Housing and Tax-deferred Retirement Accounts

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Introduction I

- Assets in tax-deferred accounts (TDA) and housing wealth are two major assets in household portfolio
- Common types of TDA in the US: defined contribution (DC) pension plans (401(k), 403(b), 457) and Individual Retirement Accounts (IRA)
- Over 50% of US households have TDA
  Assets in TDA: \$8.6T (\$11.9T) in 2007 (2013)
- Home ownership in the US: 68% (65%) in 2007 (2013)
- Housing is the single most important asset for a typical household
  Guiso, Jappelli, and Haliassos (2001), Sinai and Souleles (2007)

Introduction II

- TDA in the US
  - Contributions to TDA are deductible from taxable income
  - Capital income for assets in TDA is tax exempted
  - Subsequent asset withdrawals are taxed as ordinary income
- Liquidity risk: Early withdrawal of TDA assets receives a 10% penalty
- Does TDA wealth represent new savings?

  Gale and Scholz (1994); Poterba, Venti, and Wise (1995); Imrohoroglu, Imrohoroglu, and Joines (1998); Laibson, Repetto, Tobacman (1998); Kitao (2010); Nishiyama (2011)
- Portfolio choice in presence of TDA

  Amromin (2003); Dammon, Spatt, and Zhang (2004); Zhou (2009)

Introduction III

- Preferential tax treatments on home ownership:
  - Mortgage interest and property tax are income tax deductible in the US
  - Costs of housing service for homeowners lower than rental costs
  - Untaxed capital gains (up to a limit) from housing
  - Untaxed service flow from owners-occupied housing
- Down payment requirement and high transaction costs
- Literature on preferential tax treatment of housing, interactions between housing and non-housing consumption, housing and B.C.

  Gervais (2002); Li and Yao (2007); Yang (2009); Chen (2010); Iacoviello and Pavan (2013); Halket and Vasudev (2014)

  Impact of housing on asset allocation:

  Cocco (2005); Yao and Zhang (2005); Becker and Shabani (2010); Chetty and Szeidl (2014)

Introduction IV

- TDA and home ownership share similarities in terms of favorable tax treatments and liquidity risk
- Interactions between housing tenure choice and households' use of TDA? Joint decisions.
  - Holdings in TDA remained low (Munnell (2012), Poterba (2014))
  - Home ownership may affect HHs' use of TDA due to down payment requirement and committed mortgage payments
  - TDA may affect HH mortgage and home ownership
- Existing literature treats these assets separately
- Research on TDA *with* housing is about tax arbitrage:

  Mortgage prepayment vs. TDA contribution

  Amromin, Huang, and Sialm (2007)

  Asset allocation (fixed TDA contribution & maximum mortgage)

