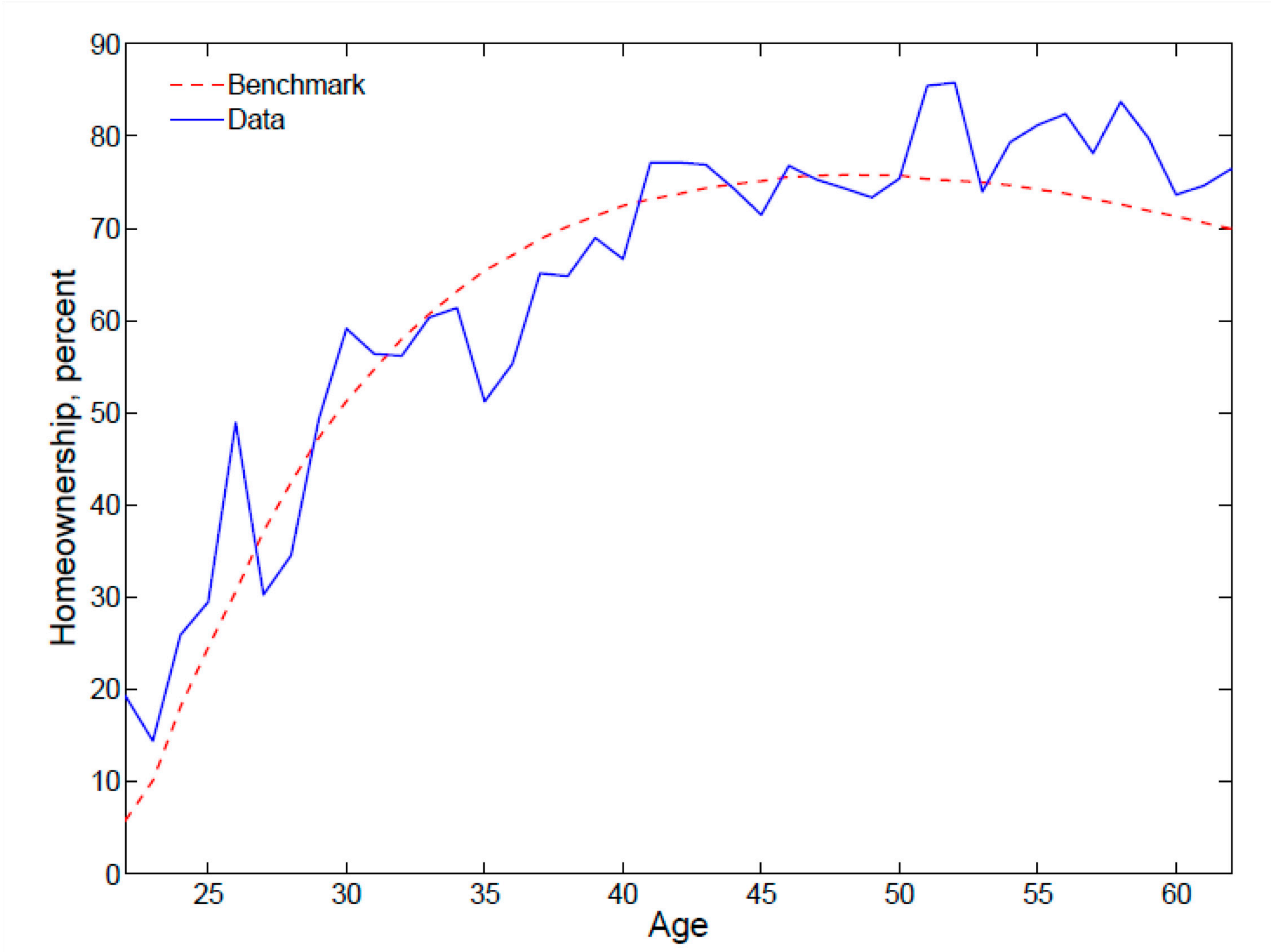
3. Down payment distribution (not targeted)



Default rate (not targeted)

- 0.6% in our simulations
- Jeske and Krueger (2010) target 0.5%

Home ownership over the life cycle (not targeted)



4. Self-insurance (not targeted)

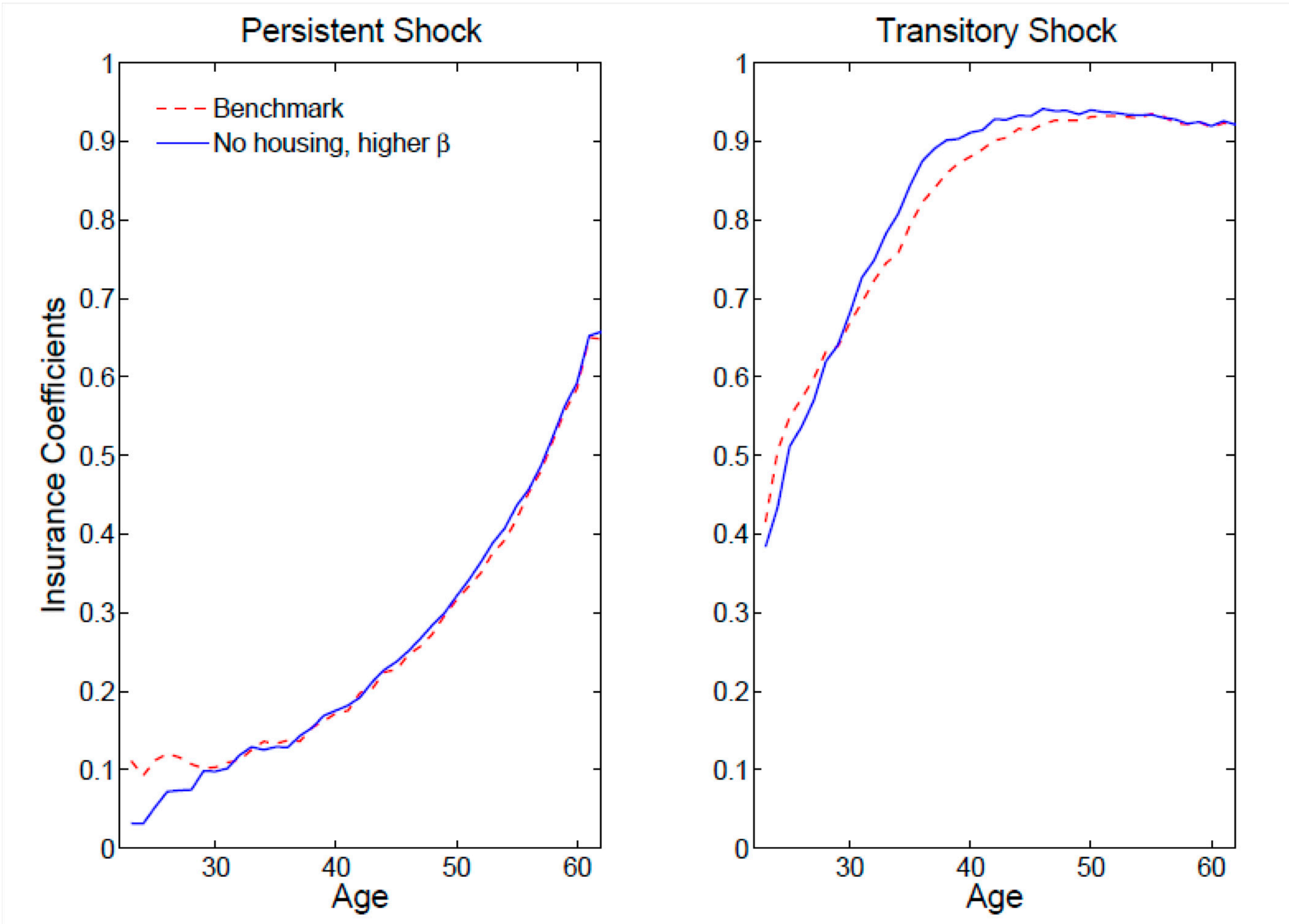
Share of the variance of shock x that does not translate into $C_{i,t}$ growth. Let μ^x denote the insurance coefficient for shock x at age t

$$\mu_t^x = 1 - \frac{cov(\Delta c_{it}, x_{it})}{var(x_{it})},$$

where $c_{it} = log(C_{i,t})$

Shock	Benchmark	No Housing	KV (AEJ 10)	Blundell et al. (AER 08)
Persistent shock	25.7	25.3	27.0, 30.0	36.0 (9.0)
Transitory shock	81.9	82.9	82.0, 93.0	95.0 (4.0)
House-price shock	98.4	na	na	na

