The Effect of Housing on Portfolio Choice: House Price Risk and Liquidity Constraint *

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Abstract

Although the crowding out effect of housing on stock holdings through *house price risk channel* and *liquidity constraint channel* simultaneously has been studied in numerous research, the separate influences through the two individual channels on the crowding out effect has not been studied as much. In this paper, by exploiting unique Korean housing tenure type called *Jeonse* which affects household's investment decision only through the *liquidity constraint channel*, I study both effects separately. A calibrated life-cycle portfolio choice model with endogenous housing tenure choice shows that *liquidity constraint channel* only affects young households and households with low net wealth to income ratio. On the contrary, *house price risk channel* affects all types of households even including households with high wealth to income ratio. Regressions with household level panel survey shows that crowding out effect from *Jeonse* only exists for low net wealth to income ratio households while the crowding out effect from homewownership affects even the households with high net wealth to income ratio.

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1 Introduction

Housing is the single most important asset to most of the households. According to Yao and Zhang (2005), the 2001 Survey of Consumer Finance (SCF) showed that more than 66% of households have their own houses, and values of those housings account for 55% of their total wealth. In comparison, about 50% of households hold risky financial assets, and those account for only 12% of total wealth. This importance of housing asset leads many economist naturally to get interested in the effect of housing on household's portfolio choices.

After the conventional life-cycle model failed to explain the data of household's portfolio choices, economists started to focus on the effect of durable consumption goods, especially houses. Having such good is costly because, when households want to adjust the level of the consumption of the good, it requires adjustment costs. In addition, it requires households to pay huge amount of money to purchase it. Also, houses are risky goods due to their changing market values. Based on these natures of housing, most papers theorize and show that owning a house usually decreases households' demand for other risky assets such as stocks. Especially, they mention about *liquidity constraint channel* and *house price risk channel*. (Yao and Zhang (2005), Grossman and Laroque (1990), Faig and Shum (2002), Flavin and Yamashita (2002), Cocco (2005), Vestman (2019)).

Here, being liquidity constrained means that households cannot borrow fully against their future labor income or housing as in Boar et al. (2022). It does not depend on how much liquid asset the households have now in level but how much households have now compared to the future income or their illiquid assets they have. Even though households have only $1,000 currently, if they expect no income in the future, they are not liquidity constrained because anyway they have to live their life with $1,000. On the other hand, even though households have $100,000 currently, if they expect $1,000,000 of income in the future, and if they cannot borrow now against it due to the nature of incomplete market, we call them as liquidity constrained households. They would want to consume and invest their life-time wealth throughout their life-time smoothly. However, this liquidity constraint prevents them from making optimal consumption and portfolio choices.

Once we introduce housing in this thought experiment, we see what the *liquidity constraint channel* of housing crowding out effect means. Purchasing a housing connects the housing consumption and investment choice. Purchasing a house means that, when you want to consume a certain level of housing consumption, you need to save substantial portion of your current asset in the form of the housing asset. Though you can choose the renting, due to the benefits of homeownership such as positive expected return on housing asset and no transaction cost caused after purchasing a house, purchasing a house in the end becomes an optimal policy. Consequently, given the liquidity constraint nature of their life-cycle, households face harder frictions. With a limited amount of asset in their hand contemporaneously, while not being able to borrow fully against their future income, they need to decide how to allocate their wealth in hand across consumption, housing asset, and stock investment. In the end, housing asset substitutes the financial assets in our model, which we call *substitution effect*, which subsequently crowd outs risky financial assets such as stocks. In this mechanism, we see that the housing friction makes households face harder liquidity constraint problem when they make a portfolio choice including stock investment. We call this as *liquidity constraint channel* of the crowding out effect from housing.