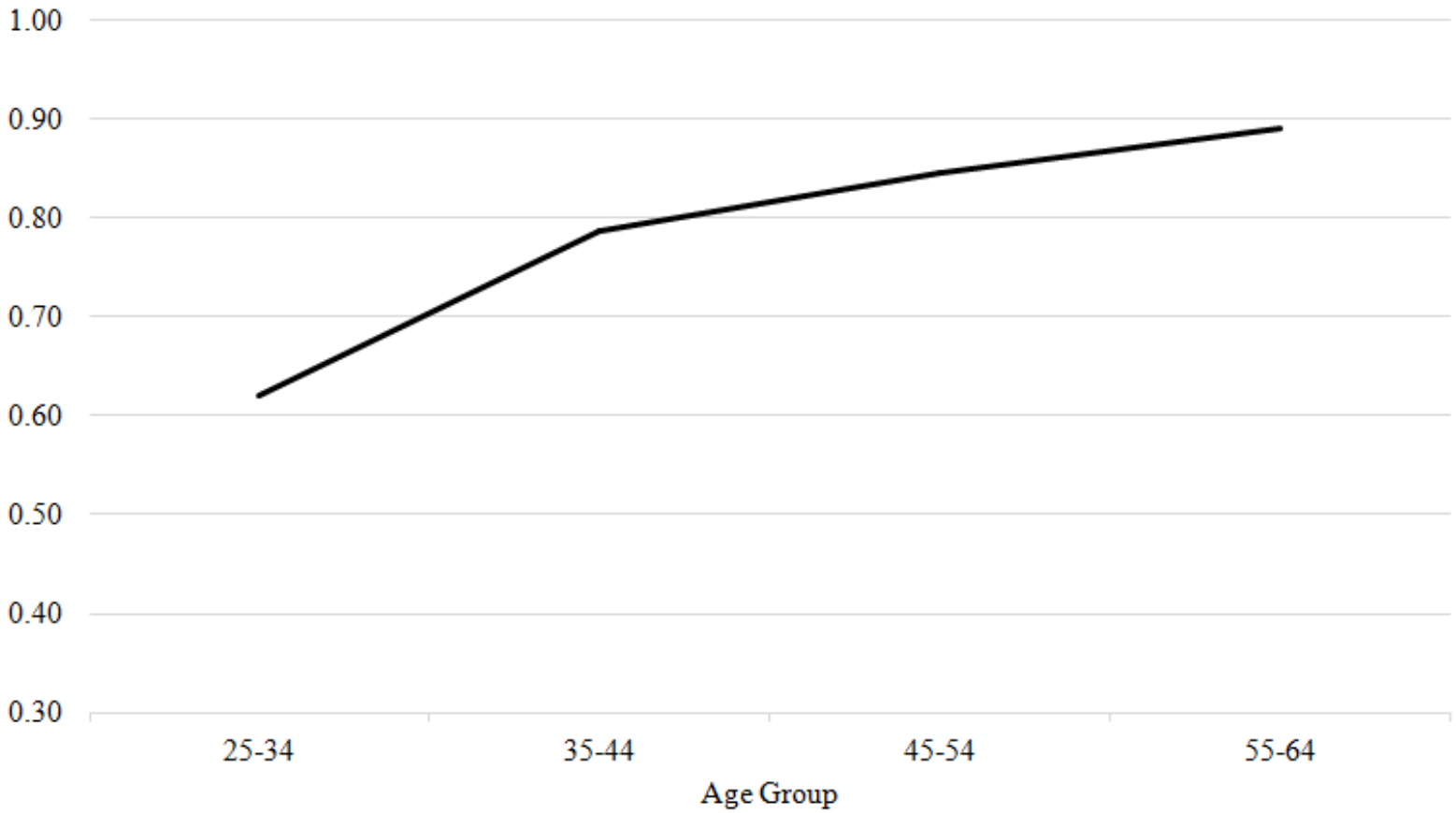
  Marekwica, Schaefer, and Sebastian (2013)

What We Do

- Survey of Consumer Finance (SCF) data:
  - Focus on households with TDA
  - Document patterns of cross-sectional variation in net worth composition regarding home equity, TDA wealth and TA wealth
- Model:
  - Study the joint decisions of housing tenure choice and households' use of TDA
  - Evaluate household behavior in the counterfactual experiments (TDA-related policies and housing-related factors)