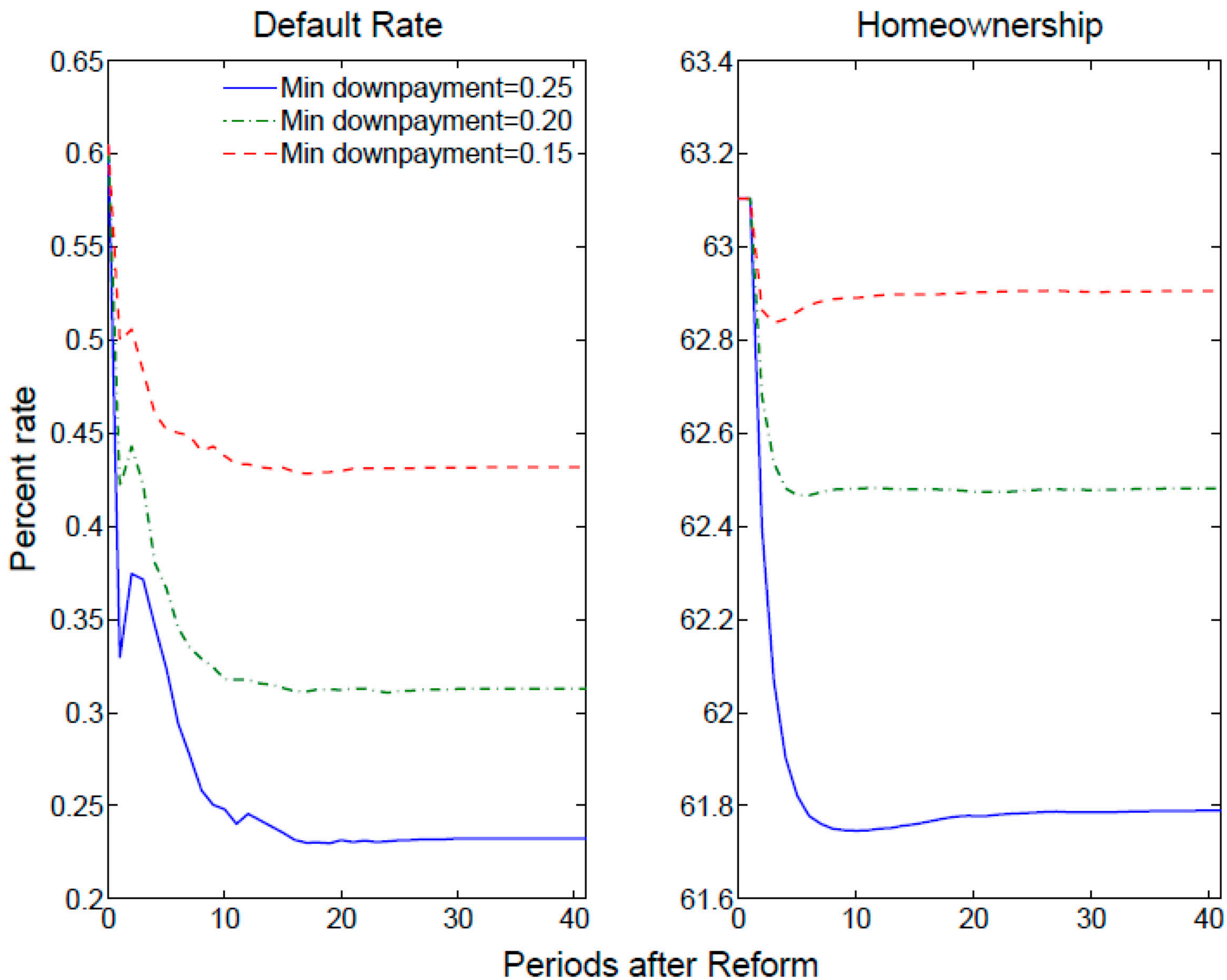
Higher coefficients for young agents



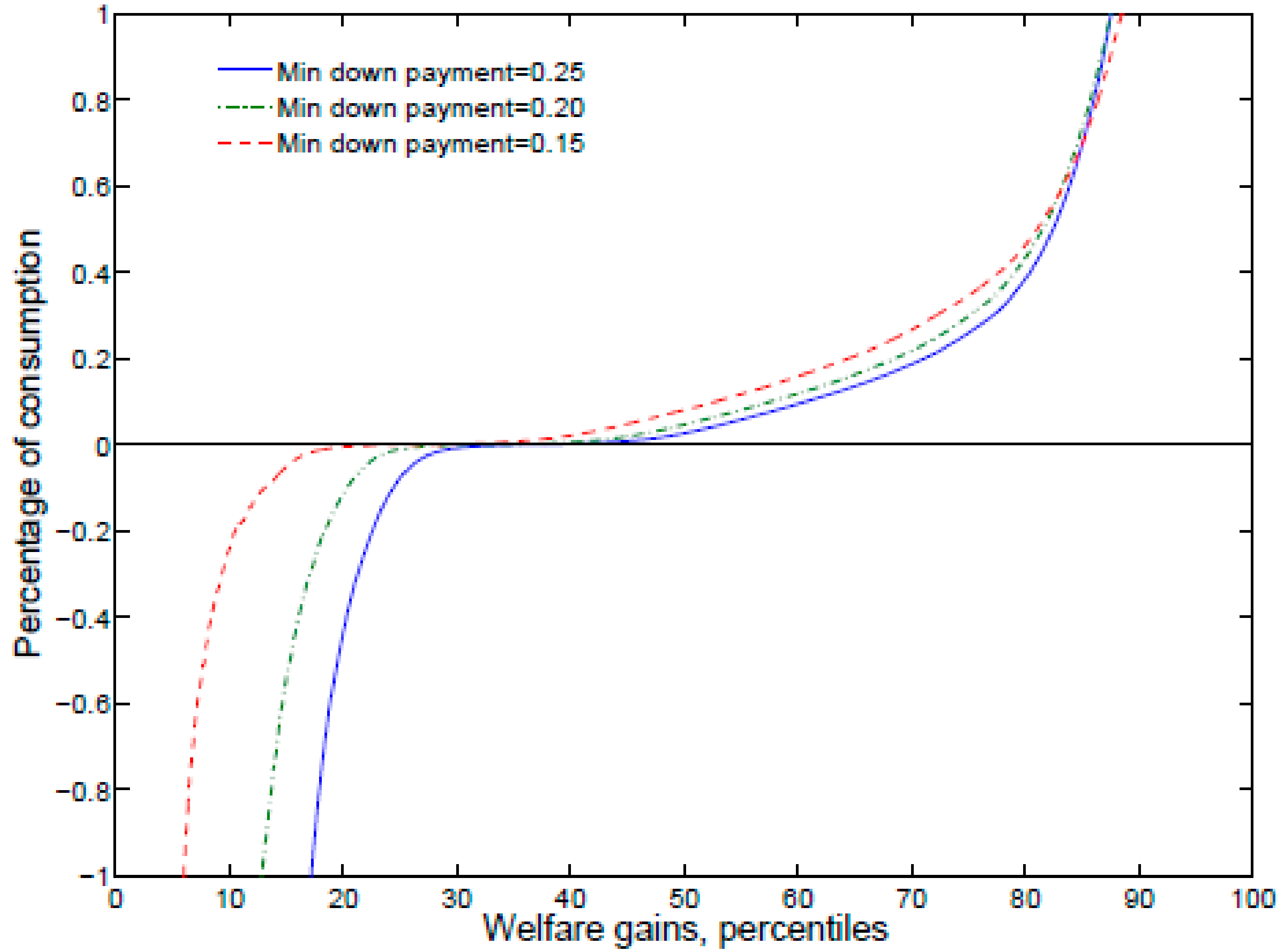
5. Minimum down-payment requirement

Down payment	Benchmark ($\geq$ 0%)	$\geq$ 15%	$\geq$ 20%	$\geq$ 25%
Default rate (%)	0.6	0.4	0.3	0.2
Home ownership (%)	63.1	62.9	62.5	61.8

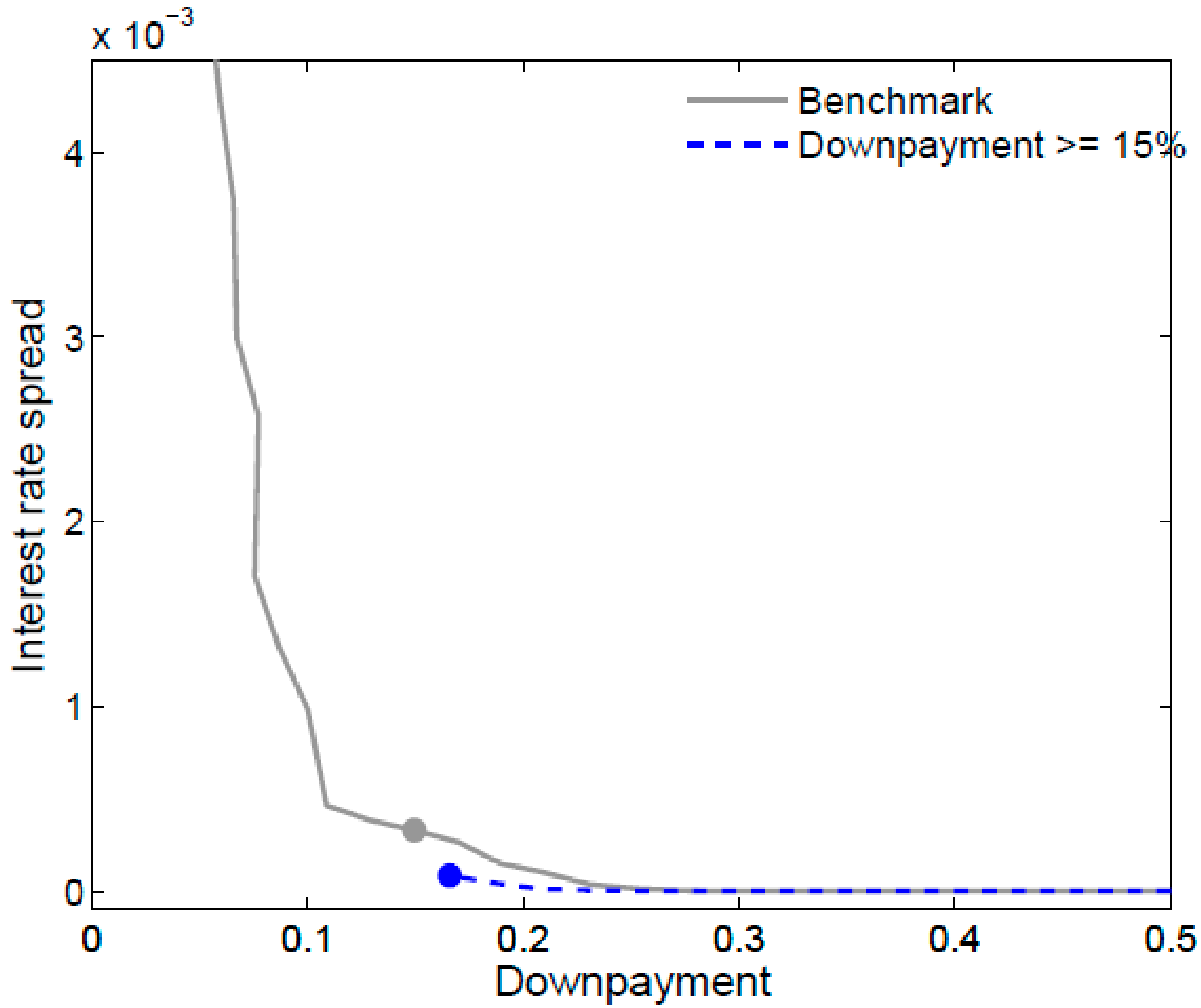
Figure 7: Transitions after the imposition of down payments requirements



Most home owners (most agents) benefit from requirements



Lower interest rates with requirements



Aggregate price adjustments

	Constant $\bar{p}$	Intermediate	Constant ownership
	Minimum down payment = 15%		
$\bar{p}$ decline, %	0.0	0.3	0.7
Home ownership, %	62.9	63.0	63.1
Default rate, %	0.4	0.4	0.4
Ex-ante welfare gain, %	-0.02	-0.02	-0.01
	Minimum down payment = 20%		
$\bar{p}$ decline, %	0.0	1.0	2.0
Home ownership, %	62.5	62.8	63.1
Default rate, %	0.3	0.3	0.3
Ex-ante welfare gain, %	-0.09	-0.06	-0.04

Garnishment of defaulter's income

- Garnishment for **one year** of all income **above a threshold** up to the amount owned to the lender

Safe income/median-cons.	All	100% ($\phi = 1.45$)	43% ($\phi = 0.63$)	17% ($\phi = 0.25$)
Default rate, %	0.6	0.6	0.4	0.1
Home ownership, %	63.1	63.7	67.4	69.8
Median down payment, %	19.0	16.8	9.0	6.6

