Optimal Life-Cycle Housing Renting and Owning Behavior of Chinese Resident’s

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Abstract: Resident’s housing consumption and investment behavior is an important micro basis of housing policies in China, and has an important influence on the development of real estate market and the structure of housing supply. In this article, I developed a dynamic optimization model base on utility maximization to simulate the housing behavior of Chinese resident during all his life, and analyzed the basic characteristics and internal mechanisms of resident’s housing renting and owning decisions.

Key Words: Housing, Renting and Owning Behavior, Life Cycle, Utility Maximization

1 Introduction

Housing services can be acquired by either renting or owning a house. Owing to the character of its high value, simultaneous role of important consumption good and dominant asset, illiquidity, mortgage, and high transaction cost, housing has a major impact on households wealth accumulation and welfare. Therefore, it’s quite meaningful to study the basic characteristics and internal mechanisms of Chinese resident’s housing renting and owning behavior, and this research is useful under the background of irrational housing supply structure and high housing price in China.

Since Life-Cycle Hypothesis was provided by F. Modiglianli(1963) [1], researches of household’s consumption and investment behavior breakthrough the framework of traditional Markowitz mean-variance portfolio theory, and begin to consider the consumption and multi-period smoothing of asset allocation of residents. Grossman and Laroque(1990) [2] analyze investment decisions when consumption is derived from indivisible durable good that is costly to adjust. Cocco(2004) [3] introduces housing to a standard life-cycle consumption and portfolio choices model. Campbell and Cocco(2003) [4] have uncovered important characteristics on housing mortgage choices. In this paper, I analyze the optimal dynamic housing renting-owning behavior of Chinese household in a realistic life-cycle model, and try to reveal the internal mechanisms of renting-owning decisions. This paper differs from the previous researches in three dimensions: First, the model explicitly incorporates a house rental market; Second, the model focus on the optimal dynamic housing renting and owning behavior of resident; Third, I describe the character of Chinese families with special housing risk and stochastic labor income.

2 The Model

I model the dynamic consumption and investment decisions of a typical Chinese resident who lives from time 1 to time T, and put forward the following hypotheses:

Hypothesis 1: There are two financial assets: A riskless asset(\( B_t \)) with gross real return \( r_{f,t} \), and a risky asset(\( S_t \)) with gross real return \( r_{s,t} \). A investor changes his riskless asset without incurring any cost, and spends a transaction rate \( \phi \) on risky stock. No short sale of financial assets.

Hypothesis 2: If a homeowner sells his house at time \( t \), he should became a renter or buy a new one at the same time.

2.1 Preference function

The household derives utility from housing services (\( H_t \)) and a numeraire good (\( C_t \)) at each period, as well as from bequeathing terminal wealth (\( W_{T+1} \)) after date T. The resident’s utility described by:

\[
U_t = E_t \sum_{t=1}^{T} \left[ \beta^{T-t} U(C_{t,T}, H_{t,T}) \right] + \beta^T B(Q_t) \tag{1}
\]

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Where \( U(C_t, H_t) = \frac{(C_{t-1}^\gamma H_t^\theta)^{1-\gamma}}{1-\gamma} \) \( B(Q_t) = \frac{W_{t-1}^d}{1-\gamma} \)

(2)

Where \( \gamma \) is the coefficient of relative risk aversion, \( \beta \) is the time discount factor, \( \theta \) determines preference for housing relative to the other consumption good.

2.2 Labor Income Process

Before retirement, the resident receives a stochastic labor income \( L_t \) is given by:

\[ L_t = L_{e_t} + L_{e_t} = L_{h_{t-1}} \quad \text{for } t \leq K \]

(3)

Where \( L_{e_t} \) is the permanent component which determined by economy situation and individual characteristics of household. \( L_{e_t} \) is an idiosyncratic temporary shock distributed as \( N(0, \sigma^2_{e_t}) \).

Retirement income is modeled as a fixed pension (P).

\[ L_t = P \quad \text{for } t > K \]

(4)

2.3 Financial assets

Return on the risky asset \( r_{t,s} \) is given by:

\[ r_{t,s} = \mu + \varepsilon_t \]

(5)

Where \( \varepsilon_t \) distributed as \( N(0, \sigma^2_{e_t}) \), \( \mu \) denote the risk compensation of stock. No short sale of financial assets is described by:

\[ S_t > 0, B_t > 0 \quad \text{for all } t \]

(6)

2.4 Housing and mortgage contracts

0 = \( D_t^h \) denotes the household is a renter at time t, and a homeowner otherwise. A renter at time t-1 can keep renting, or buy a house at time t. \( D_t^h = 1 \) means the household buy a house at time t. A fraction (b) of house value should be paid to search a house to buy. Down payment ratio is a fraction (d) of the house value, and the rest by borrowing a mortgage with a constant rate of interest \( r_{t,H} \).