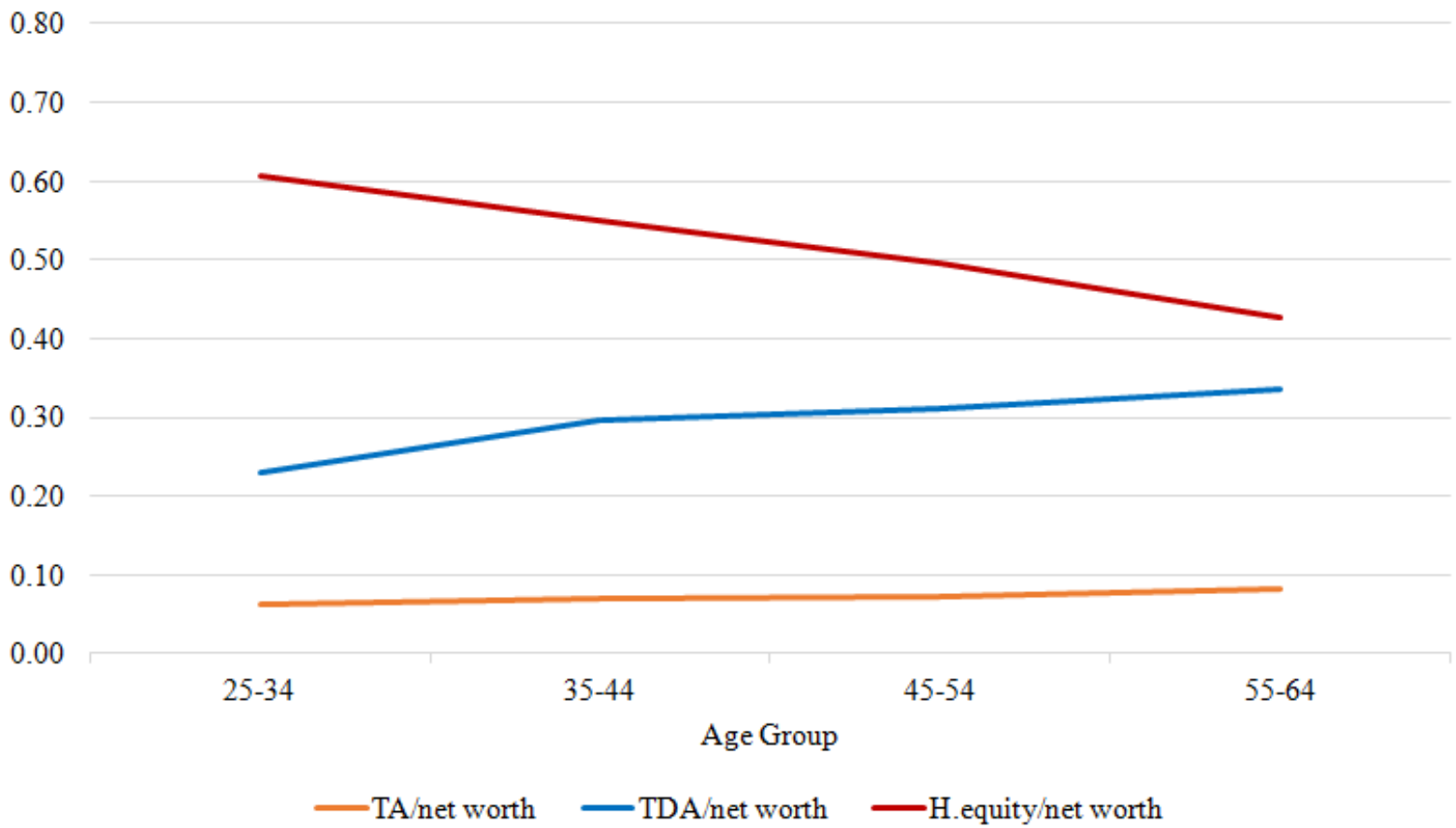
Stylized Facts I

Figure: Home ownership for DC participants: average in 2001–2007 SCF



Stylized Facts II

Figure: Net worth composition for homeowners: DC participants



Main Findings

- Benchmark model matches well with the life-cycle patterns of home ownership rate and homeowners' net worth composition
- TDA promotes home ownership (i.e., households borrow earlier and pay lower down payments) and household debt (mortgages)
- An increase in min. down payment ratio has a large impact on young households (home ownership $\downarrow$ and TA share $\uparrow$), but little impact on older households
- When mortgage interest payments and property taxes are not income tax deductible, home ownership drops significantly, while households do not increase their use of TDA.
- Eliminating social security system increases home ownership, but decreases the importance of home equity and TDA in net worth composition

Model: Key Features

- Discrete time life-cycle model
- Aggregate and idiosyncratic income shocks
- Long-term mortgage arrangement (no mortgage default and refinancing)
- Households have access to both TA and TDA
- Social security system and progressive income tax system that mimics the U.S. tax codes
- Households make decisions on:
  (1) TDA and TA savings, (2) housing tenure choice, (3) house size, (4) down payment, and (5) consumption

Preferences

- Stochastic lifetime and at most live for J periods
- Households' preferences are represented by

$$E_1 \sum_{j=1}^{J} \beta^{j-1} \left\{ \Pi_{t=1}^{j} s_t \frac{(c_j^{1-\omega} h_j^{\omega})^{1-\gamma}}{1-\gamma} + (1 - \Pi_{t=1}^{j} s_t) \frac{(W_j)^{1-\gamma}}{1-\gamma} \right\} \quad (1)$$

$0 < \beta < 1$: the discount factor
γ: the relative risk aversion
s_t: conditional survival probability in period t
ω: preference for housing
W_j: the estate when a household dies in period j

Income Process I

- Households supply labor inelastically to work in first R periods of life
- Household i at age j receives stochastic labor income Y_{ij} such that

$$\ln(Y_{ij}) = y_{ij} = f_{ij} + \eta_j + \varepsilon_{ij} \tag{2}$$

f_{ij}: the deterministic hump-shape age earnings profile
η_j: aggregate shock among all households
ε_{ij}: idiosyncratic persistent shock

- Both η_j and ε_{ij} follow AR(1) processes

$$\eta_{j+1} = \rho_\eta \eta_j + \xi^\eta_{j+1}, \text{ with i.i.d. } \xi^\eta_j \sim N(0, \sigma^2_\eta) \tag{3}$$

$$\varepsilon_{ij+1} = \rho_\varepsilon \varepsilon_{ij} + \xi^\varepsilon_{j+1}, \text{ with i.i.d. } \xi^\varepsilon_j \sim N(0, \sigma^2_\varepsilon) \tag{4}$$