Better borrowing opportunities with garnishment

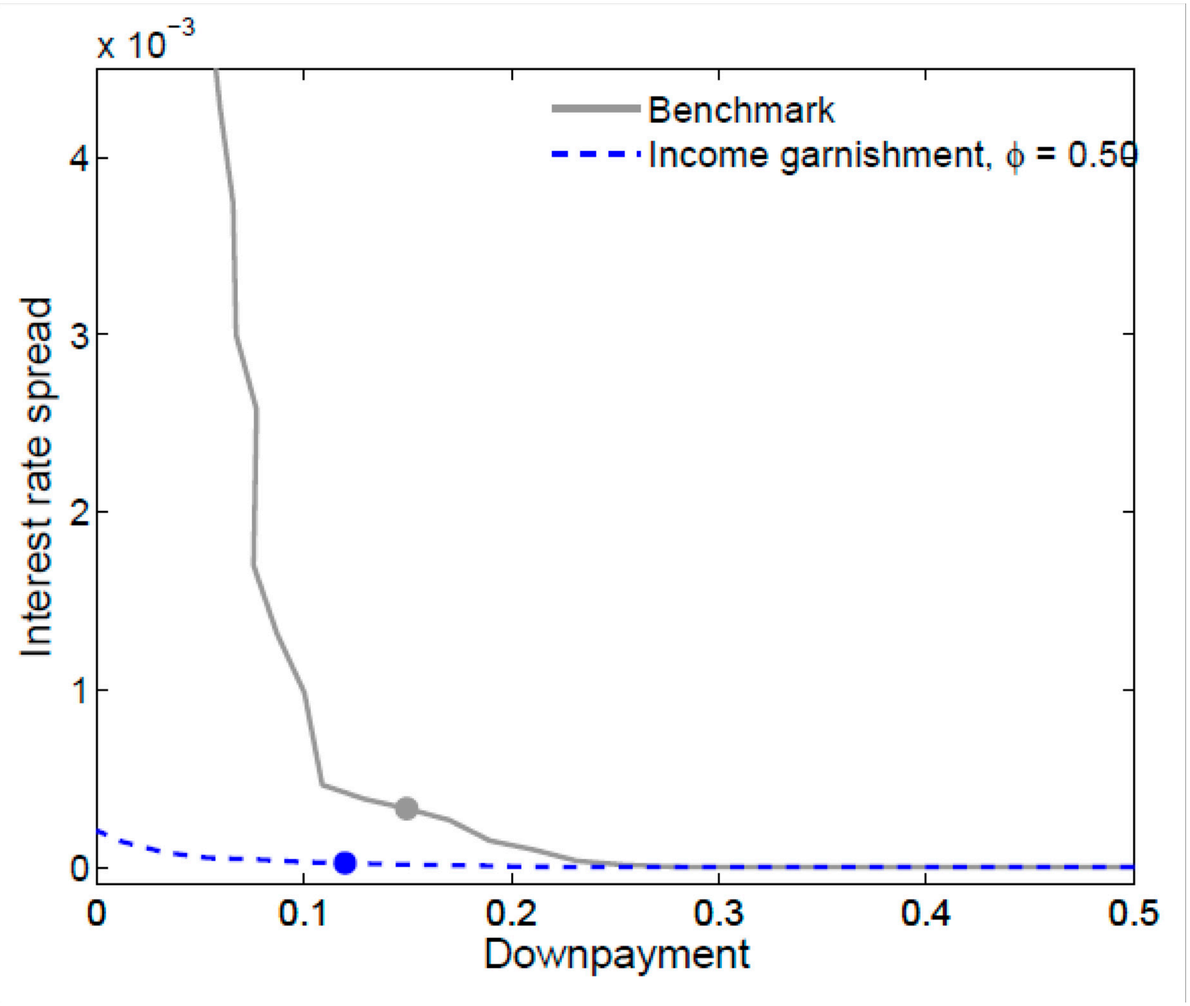
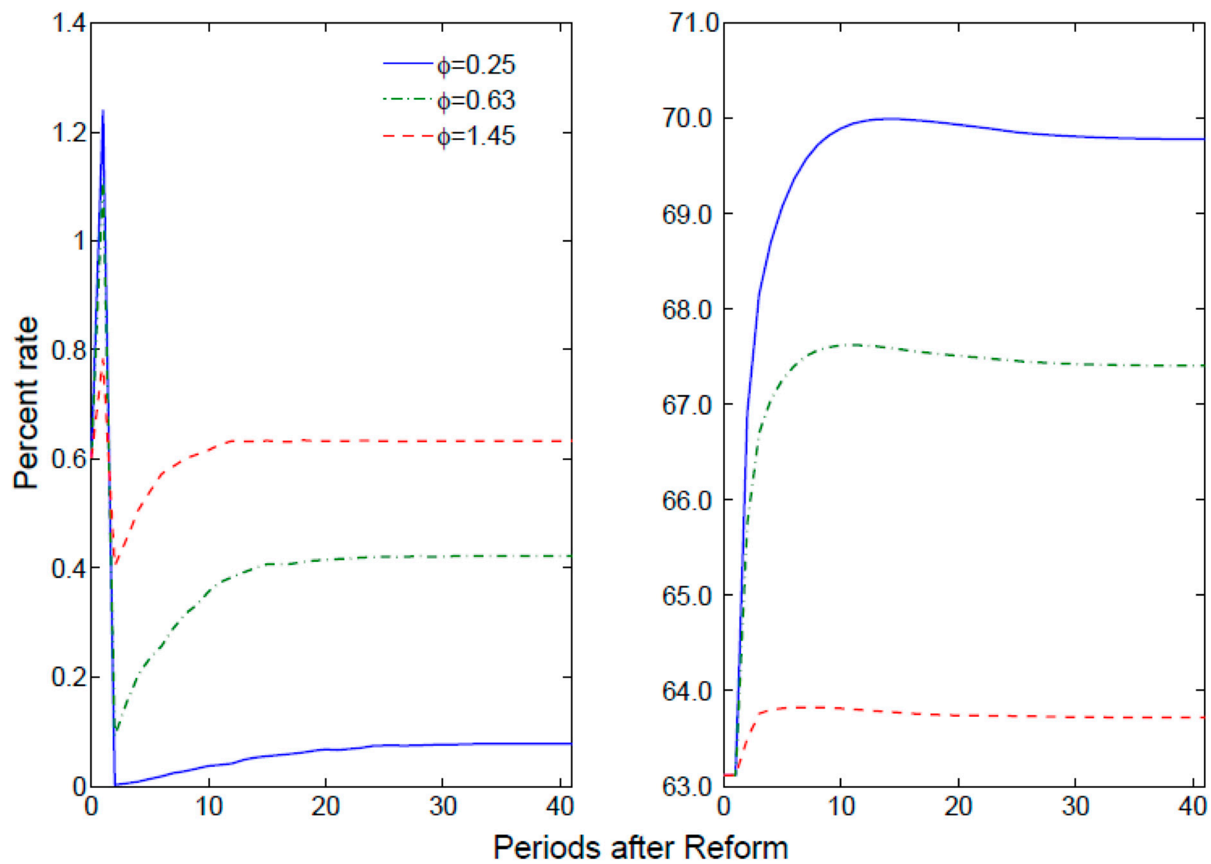
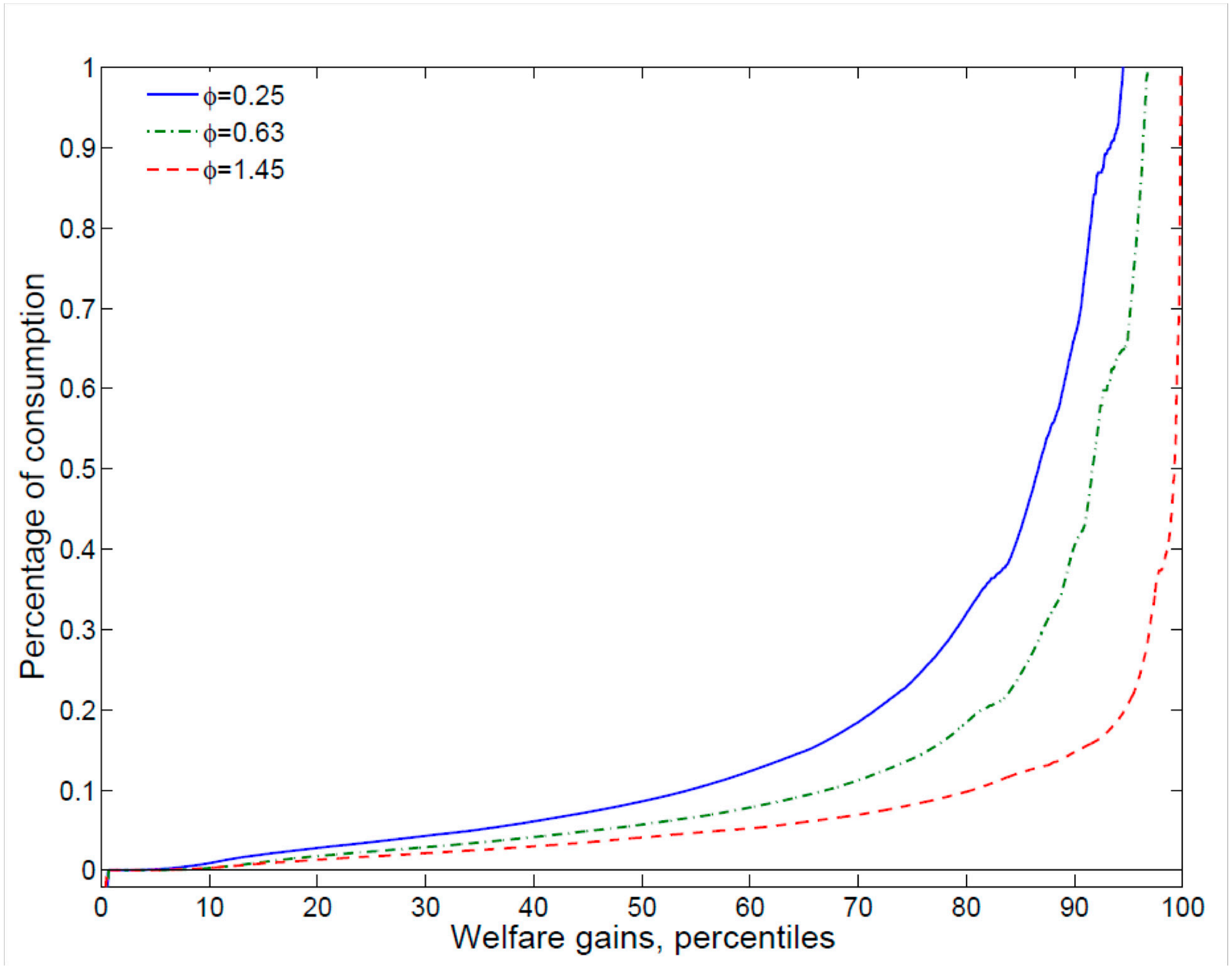


