

A Life Cycle Model On Optimal Housing Equity

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CANNOT avoid talking about housing

- the dominant wealth of a household: represent at around 85 per cent of household wealth (2010 HILDA Survey).
- a lifespan consumption good and also a lifespan investment asset.
- high leverage investments; regular mortgage repayments, and refinancing
- rental yields, capital growth, housing price risks
- costs of buying, costs of selling, downpayment, maintenance costs
- tax treatments: subsidizations or extra burdens

Table: Tax treatment of existing owner housing

| | Property tax | Capital gain tax | Imputed rent | Mortgage deduction |
|-----------|--------------|------------------|--------------|--------------------|
| Australia | Yes | No | No | No |
| Canada | Yes | No | No | No |
| France | Yes | No | No | Credit |
| Germany | Yes | No | No | No |
| Japan | Yes | No | No | No |
| U.K. | No | No | No | Deduction |
| U.S. | Yes | Yes | No | Deduction |
| Sweden | No | Yes | No | Deduction |
| Italy | Yes | Yes | Yes | Deduction |

Notes. source: <https://en.wikipedia.org/wiki/Negativegearing>

Table: Tax treatment of existing rental housing

| | Property tax | Capital gain tax | Imputed rent | Mortgage deduction |
|-------------|--------------|------------------|--------------|--------------------|
| Australia | Yes | Yes | Yes | Deduction |
| New Zealand | Yes | Yes | Yes | Deduction |
| U.K. | No | No | No | No |
| Netherlands | No | No | No | No |
| Canada | Yes | No | No | No |
| France | Yes | No | No | Credit |
| Germany | Yes | No | No | No |
| Japan | Yes | No | No | No |
| U.S. | No | Yes | No | No |

Notes. source: <https://en.wikipedia.org/wiki/Negativegearing>

Priors

- Market 1: with beneficial tax treatments to owner housing
 - higher homeowner rates
 - bigger owner houses
 - lower rates of transition into owning the second rental house
- Market 2: with beneficial tax treatments to rental housing
 - higher rates of renting
 - older to own
 - higher rates of transition into owning the second rental house

Structure

- literature review
- the model economy
- the optimization problem
- solving the life cycle model
- country details
- calibration results
- simulation results
- conclusions

Literature Review

Our literature review includes two aspects.

One is that we review the literature that studies the impacts of preferential tax treatment of owner housing or rental housing to the tenure choice and housing investments.

The other is that we review literature that incorporates investments for both owner housing and rental housing in either a static general equilibrium framework, or a multi-period dynamic life cycle models.

- the preferential tax treatment of owner housing encourages homeownership rate and induces over-consume housing services: (Laidler 1969; Poterba 1984; Rosen 1985; Poterba 1990; Poterba 1992).
- the general equilibrium effects of the preferential tax treatment on owner housing: Berkovec and Fullerton (1992), Gervais (2002), Floetotto, Kirker, and Stroebel (2016).
- the tax treatments to housing along a dynamic life cycle transition path in a general equilibrium framework
 - Sommer and Sullivan (2018). Implications of US tax policy for house prices, rents, and homeownership, *AER*.
 - Cho, Li, and Uren (2017). Negative Gearing and Welfare: A Quantitative Study for the Australian Housing Market

Two papers that provide good references: Sommer and Sullivan, 2018, *AER* and Cho, Li, and Uren (2017).

Household preferences:

$$u_t(c, \tilde{j}) = \psi \frac{c_t^{1-\gamma}}{1-\gamma} + (1 + I^o \Re) \frac{R_t^c(\tilde{j})^{1-\delta}}{1-\delta} \quad (1)$$

Household bequest motivations:

$$\begin{aligned} B(W_t) &\equiv \sum_{\tilde{t}=t+1}^{t+\tilde{T}} \beta^{\tilde{t}-t} \left[\frac{(\omega A_{\tilde{T}} W_t)^{1-\delta}}{1-\delta} + (1 + \Re) \frac{((1-\omega) A_{\tilde{T}} W_t)^{1-\delta}}{1-\delta} \right] \\ &\equiv \frac{\beta(1 - \beta^{\tilde{T}})}{(1 - \beta)} \left[\frac{(\omega A_{\tilde{T}} W_t)^{1-\delta}}{1-\delta} + (1 + \Re) \frac{((1-\omega) A_{\tilde{T}} W_t)^{1-\delta}}{1-\delta} \right] \end{aligned} \quad (2)$$

where, $A_{\tilde{T}}$ is the annuity factor (Dammon, Spatt, and Zhang 2001) written as,

$$A_{\tilde{T}} \equiv \frac{r^f(1 + r^f)^{\tilde{T}}}{(1 + r^f)^{\tilde{T}} - 1}, \quad \tilde{T} = 18 \quad (3)$$