- Aggregate shock and idiosyncratic shock are uncorrelated

Income Process II

- After R working periods, households retire and receive retirement income
- Retirement income is modeled as

$$y_{ij} = log(\lambda) + f_{iR} + \varepsilon_{iR} \tag{5}$$

where λ is a constant fraction

Housing I

- Size of housing services: $H = \{H_1, H_2, H_3, H_4, H_5\}$
- P_j is the price per unit of housing in terms of consumption goods Hence, the value of a house of size h is $P_j h$ in period j
- Let $p_j = log(P_j)$, and $\tilde{p}_j = p_j - g(j-1)$ be the detrended log price of housing
- We assume aggregate labor income shocks and housing price shocks are perfectly correlated (Cocco 2005)

Housing II

- Housing services can be obtained by owning ($DR = 0$) or renting ($DR = 1$)
- For $j \leq R$, households can choose to be a renter or an owner
- For $j > R$, homeowners decide whether to stay in the same house, downsize to own a smaller house, or become a renter. Renters can only rent and choose the size of the rental property

- Differences in house size for rental and owner-occupied housing
- Generally rental housing are smaller units (Gervais 2002)

$$h_j = \begin{cases} \in \{H_1, H_2, H_3\} & \text{if } DR = 1 \\ \in \{H_2, H_3, H_4, H_5\} & \text{if } DR = 0 \end{cases} \tag{6}$$

Housing III

- Renters pay ϕ of the house value as rental cost per period
- Buying a house requires a N-period mortgage loan with fixed mortgage interest rate r_m
- Require θ^D fraction of the house value as down payment

$$\theta^D = \begin{cases} \in \{0.1, 0.2, 0.5, 0.75, 1.0\} & \text{if } j \leq R \\ = 1 & \text{if } j > R \end{cases} \tag{7}$$

Housing IV

- The initial loan principle (L) is given by

$$L = \begin{cases} (1-\theta^D)e^{g(n-1)+\tilde{p}_n}h & \text{if } n \in [1,R] \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

where n is the period in which a household buys a house

- The mortgage payment is defined as

$$M_j = \begin{cases} \frac{r_m L(1+r_m)^N}{(1+r_m)^N-1} & \text{if } n \in [1,R] \text{ and } n \leq j \leq (n+N-1) \\ 0 & \text{otherwise} \end{cases} \tag{9}$$

Housing V

- The principle payment (E) in period j is

$$E_j = \begin{cases} \frac{r_m L(1+r_m)^{j-n}}{(1+r_m)^N - 1} & \text{if } n \in [1, R] \text{ and } n \leq j \leq (n+N-1) \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

- The interest payment (I) in period j is

$$I_j = \begin{cases} \frac{r_m L\left[(1+r_m)^N - (1+r_m)^{j-n}\right]}{(1+r_m)^N - 1} & \text{if } n \in [1, R] \text{ and } n \leq j \leq (n+N-1) \\ 0 & \text{otherwise} \end{cases} \tag{11}$$

- The remaining loan principle (LL) is

$$LL_j = \begin{cases} \frac{L\left[(1+r_m)^N - (1+r_m)^{j-n+1}\right]}{(1+r_m)^N - 1} & \text{if } n \in [1, R] \text{ and } n \leq j \leq (n+N-1) \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

Housing VI

- Annual maintenance costs is δ of the house value
- Property tax rate is τ
- Transaction cost of buying a house is θ^B fraction of the house value
- Transaction cost of selling a house is θ^S fraction of the house value
- The household expenditure on housing (x_j) is given by

$$x_j = \begin{cases} \phi P_j h & \text{if } DR_{j-1} = DR_j = 1 \\ \phi P_j h_j + LL_{j-1} - (1-\theta^S) P_j h_{j-1} & \text{if } DR_{j-1} = 0 \text{ and } DR_j = 1 \\ M_j + \left(\theta^B + \theta^D + \tau + \delta\right) P_j h_j & \text{if } DR_{j-1} = 1 \text{ and } DR_j = 0 \\ M_j + (\tau + \delta) P_j h_j & \text{if } DR_{j-1} = DR_j = 0 \text{ and } h_j = h_{j-1} \\ M_j + \left(\theta^B + \theta^D + \tau + \delta\right) P_j h_j & \text{if } DR_{j-1} = DR_j = 0 \text{ and } h_j \neq h_{j-1} \\ \quad + LL_{j-1} - (1-\theta^S) P_j h_{j-1} & \end{cases} \tag{13}$$