Figure 14: Transitions after the imposition of income garnishment



Almost all agents benefit



Aggregate price adjustments

	Constant $\bar{p}$	Intermediate	Constant ownership
	Safe income / median-cons = 43%		
$\bar{p}$ increase, %	0.0	9.4	15.8
Home ownership, %	67.4	65.0	63.1
Default rate, %	0.4	0.4	0.4
Ex-ante welfare gain, %	0.64	0.34	0.15
	Safe income / median-cons = 17%		
$\bar{p}$ increase, %	0.0	13.9	27.4
Home ownership, %	69.8	66.3	63.1
Default rate, %	0.1	0.1	0.1
Ex-ante welfare gain, %	0.85	0.41	0.04

Conclusions

- We proposed an extension of a SIM model incorporating **mortgages and empirically plausible house-price risk**
- We find that the model has **reasonable implications** (endogenous distribution of down payments, the mortgage default rate, the life-cycle profile of home ownership)
- Agents' ability to **self insure against income shocks** consistent with SIM model without housing but higher insurance coefficients for **young agents**
- The **response of consumption to house price shocks** is minimal.
- We shed light on the effect of **mortgage default prevention policies**

Table 1: Parameter values.

Parameter	Value	Definition	Basis
σ_ν^2	0.302	Variance of ν	Campbell and Cocco (2003)
$\rho_{\epsilon,\nu}$	0.115	Correlation ϵ and ν	Campbell and Cocco (2003)
ρ_p	0.970	Persistence in p	Nagaraja et al. (2009)
$f(a)$	–	Life-cycle component	Kaplan and Violante (2010)
σ_ε^2	0.0630	Variance of ε	Storesletten et al. (2004)
σ_ϵ^2	0.0166	Variance of ϵ	Storesletten et al. (2004)
ρ_z	0.990	Persistence in z	Storesletten et al. (2004)
ϕ	∞	Income not subject to garnishing	No garnishment
r	0	Rent	Positive consumption
$\overline{r}$	0.020	Risk-free rate	Kocherlakota and Pistaferri (2009)
b_0	0.250	Initial wealth	SCF
γ	2.000	Risk aversion	Standard RBC
ξ_B	0.025	Cost of buying, hhds	Gruber and Martin (2003)
ξ_S	0.070	Cost of selling, hhds	Gruber and Martin (2003)
$\overline{\xi}_S$	0.220	Cost of selling, bank	Pennington-Cross (2006)
θ	0.105	Renting disutility	Calibrated to match targets
$\overline{p}$	5.699	Mean price	Calibrated to match targets
β	0.945	Discount factor	Calibrated to match targets

Figure 3: Mortgages in default by tenure (in the simulations)