If a homeowner sells his house at time t-1, he should become a renter or buy a new one at once. \( D_t^f = 1 \) means the homeowner sells his house, and 0 otherwise. Transaction cost equals to a fraction (n) of the house value. Maintenance cost equals to a proportion (m) of the house value, and renting cost is a fraction (u) of house market value. The mortgage balance denoted by \( M_t \) needs to satisfy:

\[ M_t = M_{t-1}(1 + r_{t,H}) - \sum_{j=t}^{\tau}(1+r_{t,j})^{\tau-j-1} M_{t+j-1} \]

(8)

2.5 Budget constraints

I denote the resident’s spendable resources by \( Q_t \), which can be written as follows:

For a renter at time t-1:

\[ S_{t-1}(1 + r_{t-1,H}) + B_{t-1}(1 + r_{f}) + L_{t-1} = Q_t \]

(9)

For a homeowner at time t-1:

\[ S_{t-1}(1 + r_{t-1,H}) + B_{t-1}(1 + r_{f}) + L_{t-1} + P_{t-1}^d H_{t-1} (1 + r_{H,t})(1 - n) - M_{t-1}(1 + r_{g}) = Q_t \]

(10)

Each period a resident’s invests in financial asset after it pays for consumption and housing. Therefore, the budget constraints need to satisfy:

Case 1: For a renter at time t-1, who decides to keep renting at time t, or a homeowner at time t-1,
who decides to sell his house, and becomes a renter at time t:

\[ (D^u_t = D^u_{t-1} = D^h_t = D^r_t = 0; \text{ or } D^u_t = = D^h_t = D^r_t = 1, D^d_t = 0) \]

\[ Q_t = S_t + B_t + C_t + |S_t - S_{t-1}| \phi + u P^u_t H_t \]  

(11)

Case 2: For a renter at time t-1, who decides to buy a house at time t, or a homeowner at time t-1, who decides to sell his house, and buy a new one at time t.

\[ (D^u_t = 0, D^u_{t-1} = D^h_t = 1, D^d_t = D^r_t = 0; \text{ or } D^u_t = D^d_t = D^r_t = 1, D^h_t = 0) \]

\[ Q_t = S_t + B_t + C_t + |S_t - S_{t-1}| \phi + (1 + b + m) P^d_t H_t - M_t \]  

(12)

Case 3: For a homeowner at time t-1, who decides to stay at the same house, and without refinancing his mortgage at time t.

\[ (D^u_t = D^u_{t-1} = 1, D^h_t = D^d_t = D^r_t = 0) \]

\[ Q_t = S_t + B_t + C_t + |S_t - S_{t-1}| \phi + (1 + m - n) P^u_t H_t - M_t \]  

(13)

Case 4: For a homeowner at time t-1, who decides to stay at the same house, and refinancing his mortgage at time t.

\[ (D^u_t = D^u_{t-1} = 1, D^h_t = D^d_t = D^r_t = 1) \]

\[ Q_t = S_t + B_t + C_t + |S_t - S_{t-1}| \phi + (1 + m - n + a) P^d_t H_t - M_t \]  

(14)

2.6 The optimization problem

The target of household is to maximize his expected lifetime utility:

\[ \max_{\{t, \theta, a, h, m, d, r, d, \phi, u\}} E(U_t) \]  

where \(U_t\) is given by equations (1) and (2), and subject to equations (3) to (14).

3 Parameterization and Numerical Solution Method

3.1 Model Parameterization

I assume that a resident enters the economy at age of 25, retires at age 60, and dies at age 75. The decision frequency is annual. I use the date 899RMB as the base year income at the beginning of Life-cycle according to the disposable income of Chinese citizen in 1987. The incremental rate is 14.8% according to the average incremental rate of labor income from 1987 to 2004. Retirement pension is set to 80% of the Labor income at time K-1. Parameter values shown in tab.1:

<table>
<thead>
<tr>
<th>Parameter symbol</th>
<th>value</th>
<th>Parameter symbol</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of relative risk aversion</td>
<td>0.99</td>
<td>Time discount factor</td>
<td>0.99</td>
</tr>
<tr>
<td>Housing preference factor</td>
<td>0.7</td>
<td>Variance of labor income</td>
<td>0.02</td>
</tr>
<tr>
<td>Incremental rate of labor income</td>
<td>0.15</td>
<td>Risk free rate</td>
<td>0.02</td>
</tr>
<tr>
<td>Risk compensation of stock</td>
<td>0.7</td>
<td>Variance of stock return</td>
<td>0.04</td>
</tr>
<tr>
<td>Transaction rate of stock</td>
<td>0.05</td>
<td>Down payment ratio</td>
<td>0.2</td>
</tr>
<tr>
<td>Mortgage rate</td>
<td>0.06</td>
<td>House Maintenance</td>
<td>0.01</td>
</tr>
<tr>
<td>House selling cost</td>
<td>0.03</td>
<td>House purchase cost</td>
<td>0.015</td>
</tr>
<tr>
<td>Mortgage refinancing cost</td>
<td>0.01</td>
<td>Renting cost</td>
<td>0.056</td>
</tr>
</tbody>
</table>

3.2 Numerical Solution Method

I derive numerical solutions through value function iterations. With the recursive nature of the problem, I can rewrite it with Bellman Equation as follows:

\[ V_t(X_t) = \max_{\{a, u, \theta, m, \phi, d, r, d\}} \left\{ \frac{(C_t - H_t^u)^{\gamma} - \gamma}{1 - \gamma} + \beta E_t[V_{t+1}(Q_{t+1})] + B(Q_t) \right\} \]

Where \(X_t = \{H_t, M_{t+1}, Q_t, D^u_t\}\) is the vector of state variables, and \(A = \{S_t, B_t, C_t, H_t, M_t, D^u_t, D^d_t, D^r_t\}\) is the vector of choice variables. I use Newton iterated algorithm and simulation analysis (100,000 times) to optimize the different choices, and find a good feasible solution with improving the initial states.
4 Results

4.1 Life-cycle asset allocation of Chinese residents

Tab2 summarizes the results for 100,000 simulation trials, and the simulation begin with renters with zero initial net worth. It indicates that:

<table>
<thead>
<tr>
<th>Age</th>
<th>Home ownership ratio</th>
<th>Labor income</th>
<th>Housing</th>
<th>Non-housing consumption</th>
<th>Stock (S)</th>
<th>Saving (B)</th>
<th>S/(S+B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R O</td>
<td>O R</td>
<td>R O</td>
<td>R O</td>
<td>R O</td>
<td>R O</td>
<td>R O</td>
</tr>
<tr>
<td>25</td>
<td>0 0.93</td>
<td>12.5 -</td>
<td>0.3 -</td>
<td>0 -</td>
<td>0 -</td>
<td>0 -</td>
<td>0% -</td>
</tr>
<tr>
<td>30</td>
<td>0 2.06</td>
<td>18.7 -</td>
<td>0.92 -</td>
<td>0.21 -</td>
<td>0 -</td>
<td>100% -</td>
<td>-</td>
</tr>
<tr>
<td>35</td>
<td>0.41 4.12</td>
<td>36.4 98.9</td>
<td>2.14 1.68</td>
<td>169 0</td>
<td>0.04 0</td>
<td>97.6 0%</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>0.6 6.94 9.56</td>
<td>56.8 116.3</td>
<td>3.68 2.01</td>
<td>1.96 1.38</td>
<td>0.34 1.95</td>
<td>85.2% 0%</td>
<td>-</td>
</tr>
<tr>
<td>45</td>
<td>0.89 9.47 13.58</td>
<td>62.1 126.5</td>
<td>4.8 4.76</td>
<td>2.89 1.66</td>
<td>0.88 2.13</td>
<td>76.7% 41.44%</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>1 - 23.27</td>
<td>- 138.5</td>
<td>- 6.89</td>
<td>- 1.82</td>
<td>- 2.43</td>
<td>- 43.80%</td>
<td>-</td>
</tr>
<tr>
<td>55</td>
<td>1 - 46.54</td>
<td>- 149.9</td>
<td>- 8.65</td>
<td>- 2.11</td>
<td>- 2.65</td>
<td>- 42.82%</td>
<td>-</td>
</tr>
<tr>
<td>60</td>
<td>1 - 21.65</td>
<td>- 156.8</td>
<td>- 9.21</td>
<td>- 2.34</td>
<td>- 2.71</td>
<td>- 44.33%</td>
<td>-</td>
</tr>
<tr>
<td>65</td>
<td>0.95 5.68 8.63</td>
<td>53.4 148.9</td>
<td>5.45 8.65</td>
<td>2.69 3.12</td>
<td>1.43 3.67</td>
<td>65.3% 46.34%</td>
<td>-</td>
</tr>
<tr>
<td>70</td>
<td>0.92 4.29 6.59</td>
<td>52.4 146.7</td>
<td>5.06 8.21</td>
<td>1.68 2.76</td>
<td>1.56 3.58</td>
<td>51.9% 45.95%</td>
<td>-</td>
</tr>
<tr>
<td>75</td>
<td>0.801 3.8 6.82</td>
<td>53.8 141.6</td>
<td>4.36 7.63</td>
<td>1.54 2.01</td>
<td>1.63 4.09</td>
<td>48.6% 43.53%</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: All numbers are mean values in thousands of RMB. R denotes renter, and O denotes homeowner.