Tax-deferred Account (TDA) I

- For age $j \leq R$, households can contribute their pre-tax labor income to TDA, up to $\bar{q} = 8\%$ of labor income
- Assets in TDA can be withdrawn prior to retirement age at the cost of a penalty rate $pen = 10\%$ in addition to the ordinary income tax incurred
- For age $j > R$, household decides the amount withdrawn from TDA
- Pays tax on the withdrawals at the ordinary income tax rate
- q_j is a household's contributions to (withdrawal from) TDA

$$q_j \begin{cases} \in \left[-a_j^D, \bar{q} * Y_j\right] & \text{if } j \leq R \\ \in \left[-a_j^D, 0\right] & \text{if } j \geq R+1 \text{ and } j \leq R+6 \\ \in \left[-a_j^D, -\frac{1}{J-j+1} a_j^D\right] & \text{if } j > R+6 \end{cases} \tag{14}$$

where a_j^D is the amount of assets in TDA

Tax-deferred Account (TDA) II

- Employers match 33.3% of employee's contribution
- Only applies up to 6% of an employee's labor income
- The employer's contribution (q_j^E) is

$$q_j^E = \begin{cases} \min(0.333 * q_j, 0.333 * 0.06 * Y_j) & \text{if } j \in [1, R] \text{ and } q_j > 0 \\ 0 & \text{otherwise} \end{cases} \tag{15}$$

- Assets earn a constant rate of return, r, in both TDA and TA. The law of motion of assets in TDA is

$$a_{j+1}^D = \begin{cases} (1+r)(a_j^D + q_j + q_j^E) & \text{if } j \leq R \\ (1+r)(a_j^D + q_j) & \text{if } j > R \end{cases} \tag{16}$$

Taxable Account (TA)

- a_j^T is the financial wealth in the TA plus current labor income. The law of motion of assets in the TA is

$$a_{j+1}^T = (1+r)\left[a_j^T - c_j - x_j - q_j - \Gamma_j\right] + Y_{j+1} \tag{17}$$

- Both TDA and TA are subject to zero borrowing constraint

$$a_j^T \geq Y_j \text{ and } a_j^D \geq 0 \text{ for all } j \tag{18}$$

- Households are randomly endowed with initial wealth a_0^T when they are born
- The bequest left by a household is

$$W_j = \begin{cases} a_j^T + a_j^D + (1-\theta^S) P_j h_{j-1} - LL_{j-1} & \text{if } DR_{j-1} = 0 \\ a_j^T + a_j^D & \text{if } DR_{j-1} = 1 \end{cases} \tag{19}$$

Taxes I

- Income is taxed through a piece-wise linear progressive tax system
- Adjusted gross income (AGI) is defined as

$$AGI_j = \begin{cases} r\left(\frac{a_j^T - Y_j}{1+r}\right) + Y_j - q_j - I_j - \tau P_j h & \text{if } DR_j = 0 \\ r\left(\frac{a_j^T - Y_j}{1+r}\right) + Y_j - q_j & \text{if } DR_j = 1 \end{cases} \tag{20}$$

- $IC = \{IC_1, IC_2, IC_3, IC_4, IC_5\}$ is the cutoff points of the tax brackets
- $\tau_1, \tau_2, \tau_3, \tau_4$, and τ_5 denote corresponding marginal tax rates
- Suppose $AGI_j \in (IC_3, IC_4]$, then
  $T(AGI_j) = \tau_1 (IC_2 - IC_1) + \tau_2 (IC_3 - IC_2) + \tau_3 (AGI_j - IC_3)$

Taxes II

- τ_{ss} is the payroll tax rate and Y_{ss} be the earnings limit up to which earnings are subject to payroll tax
- For households who withdraw funds from TDA before age $R-4$, the penalty payment incurred is also included in the tax payments

- The total tax liability of a household is defined as

$$\Gamma_j = \begin{cases} T(AGI_j) + \min(\tau_{ss} * Y_j, \tau_{ss} * Y_{ss}) - pen * q_j & \text{if } q_j < 0 \text{ and } j < (R-4) \\ T(AGI_j) + \min(\tau_{ss} * Y_j, \tau_{ss} * Y_{ss}) & \text{otherwise} \end{cases} \tag{21}$$

Household Problem

A household's decision problem in recursive form is written as

$$
\begin{aligned}
& V(j, \eta_j, \varepsilon_j, a_j^T, a_j^D, DR_{j-1}, h_{j-1}, n, \tilde{p}_n, \theta_n^D) \\
= & \max_{c_j, q_j, DR_j, h_j, \theta_n^D} \frac{\left(c_j^{1-\omega} h_j^{\omega}\right)^{1-\gamma}}{1-\gamma} \\
& + \beta s_{j+1} E_j \left[V(j+1, \eta_{j+1}, \varepsilon_{j+1}, a_{j+1}^T, a_{j+1}^D, DR_j, h_j, n, \tilde{p}_n, \theta_n^D) \right] \\
& + \beta (1 - s_{j+1}) \frac{(W_{j+1})^{1-\gamma}}{1-\gamma} \qquad (22)
\end{aligned}
$$

subject to constraints given by (6) to (21) and the labor income process given by (2) to (5), in addition to the non-negativity constraint on consumption.