Participants:

Households: renters, homeowners, landlords

Labor income: a function of age and education with a stochastic term, exogenous

House prices (housing market): exogenous

Financial assets (nondurable): a risk-free bond

Housing assets (durable): the owner house, and the rental house

Tax rates: progressive income taxation rates, exogenous

Mortgage contracts: a fixed term mortgage allowable for refinancing

Household behaviors(choices by the household type):

Consumption:

nonhousing goods

housing goods

Investments:

Renters: financial assets (risk-free savings), owner housing

Homeowners: financial assets (risk-free savings), owner housing, rental housing

Landlords: financial assets (risk-free savings), owner housing, rental housing

State variables:

Owner house j^o ,

Renter house j^k ,

Loan balance for the owner house σ_t^o ,

Loan balance for the rental house σ_t^k ,

Labor income L_t

Financial assets: S_{t-1}

Choice variables

Consumption:

Nonhousing c_t

Housing services j^r

Investment:

Owner house j^o ,

Renter house j^k ,

Refinancing to owner house

Refinancing to rental house

Financial assets S_t

By household type, the state space and choice sets:

Existing renters:

State variables (state space): $X_t^r = \{s_t\}$

Choice sets: $d_t^r = \{j^o, 0, j^r, c\}$

Existing owners or Landlords:

State variables (state space): $X_t^o = \{j^o, j^k, \sigma^o, \sigma^k, s_t, L_t\}$

Choice Sets: $d_t^o = \{j^o, j^k, 0, c\}$

Table: Housing transitions

| State at t | State at t +1 | |
|------------|--|-------|
| Renters | 1 no purchase | (0,0) |
| | 2 Buy an owner house | (1,0) |
| Homeowners | 1 Stay with the same home | (1,0) |
| | 2 Stay with the same home + buy the second | (1,1) |
| | 3 Sold the old house, no new purchase | (0,0) |
| | 4 Sold the old house and purchased a new one | (1,0) |
| | 5 Sold the old house and purchased a new one + buy the second | (1,1) |
| Landlords | 1 Stay with the old home and the old rental house | (1,0) |
| | 2 Stay with the old home and resized the old house | (1,1) |
| | 3 Stay with the old home and sold the rental house | (1,0) |
| | 4 Sold both houses, purchase a new home | (1,0) |
| | 5 Sold the old home, purchase a new home and keep the old rental house | (1,1) |
| | 6 Sold both houses, purchase a new home and the second | (1,1) |
| | 7 Sold both houses, holding no properties | (0,0) |

Table: Household's balance sheet in the beginning of the period t

| Assets | Tax rates |
|--|-----------|
| Housing | |
| Owner-occupied housing, $H_t(j^o)(1 - \phi^s)$ | |
| Rental housing, $H_t(j^k)(1 - \phi^s)$ | |
| Liquid assets, Q_t | |
| Savings, $S_{t-1}R_t^{f,s}$ | τ^y |
| Labor income, L_t | τ^y |
| Rental income, $H_{t-1}(j^k)r^b, H_{t-1}(j^o)r^b$ | |
| Net income effects, N_t | τ^y |
| Liabilities | |
| Mortgage of owner housing, $H_t(j^o)(1 - \sigma^o)R^f$ | |
| Mortgage of rental housing, $H_t(j^k)(1 - \sigma^k)R^f$ | |
| Full income W_t | |
| $H_{t-1}(j^o)[r^b + R_{t-1}^H(1 - \phi^s) - (1 - \sigma_{t-1}^o)R^f] + H_{t-1}(j^k)[r^b + R_{t-1}^H(1 - \phi^s) - (1 - \sigma_{t-1}^k)R^f] + S_{t-1}R_t^{f,s} + L_t(1 - \tau^y) + N_t$ | |