On the other hand, *house price risk channel* means that return of housing asset is stochastic. This channel has two consequences in household portfolio choices. Firstly, due to the stochastic nature of the housing return process, once the households purchase houses, they face more risk in the sense that their total net wealth will fluctuate more. Given the concave utility functions, this generates a substantial risk, and decreases the future expected utility. In the end, this leads households to decrease their stock exposure. Secondly, if the housing return has negative correlation with the stock return, it generates a *diversification effect*. Negative correlation can generate the lower variance in their total portfolio including housing and stock, which induce homeowners to have more stock exposure while the positive correlation between housing return and stock return will do the opposite. This *house price risk channel* is well studied in Yao and Zhang (2005) and Kullmann and Siegel (2005) which empirically shows that the real estate risk can work as a possible background risk which decreases the households' exposure to stock market risk.

In previous studies, it has been impossible to understand these two channels of the crowding out effect separately because households are exposed to *liquidity constraint channel* and *house price risk channel* simultaneously upon purchasing their home. In addition, the size of the purchased house depends on households' characteristics such as net wealth and income which also affect their financial portfolio choices. These complications prevent researchers from understanding such channel's nature comprehensively and separately.

Unlike previous studies, I investigate the respective effects coming from these two channels of the crowding out effect of housing on stock holdings separately by exploiting the data variation coming from the unique Korean housing tenure type called *Jeonse*. By developing a life-cycle model where households optimally choose one of the housing tenures including *Jeonse* and, comparing its prediction with actual households' portfolio choice data from the Korea Labor Income Panel Study (KLIPS), I identify the existence of the *liquidity constraint channel* and *house price risk channel*, and study each channel's characteristics separately.

From our analysis, we see that the crowding out effect coming from *Jeonse* which likely accompanies only the *liquidity constraint channel* affects only the households with low net wealth to income ratio, while the *house price risk channel* affects even the households with high net wealth to income ratio in both of the model and data. Also, the size of crowding out effect decreases as households have higher net wealth to income both in the model and the data.

Data and model clearly shows the existence of the *substitution effect* which comes from the *liquidity constraint channel* while the *diversification effect* coming from *house price risk channel* appears only in the model. As diversification effect depends on the covariance structure between housing return and stock return which differs across households, it is natural that we cannot find any specific pattern in the data. As these effects also depend non-linearly on the stock market participation costs, we need to carefully interpret the data. In conclusion, data seems to support the heterogeneous correlation structures between housing return and stock return across the households while Korean households are experiencing very high stock market participation costs compared to the U.S. and other countries.

To my best knowledge, there is no paper which shows the empirically relevant data of two channels by decomposing the crowding out effect into *liquidity constraint channel* and *house price risk channel*. This paper contributes to the literature by showing how two channels of crowding out effect interact through the structural model and actual data of the unique housing institution, *Jeonse*.

2 Literature

Grossman and Laroque (1990) is the one of the early papers that analyzed household portfolio choices with durable consumption goods. They came up with a household who consumes a single durable good and assume that the household needs to pay adjustment cost when households adjust the consumption of durable goods. They argue that optimal consumption policy is characterized by three values: Two of them are threshold values while the other is the optimal consumption level. The interval made by two threshold values always contains the optimal consumption level. Whenever a household changes the consumption level, household tries to target the optimal consumption level. However, the household decides to change the consumption level only when the household's current consumption level is out of interval constructed by these threshold values. Though their current consumption level is not equal to optimal consumption level, if the value is within the interval constructed by the threshold values, they decide not to change their consumption level because the adjustment cost is too costly. Then, for portfolio choice, they argue that a household becomes less risk-averse when their consumption level is closer to the threshold values while household becomes more risk-averse when their consumption level is closer to the optimal consumption level. My model also captures such optimal housing consumption behavior. Once a household purchases a house, they sell it only when its value deviates too far from the optimal consumption level, which means my model also contains the effect of housing on investment decision in Grossman and Laroque (1990).

Faig and Shum (2002) argues that households are more likely to hold liquid assets if they have some illiquid projects which require constant financing in the future. Additionally, they use 1995 Survey of Consumer Finance to do cross-section regression to see the effect of these projects such as small business or home purchase. Their model predicts that more productive personal projects and larger penalties from discontinuing induce households to be risk averse. Because housing is also one of the important illiquid assets, Faig and Shum (2002) also shows that housing can crowd out the risky financial asset investment.