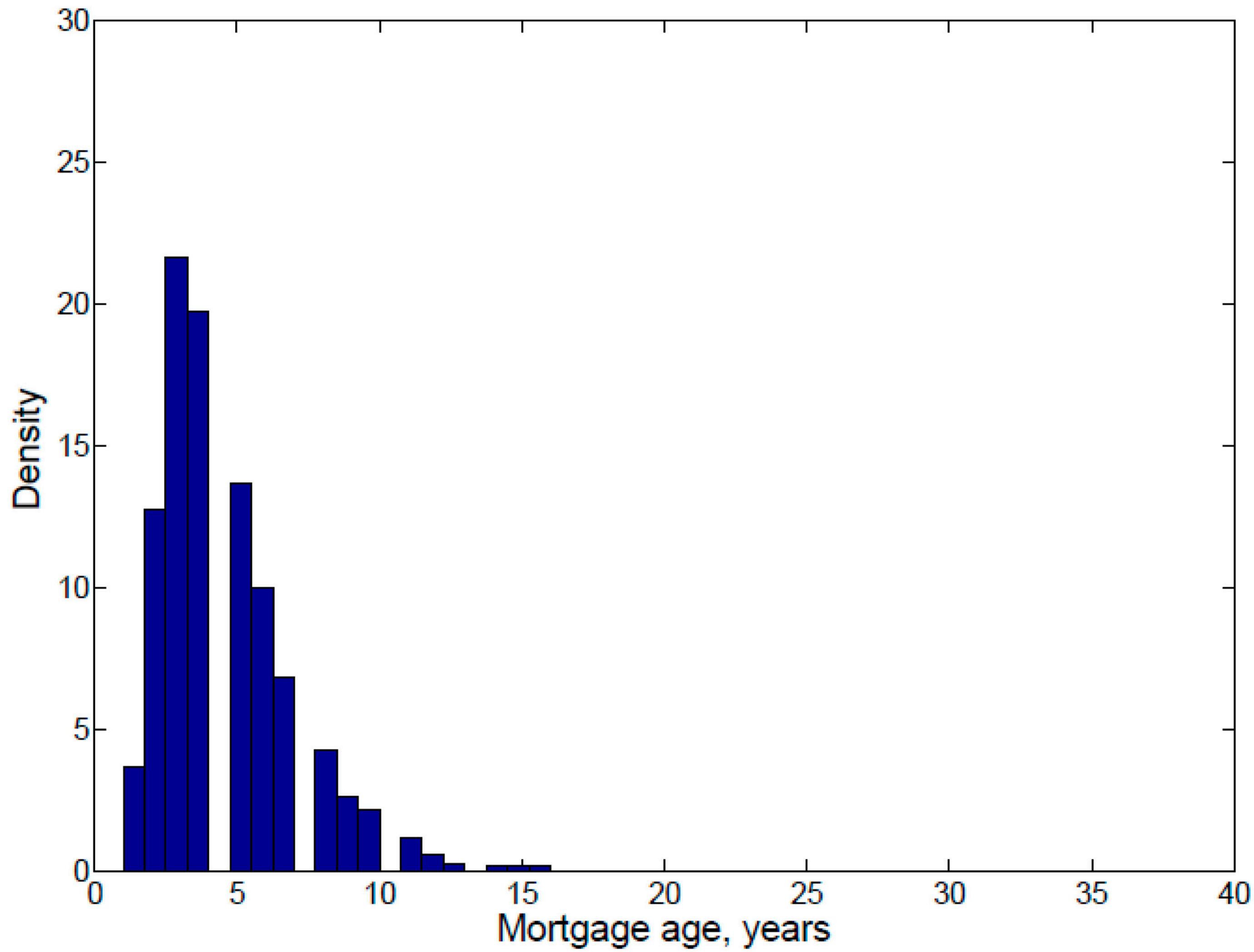


Figure 4: Mortgages not in default by tenure (in the simulations)

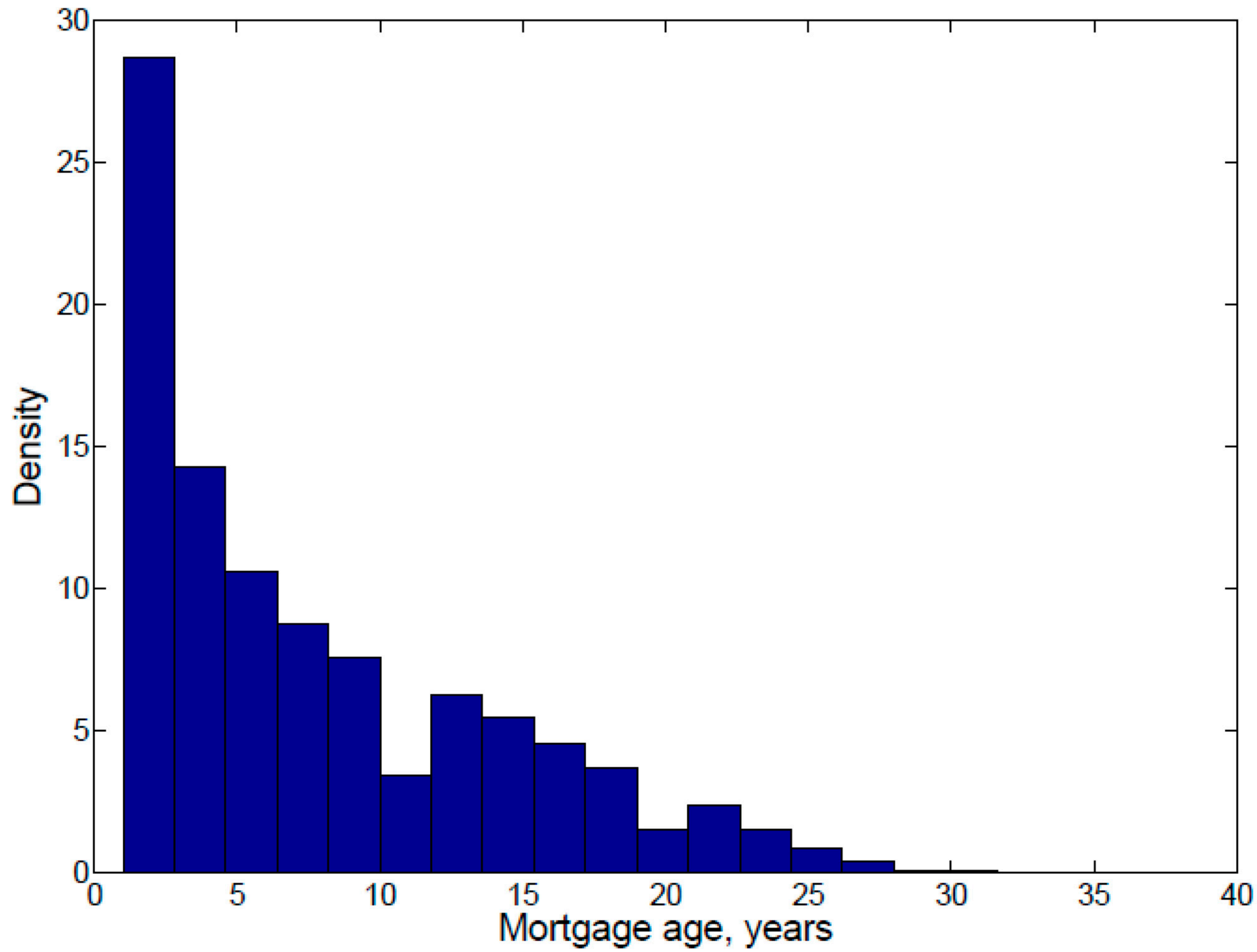
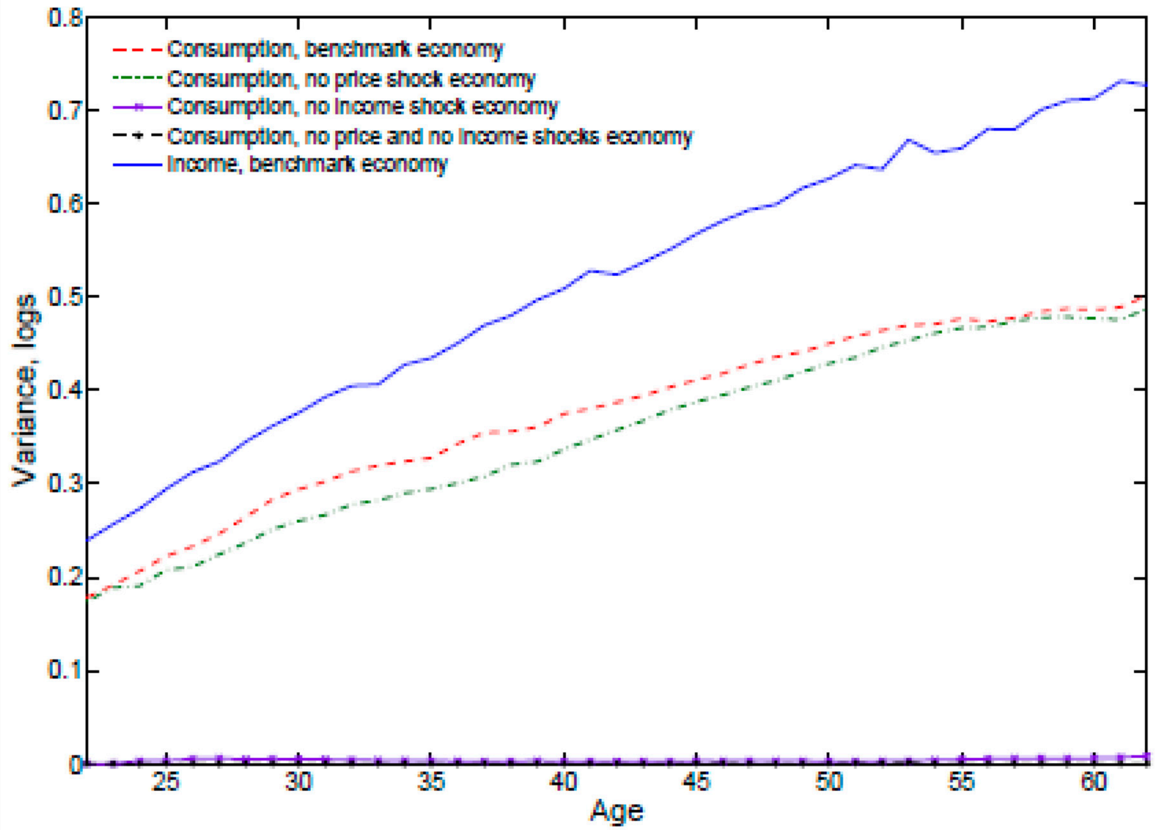