Table: Household's expenditure sheet in the beginning of the period t

| Expenditure | Tax rates |
|---|-----------|
| Consumption | |
| Nonhousing consumption, C_t | |
| Housing services consumption, $R_t^c(\tilde{j})$ | |
| Housing costs | |
| Owner-occupied housing, $H_t(j'^o)(\phi^u + I^b \phi^b)$ | |
| Rental housing, $H_t(j'^k)(\phi^u + I^{b'} \phi^b)$ | |
| Savings, S_t | τ^y |
| Holdings of equity | |
| Mortgage of owner housing, $H_t(j'^o)\sigma_t^o$ | |
| Mortgage of rental housing, $H_t(j'^k)\sigma_t^k$ | |
| Budget constraint W_t | |
| $C_t + S_t + H_t(j'^o)(\phi^u + \sigma_t^o + I^b \phi^b) + H_t(j'^k)(\phi^u + \sigma_t^k + I^{b'} \phi^b) + R_t^c(\tilde{j})$ | |

Other constraints

Positive amounts of nonhousing goods: $C_t > 0$

No negative amount of savings after expenses: $S_t \geq 0$

Household's optimization problem

In the start of the life cycle $t = 0$, the inter-temporal multi-period optimization problem can be written as follows:

$$V_0(X_0) = \max_{d_t \in \Omega^D} E \left\{ \sum_{t=0}^{t=T} \beta^t [\rho_t (u_t(X_t, d_t) + v_{d_t}) + (1 - \rho_t) B(W_t)] \right\} \quad (4)$$

$$d_t = \{c, j^o, j^k, j^r\} \in \Omega^D, j^o \in \{0, 1, 2, \dots, J^o\}, j^k \in \{0, 1, \dots, J^k\} \quad (5)$$

$$j^r \in \{1, \dots, J^k\} c \in \{1, 2, \dots, C\},$$

$$X_t \equiv \{H_{t-1}(j^o), H_{t-1}(j^k), \sigma_t^k, \sigma_t^o, Q_t\}, Q_t \equiv \{L_t, S_{t-1}\}, t = 0, \dots, T \quad (6)$$

Variables that contain information for:

Demographics,
Housing tenure status: own or rent,
The number of bedrooms of the property that provides the housing services,
Home value,
The value of the other real estate,
The household gross expenditure,
Household labor income
Household net wealth.

Data sources

HILDA survey data in 2002, 2006, 2010 for Australia Households
PSID survey data from 1984 -2013 for US Households

Three stages:

Stage 1: calibrate the exogenous parameters (parameters that are drawn from other literature)

Stage 2: estimate the exogenous parameters (for house prices and labor income)

Stage 3: calibrate the remaining structural parameters (by matching the model moments to the empirical moments).

Table: Calibrated exogenous variables

| Variables | Explanations | AU | US |
|--|---|----|----|
| Housing costs | | | |
| $\bar{\sigma}$ | the minimum downpayment on purchase | | |
| r^b | the rent-price ratio. | | |
| ϕ^u | annual running costs for a rental house. | | |
| ϕ^o | annual usage costs for an owner house. | | |
| ϕ^d | the depreciation rate of a property. | | |
| ϕ^b | Buying costs | | |
| ϕ^s | Selling costs. | | |
| Interest rates | | | |
| r^f | the real interest rate; | | |
| R^f | the real gross return on risk free liquid assets, $R^f = r^f + 1$ | | |
| Utility function $u(X_t, d_t, \theta)$ | | | |
| β | the annual discount rate . | | |
| $1 - \rho_t$ | the mortality probability | | |
| \mathfrak{R} | the incentive of owning to consume | | |
| Bequest Function $B(W)$ | | | |
| \tilde{T} | $\tilde{T} = 18$, the strength of bequest | | |
| ω | The beneficiaries' relative preference of housing services. | | |

Table: Estimated exogenous variables

| Variables | Explanations | AU | US |
|---|--|----|----|
| House prices $H(j), j \in j^o j^k$ (exogeneous) | | | |
| $H_0(1)$ | the value of a one-bed property at the initial time | | |
| $H_0(2)$ | the value of a two-bed property at the initial time | | |
| $H_0(3)$ | the value of a three-bed property at the initial time | | |
| $H_0(4)$ | the value of a four-bed property at the initial time | | |
| $H_0(5)$ | the value of a five-bed property at the initial time | | |
| b_j | the effect of size to the value of a housing property. | | |
| \bar{G} | the mean of the annual nominal rate of growth in housing prices; | | |
| σ_H | The standard deviation of the rate of growth in real house prices. | | |
| Labor income L_t (exogeneous) | | | |
| A | the constant term | | |
| A_1 | the time impact | | |
| A_2 | the impact of age | | |
| A_3 | the impact of the quadratic term of age | | |
| A_3 | the impact of the cubic term of age | | |
| ζ | the random effect of a classification of income | | |
| σ_L | standard deviation of the transitory shock to labor income. | | |