(1) The model generates a hump-shaped home ownership ratio and housing position in age. Home ownership ratio is zero before 30. It means that young residents optimal choose to rent owing to the low level of labor income and disposable wealth. With labor income and accumulation wealth increasing, owning a house is optimal for residents for providing housing service as well as investment benefits. About 50, almost all residents have their own houses. During age 35 to 60, some households with high labor income choose to improve their housing consumption by changing their old houses. After retire, the housing position descents smoothly, it means that some households choose to refinance the mortgage, and cash out a fraction of their house equity to support non-housing consumption at the end of life.

(2) The result shows that the average labor income of homeowners is higher than that of renters. Owning to a large investment in housing, the non-housing consumption of young homeowners is obviously lower than that of renters. With the increase of housing position and wealth accumulation, the non-housing consumption of homeowner increase steadily, and higher than renters after age 65.

(3) Households owning a house hold a lower stock proportion in their financial asset. It means that housing has the character of risk asset, and homeownership crowds out stock holdings of residents.

4.2 Renting and owning behavior for renters

Fig.2 shows the optimal housing decisions for renters. The solid curve represents the worth-labor income ratio (Qt/Lt) trigger bound of owning versus renting. It indicates that:

(1) It shows that the optimal housing tenure choice of renters as a function of the household’s
beginning of period $Q_t/L_t$ and the investor’s age. At a given age, the household with a high $Q_t/L_t$ chooses to buy a house, while the investor with low $Q_t/L_t$ chooses to rent. Because the investor with high $Q_t/L_t$ is less liquidity constrained and can afford a house closer to his desired size.

(2) The $Q_t/L_t$ trigger bound decreases in the age of resident before age 60s and increase thereafter. A young resident has a high present value of labor income and wishes to own a large house relative to his current labor income in order to smooth inter-temporal housing services and minimize house liquidation cost. Therefore, a young household will require a higher $Q_t/L_t$ to trigger house ownership. As the household ages and the present value of his earnings decline, his desire house size also decreases relative to his labor income, a lower level of $Q_t/L_t$ is enough to trigger home ownership. After retirement, the $Q_t/L_t$ trigger bound increases as the probability of incurring liquidation cost increase.

4.3 Housing choices for homeowners

Fig.3 shows the housing tenure choice at age 40 as a function of the beginning-of-period house value-labor income ratio($P_tH_t/L_t$) and mortgage-house value ratio($M_t/P_tH_t$). It indicates that:

![Fig.2 Housing decision for homeowners](image)

When $P_tH_t/L_t$ is too low, the homeowner optimal chooses to sell his existing house and buy a bigger one to improve his housing position in order to achieve more utility from housing consumption. When $P_tH_t/L_t$ is too high, the household chooses to rent after selling his existing house, in order to improves the liquidity of his asset and non-housing consumption. If $P_tH_t/L_t$ is moderate, the homeowner optimal choose to stay in his existing house, and refinance his mortgage if $M_t/P_tH_t$ is too low.

5 Conclusions

In this article, I develop a dynamic optimization model to study the housing renting and owning behavior of Chinese resident’s. Our results show that reasonable housing behavior of resident has certain gradient in age. Residents optimal choose to rent a house in the early of lifecycle, and own a small one with labor income and wealth increasing. Some wealthy households choose to sell existing house and buy a bigger one to improve their housing consumption. Some households cash out a fraction of house equity to support their non-housing consumption at the end of lifecycle. Owning a house has investment attribution in some extent, and has substitution effect on the stock investment. A renter’s renting and owning choices are decided by age and worth-labor-income ratio, and the worth-labor-income ratio trigger bound of renting verse owning is U-shaped in age. A owner’s housing choices are decided by age, worth-labor-income ratio, house-value-labor-income ratio and loan-house-value ratio. The key of this decision is to weight the cost of renting verse owning, and consider the liquidity of asset.

References


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