Figure 6: Inequality over the life cycle



Safe income / median-cons.	Benchmark	100%	43%	17%
Var(log C)	0.4	0.4	0.4	0.4
Persistent-income-shock insurance coefficient (%)	25.7	24.9	23.6	23.2
Transitory-income-shock insurance coefficient (%)	81.9	81.6	80.3	80.3
Price-shock insurance coefficient (%)	98.4	98.4	98.3	98.1

Figure 10: Equity distributions in the benchmark economy

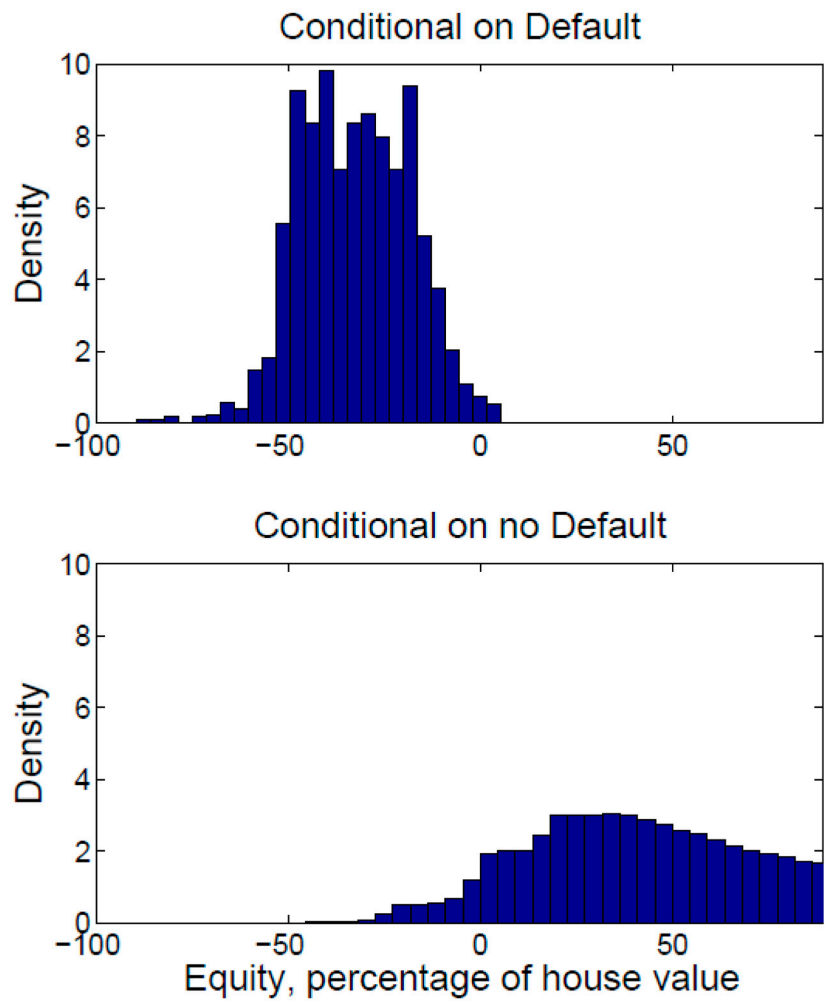


Figure 11: Income distributions in the benchmark economy

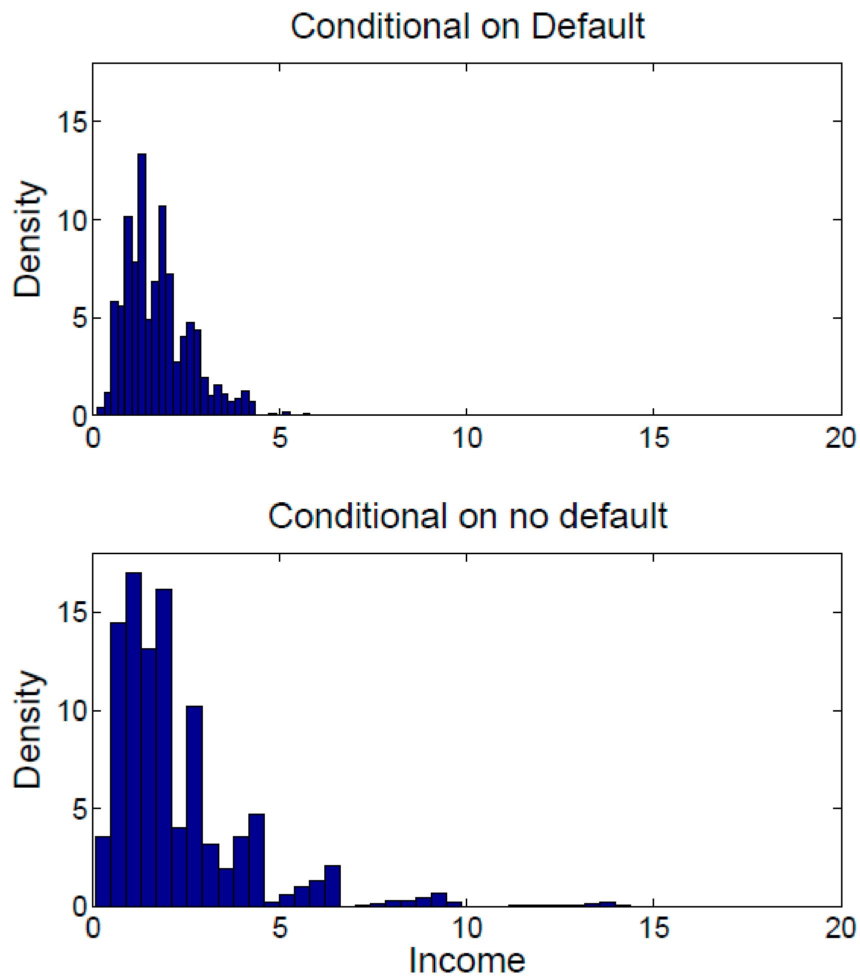
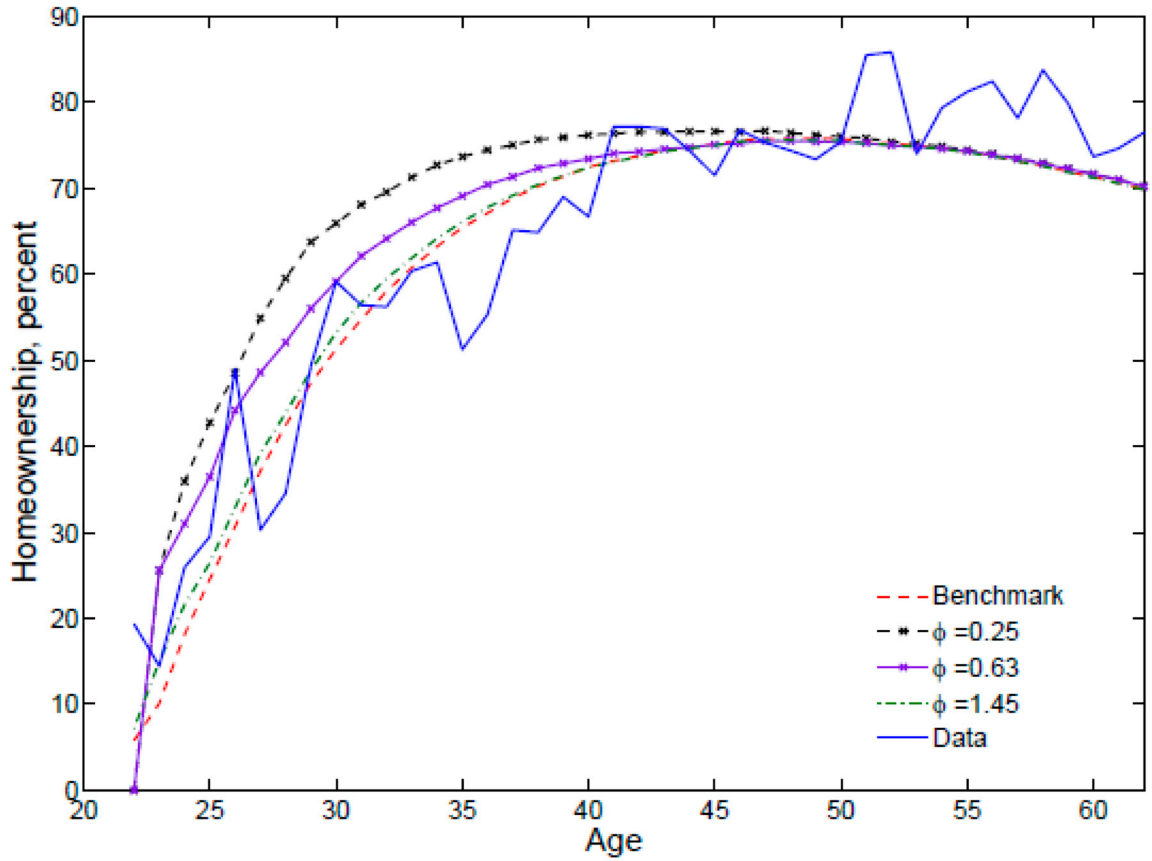


Figure 13: Home ownership over the life cycle, different garnishments



Mortgage prices

$$q(b',z,p,n) = \begin{cases} \frac{\chi_n(q_{\text{pay}}+q_{\text{prepay}}+q_{\text{default}})+(1-\chi_n)q_{\text{die}}}{1+\bar{r}} & \text{if } b' > 0 \\ \frac{\chi_n}{1+\bar{r}} & \text{if } b' \leq 0, \end{cases}$$

$$q_{\text{pay}} = \mathrm{E}\Big[I_{\text{pay}}(b',z',\varepsilon',p',n-1)(1+q(b',z',p',n-1))|z,p\Big],$$

$$q_{\text{prepay}} = \mathrm{E}\Big[I_{\text{prepay}}(b',z',\varepsilon',p',n-1)q^*(n-1)|z,p\Big],$$

$$q_{\text{default}} = E\left[\frac{I_{\text{default}}(b',z',\varepsilon',p',n-1)(p'(1-\bar{\xi}_S)+\pi(b',z',\varepsilon',p',n-1))}{b'}|z,p\right]$$

$$q_{\text{die}} = \mathrm{E}\left[\frac{min\{q^*(n-1)b',p'(1-\xi_S)\}}{b'}|p\right].$$

$$q^*(n) = \sum_{j=1}^{n}\left(\frac{1}{1+\bar{r}}\right)^j, \text{ if } b > 0$$

Renter's problem

$$R(b,z,\varepsilon,p,n) = \max\{G(\bullet),B(\bullet)\}$$