Flavin and Yamashita (2002) solves a static portfolio choice problem given the house value over net wealth as a state variable. It is assumed that households are leveraged for this home purchase. Their model predicts that, under reasonable risk aversion, high house value over net wealth (i.e. young households) induces households to hold smaller ratio of risky assets compared to low house value over net wealth (i.e. old households). Their leveraged position increases the risk, which makes households respond by reducing their stock holdinds. Also, the leveraged position due to mortgage actually induces the household to change not only the portfolio choice between risky asset and risk free asset but also the portfolio choice over risky assets.

The first comprehensive life-cycle context analysis for the effect of housing on portfolio choice was made by Cocco (2005). They find that, due to a huge down payment for housing purchase, younger and poorer households end up having limited financial wealth to invest in stocks which is connected to the *liquidity constraint channel* in this paper, which reduces the benefits of stock market participation. Consequently, with the fixed costs of stock market participation, younger and poorer households choose not to participate. Also, in their model, *house price risk channel* crowds out stock holdings, and this effect is larger for households with low financial net-worth. Though Cocco (2005) suggests these two important concepts, it only shows the empirical evidence of crowding out effect as a whole, not by component. In addition, they consider only homeowners without the endogenous choice of housing tenure, which is important to understand the size of crowding out effect.

On the other hand, Yao and Zhang (2005) made housing tenure choice endogenous in the life-cycle model so that households in the model can choose between renting and owning. They compare the renter and homeowners, yielding similar results to Cocco (2005). On the top of that, they additionally show that how the low correlation between housing return and stock return generate the *diversification effect* so that homeowners have higher stock ratio over financial asset than renters. Though Yao and Zhang (2005) explains the joint mechanism of housing tenure choice and stock investment choice, their model cannot explain the stock market participation puzzle. Their model predicts that renter should participate in the stock market more aggressively than homeowner because the expected labor income is a close substitute of safe bonds. However, data shows that homeowners participate in stock market more and hold more stocks than renters in general. Vestman (2019) explains this puzzle. To make the model compatible with these patterns in data, Vestman (2019) introduces preference heterogeneity with Epstein-Zin preferences and participation cost heterogeneity. He argues that, though there exists a crowding out effect in theory, the main forces that shape the joint distribution of homeownership rate and stock market participation rate in the data are the preference heterogeneity and heterogeneous stock market participation costs. High saving type households save much throughout their life time, which naturally gives them incentives to participate in stock market and to become homeowners while the low saving type households save less, which leads them to stay as renters and not to participate in stock market with their limited saving.

My paper is the closest to the spirit of these two papers Yao and Zhang (2005) and Vestman (2019). As a new contribution, I add another housing tenure type called *Jeonse*, and provide the actual portfolio choice data pattern from household level panel survey data, especially for the *Jeonse* tenants. As a result, I newly contribute to the literature by studying the *liquidity constraint channel* and the *house price risk channel* separately. In addition, I study the heterogeneous effects from the *liquidity constraint channel* and *housing price risk channel* depending on the household characteristics such as age and net wealth to income ratio in the data.

Chetty et al. (2017) studies the effect of housing on portfolio choice. With novel instrument variables such as housing price at the contract time, they separate the increase in house prices into changes from mortgage debt and changes from home equity, and use this separation to correctly evaluate the effect of housing. They find that increased home equity increases the stock holdings while increase in mortgage debt decreases the stock holdings, which can be interpreted as an wealth effect. Their paper is about understanding the effect of change in house price and home equity in the lense of wealth effect, not the crowding out effect. This paper tries to understand the effect of housing in life-cycle perspective to all households with the different types of housing tenures, and focus on the crowding out effect.

3 Unique Korean Housing Tenure Type: *Jeonse*

In this section, I explain the contract structure of *Jeonse* and how I decompose the crowding out effect into the *liquidity constraint channel* and the *house price risk channel*.