Table: Progressive tax system parameters, Australia

| Marginal rates | Tax payment thresholds | Bracket cutoff |
|-----------------|------------------------|--------------------|
| $\tau_1 = 0$ | $\tau^{P1} = 0$ | \$0 – \$8711 |
| $\tau_2 = 0.16$ | $\tau^{P2} = 0$ | \$8711 – \$32622 |
| $\tau_3 = 0.31$ | $\tau^{P3} = 5222$ | \$32622 – \$77000 |
| $\tau_4 = 0.38$ | $\tau^{P4} = 17544$ | \$77000 – \$163888 |
| $\tau_5 = 0.45$ | $\tau^{P5} = 50571$ | > \$163888 |

Notes. These parameters are estimated by using the average of the income tax codes for the financial years from 2005-06 to 2014-15 from the Australian Taxation Office.

Table: Progressive tax system parameters, U.S.

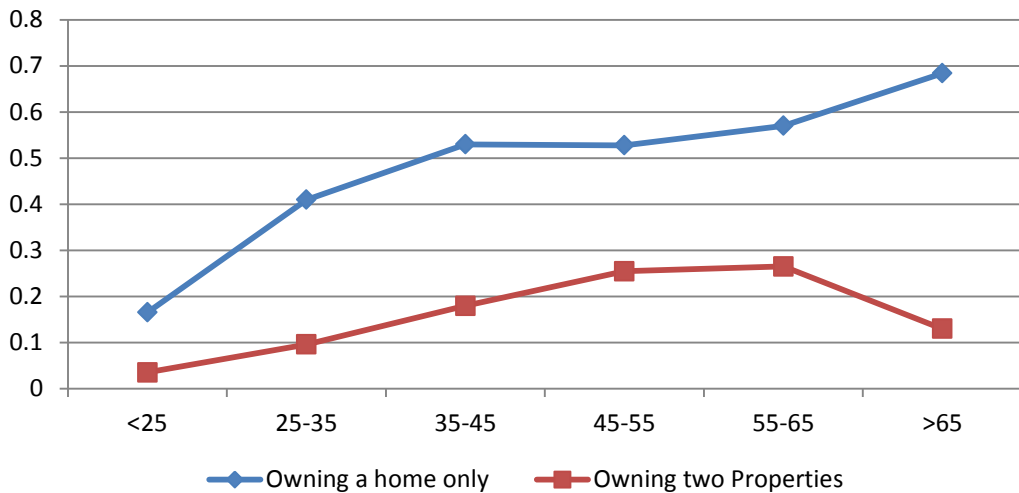
| <i>Panel A.</i> Marginal rate | Income bracket cutoff |
|-------------------------------|-----------------------|
| $\tau_1 = 0.10$ | < \$8350 |
| $\tau_2 = 0.15$ | \$8350 – \$33950 |
| $\tau_3 = 0.25$ | \$33950 – \$82250 |
| $\tau_4 = 0.28$ | \$82250 – \$171550 |
| $\tau_5 = 0.33$ | \$171550 – \$371950 |
| $\tau_6 = 0.35$ | > \$371950 |
| <i>Panel B.</i> Deduction | |
| Personal exemption | \$3,650 |
| Standard deduction | \$5,700 |