$$G(b,z,\varepsilon,p,n) = \max_{b'\leq 0}\left\{u\left(y-b+\frac{\chi_n}{1+\bar{r}}b'-r\right)-\theta\right.$$
$$\left.+\beta\chi_n \mathrm{E}[R(b'',\varepsilon',p',n-1)|z,p]\right\}$$

$$B(b,z,\varepsilon,p,n) = \max_{b'}\{u(y-b+b'q(b',z,p,n)-(1+\xi_B)p+\epsilon(b',p,n))$$
$$+\beta\chi_n \mathrm{E}[H(b',z',\varepsilon',p',n-1)|z,p]\}$$
$$s.t.$$
$$b'q(b',z,p,n) \leq p$$

Homeowner's problem (1)

$$H(b,z,\varepsilon,p,n) = \begin{cases} \max\{P(\cdot),D(\cdot),S(\cdot),F(\cdot)\} \text{if } b > 0 \\ \max\{M(\cdot),S(\cdot)\} \text{ otherwise.} \end{cases}$$

$$P(b,z,\varepsilon,p,n) = u(y-b+\epsilon(b,p,n)) + \beta\chi_n \mathrm{E}[H(b,z',\varepsilon',p',n-1)|z,p]$$

$$\epsilon(b',p,n) = \max\left\{0, \frac{1-\chi_n}{1+\bar{r}}[\mathrm{E}[p'|p](1-\xi_S) - q^*(n-1)\max\{b',0\}]\right\}$$

$$D(b,z,\varepsilon,p,n) = u(y-\pi(b,z,\varepsilon,p,n)-r) - \theta + \beta\chi_n \mathrm{E}[R(0,z',\varepsilon',p',n-1)|z,p]$$

$$\pi(b,y,p,n) = \min\{\max\{y-\phi,0\},q^*(n)b-p\}.$$

Homeowner's problem (2)

$$S(b,z,\varepsilon,p,n) = \max_{b'\leq 0}\left\{u\left(y - q^*(n)b + p(1-\xi_S) - r + \frac{\chi_n b'}{1+\bar{r}}\right) - \theta\right.$$
$$\left. + \beta\chi_n \mathrm{E}[R(b',z',\varepsilon',p',n-1)|z,p]\right\}$$

$$F(b,z,\varepsilon,p,n) = \max_{b'}\{u(y - q^*(n)b + q(b',z,p,n)b' + \epsilon(b',p,n))$$
$$+\beta\chi_n \mathrm{E}[H(b'',\varepsilon',p',n-1)|z,p]\}$$
$$s.t.$$
$$b'q(b',z,p,n) \leq p$$

$$M(b,z,\varepsilon,p,n) = \max_{b'}\{u(y - b + q(b',z,p,n)b' + \epsilon(b',p,n))$$
$$+\beta\chi_n \mathrm{E}[H(b'',\varepsilon',p',n-1)|z,p]\}$$
$$s.t.$$
$$b'q(b',z,p,n) \leq p$$