Parametrization I

- All nominal variables are normalized to 2007 values
- Monetary variable are expressed as multiples of median income in period 1 ($38,000 =1)
- Housing sizes are $\{2,4,6,8,10\}$ times of period 1 median income
- We use year 2000 income tax code

Table: Cutoff Points and Marginal Tax Rate

Taxable Income (AGI)	Normalized Income	Marginal Tax Rate
($0, $5600]	(0, 0.187]	0%
($5600, $45600]	(0.187, 1.520]	15%
($45600, $105600]	(1.520, 3.520]	28%
($105600, $155600]	(3.520, 5.187]	31%
($155600, $265600]	(5.187, 8.853]	36%
$265600 +	8.853 +	39.60%

Parametrization II

Table: Summary of Parameter Values I

Parameters	Name	Values	Target / Data Source
Demographics			
J	Lifespan	71	Real age 25–95
R	Last working period	40	Work until age 64
s	Survival probability		Life table 2000
Preferences			
γ	Relative risk aversion	2	
β	Discount factor	0.96	
ω	Preferences on housing	0.2	Li and Yao (2007)
Income			
f	Age earnings profile		Cocco et al. (2005)
ρ_η	Persistence of aggr. income shock	0.748	Cocco (2005)
σ_η	s.d. aggregate income shock	0.019	Cocco (2005)
ρ_ε	Persistence of idio. income shock	0.973	Heathcote et al. (2010)
σ_ε	s.d. idiosyncratic income shock	0.133	Heathcote et al. (2010)
λ_{COL}	Income replacement rate	0.4	Diaz and Luengo-Prado (2008)
λ_{HS}	Income replacement rate	0.6	Diaz and Luengo-Prado (2008)