Calibration targets

Transition matrix

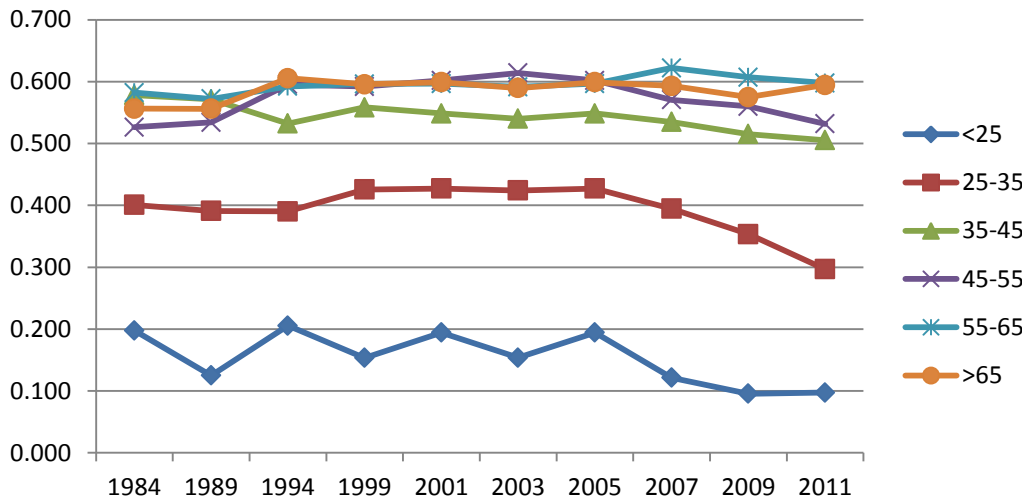
| | | (0 0) | (1 0) | (1 1) | obs |
|-------|-------|-------|-------|-------|-----|
| <25 | (0 0) | 0.782 | 0.202 | 0.016 | 386 |
| | (1 0) | 0.275 | 0.588 | 0.138 | 80 |
| | (1 1) | 0.625 | 0.125 | 0.250 | 16 |
| 25-35 | (0 0) | 0.644 | 0.325 | 0.031 | 421 |
| | (1 0) | 0.069 | 0.791 | 0.140 | 335 |
| | (1 1) | 0.089 | 0.380 | 0.532 | 79 |
| 35-45 | (0 0) | 0.766 | 0.206 | 0.028 | 316 |
| | (1 0) | 0.061 | 0.806 | 0.133 | 607 |
| | (1 1) | 0.013 | 0.321 | 0.665 | 224 |
| 45-55 | (0 0) | 0.870 | 0.110 | 0.020 | 246 |
| | (1 0) | 0.030 | 0.813 | 0.157 | 635 |
| | (1 1) | 0.013 | 0.246 | 0.741 | 301 |
| 55-65 | (0 0) | 0.918 | 0.068 | 0.014 | 147 |
| | (1 0) | 0.035 | 0.862 | 0.103 | 513 |
| | (1 1) | 0.018 | 0.281 | 0.702 | 228 |
| >65 | (0 0) | 0.939 | 0.056 | 0.005 | 196 |
| | (1 0) | 0.061 | 0.915 | 0.024 | 741 |

housing ownership rates

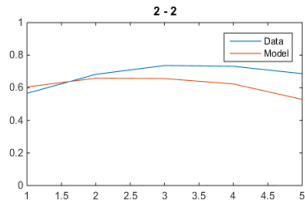
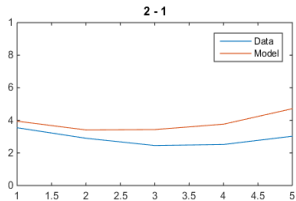
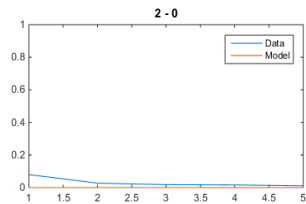
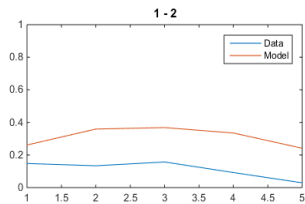
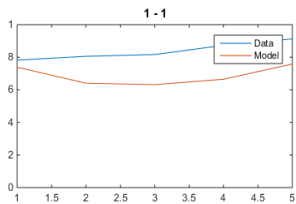
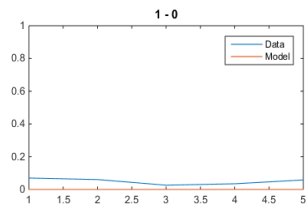
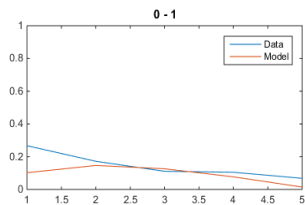
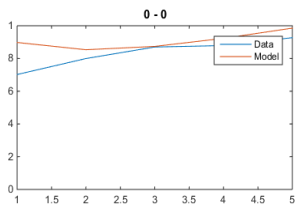


Transition matrix for the US Housing ownership: referring to the context of the paper

housing ownership rate, owning a home only, U.S.



Simulation: calibrated results of the baseline model .



Further work:

1. simulations for economy with counterpart policies.
2. Conclusions

Thank you for your time!

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