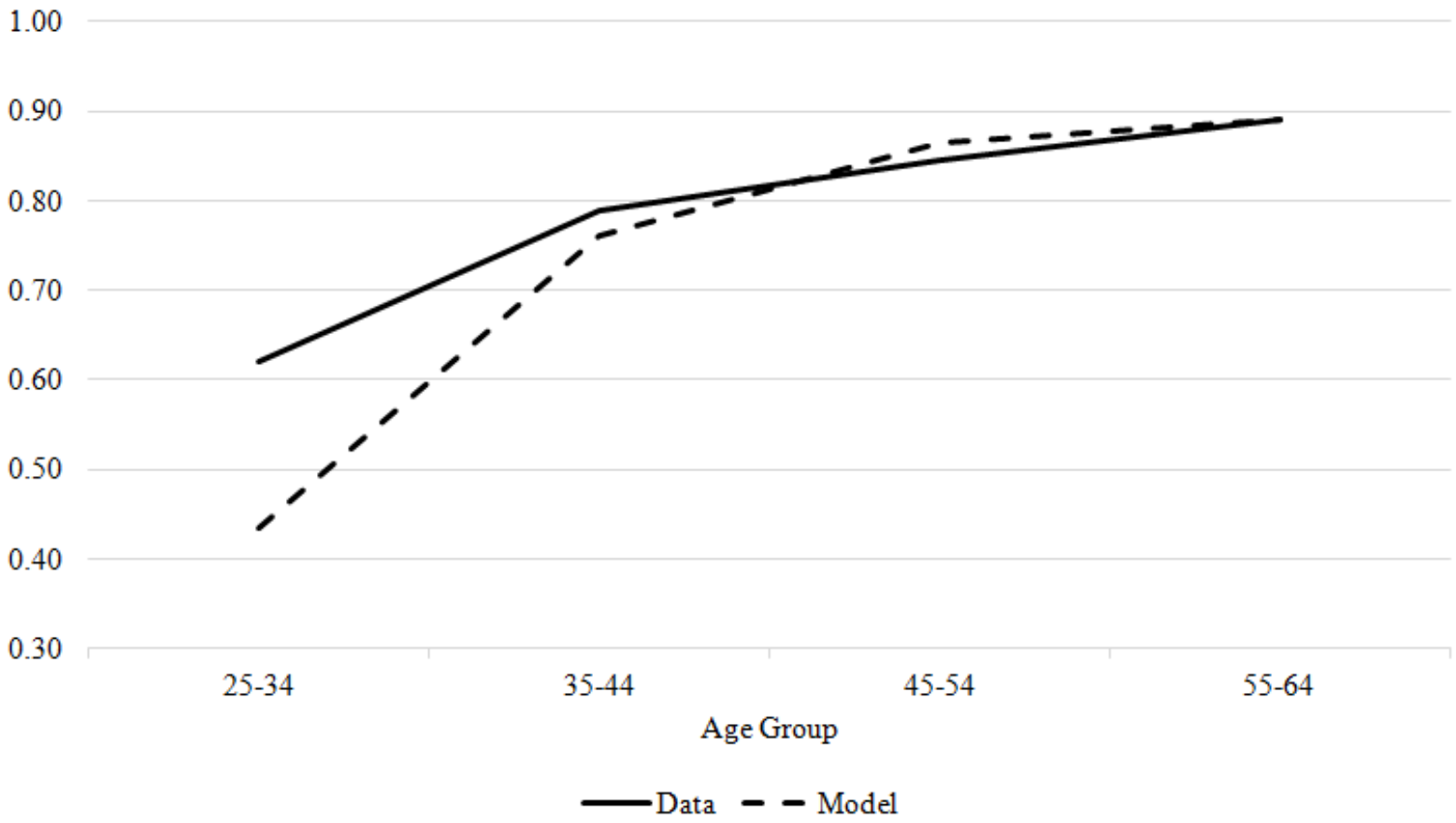
Parametrization III

Table: Summary of Parameter Values II

Parameters	Name	Values	Target / Data Source
Savings			
r	Return on saving	2%	
Housing & mortgage			
N	Mortgage length	30	Chambers et al. (2009)
r_m	Mortgage interest rate	4.7%	
g	House price growth rate	1%	Cocco (2005)
$\sigma_{\tilde{p}}$	s.d. house prices	6.2%	Cocco (2005)
θ^S	House trans. cost for seller	6%	
θ^B	House trans. cost for buyer	1.5%	
τ	Property tax rate	1%	
δ	Housing maintenance cost	1.5%	Yao and Zhang (2005)
ϕ	Rental cost of housing	6.5%	
TDA			
$\bar{q}$	Contributions limit	8%	Joulfaian and Richardson (2001)
pen	Penalty rate	10%	Zhou (2009)
Tax code			
τ_{ss}	Payroll tax rate		Historical OASDI tax rate
Y_{ss}	Earnings limit for payroll		Historical earnings limit

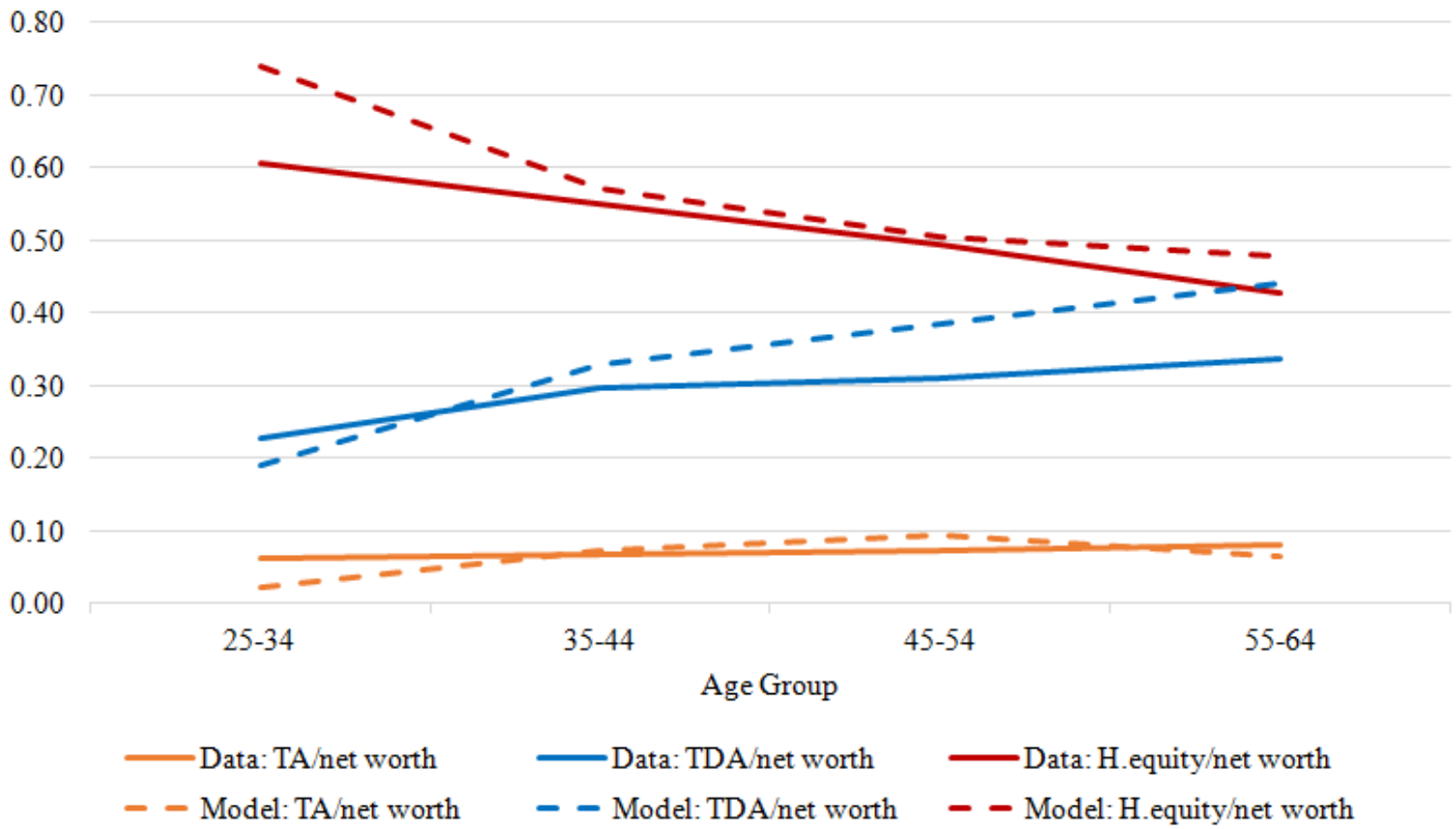
Benchmark Model I

Figure: Home ownership rate for DC participants



Benchmark Model II

Figure: Net worth composition for homeowners



List of Experiments

- TDA policies
  - No employer matching
  - Eliminating TDA *
  - Higher TDA contribution limit
- Housing-related factors
  - Increasing min. down payment *
  - Increasing rental costs
  - No tax benefits for home ownership *
- Eliminating social security *

Eliminating TDA

- Values for the benchmark model are normalized to 1

	Age Group				
	25-34	35-44	45-54	55-64	Overall
Net worth	0.468	0.758	0.878	0.872	0.818
TDA/net worth	.	.	.	.	.
TA/net worth	7.981	8.355	3.270	4.969	7.781
% of home ownership	0.380	0.564	0.746	0.900	0.685
Median income of owners	1.122	1.261	1.085	1.020	1.114
Home equity/net worth	1.169	1.376	1.478	1.410	1.363
Home equity/home value	1.504	2.414	1.520	1.053	1.765

Increase min. down payment to 20%

- Values for the benchmark model are normalized to 1

	Age Group				
	25-34	35-44	45-54	55-64	Overall
Net worth	0.885	0.997	0.995	0.995	0.998
TDA/net worth	1.117	0.938	0.967	0.985	0.981
TA/net worth	1.378	1.212	1.081	1.073	1.157
% of home ownership	0.728	0.924	0.982	0.998	0.932
Median income of owners	1.070	1.032	1.009	1.000	1.023
Home equity/net worth	1.044	1.037	1.011	1.002	1.007
Home equity/home value	1.339	1.094	0.997	0.957	1.062

No tax benefits for home ownership

- Values for the benchmark model are normalized to 1

	Age Group				
	25-34	35-44	45-54	55-64	Overall
Net worth	0.728	0.892	0.946	0.971	0.922
TDA/net worth	1.175	0.863	0.901	0.957	0.956
TA/net worth	1.488	1.304	0.990	1.230	1.191
% of home ownership	0.600	0.756	0.864	0.918	0.810
Median income of owners	1.006	1.020	1.028	1.014	1.031
Home equity/net worth	1.054	1.131	1.107	1.040	1.065
Home equity/home value	1.138	1.248	1.394	1.053	1.450

Eliminating Social security

- Values for the benchmark model are normalized to 1

	Age Group				
	25-34	35-44	45-54	55-64	Overall
Net worth	1.737	1.661	1.632	1.712	1.883
TDA/net worth	0.908	1.042	0.947	0.881	0.949
TA/net worth	0.871	1.308	1.588	2.965	1.762
% of home ownership	1.300	1.169	1.091	1.111	1.150
Median income of owners	0.920	0.917	0.923	0.976	0.940
Home equity/net worth	0.937	0.858	0.882	0.796	0.850
Home equity/home value	1.105	1.157	1.271	1.053	1.306

Conclusion

- Quantitative life-cycle model to study the interactions between housing and households' use of TDA
- Model explains the cross-sectional variation in household net worth composition
  - TDA promotes home ownership and household debt
  - Home ownership rate and net worth composition adjust to TDA policies and housing-related factors
- Future work:
  (1) household debt and housing price shocks
  (2) TDA early withdrawal penalty