When households make *Jeonse* contracts, they decide the size of *Jeonse* deposit and the contract period. At the beginning of the contract, the *Jeonse* tenant gives a *Jeonse* deposit to the landlord. After that, the *Jeonse* tenant lives in the house for a period predetermined by the contract. During the period, *Jeonse* tenant does not have to pay any rent or they pay very little rent compared to the conventional rent contract. After the contract period ends, the landlord must return back exactly the same amount of money to *Jeonse* tenant, and the *Jeonse* tenant must leave the house. *Jeonse* can be understood as a contract that has characteristics of both conventional rent and home-ownership.

The unique structure of the *Jeonse* contract represented in Figure 1 allows us to separately identify the *liquidity constraint channel* from the *house price risk channel*. First, *Jeonse* tenants

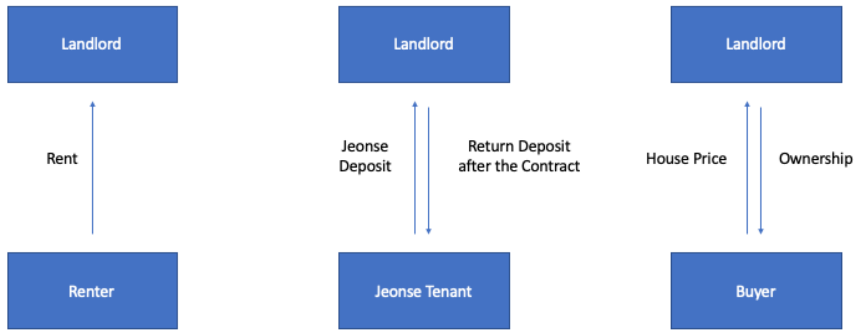


Figure 1: Housing Tenure Contracts

face the large *liquidity constraint channel* when they make a *Jeonse* contract. The national average of *Jeonse* deposit size from 2012 to 2019 was about 66.7% of the house price according to Korea Appraisal Board. In addition, there is a mortgage market for *Jeonse* tenants similar to that of home purchasers in Korea. Consequently, if we think in terms of down payment, the *Jeonse* contract also requires a huge amount of down payment like a housing purchase contract does. Assuming that households transition from a rent contract to *Jeonse* contract, we can easily imagine that they should experience a substantial *liquidity constraint channel*.[1]

Second, *Jeonse* tenants are not exposed to the *house price risk channel*. Since they are guaranteed by the contract to receive back the same amount of deposit they paid at the beginning of the contract, they do not have to worry about *house price risk channel*. Even though they are exposed to the rent rate fluctuation risk as mentioned in Sinai and Souleles (2005), we can still say that they are exposed to the same rent risk that the renter has because they have to renew the contract which is renewed usually for every 2 years. We naturally conclude that households who transition from rent to *Jeonse* contract experience the *liquidity constraint channel* only and not the *house price risk channel.* [2]

Figure 2 is the life-cycle pattern of housing tenure choice in Korea and the United States. The data is from 2017 Survey of Consumer Finance (hereafter SCF) and 2019 Korean Survey

[1] If we assume the house price is 100, *Jeonse* deposit ratio is 65%, and down payment ratio is 20% for both housing purchase and *Jeonse* contract, home buyer's down payment is 20 while the *Jeonse* tenant's down payment is 13, which is still huge.

[2] Default of landlords can be one potential risk to *Jeonse* tenants. However, according to the statistics from Korea Housing and Urban Guarantee Cooperation (hereafter HUG), the number of landlord default cases in 2016 they worked on was 23 while the number was 258 in 2018. Though there has been a rapid increase of the cases recently, it is very still low compared to the total number of *Jeonse* contracts where the monthly average of the number of *Jeonse* contracts is roughly 100,000 nationally. In addition, HUG provides good insurance product for *Jeonse* contract, which lead me to assume that households are not concerned about the landlord default when they make *Jeonse* contract.

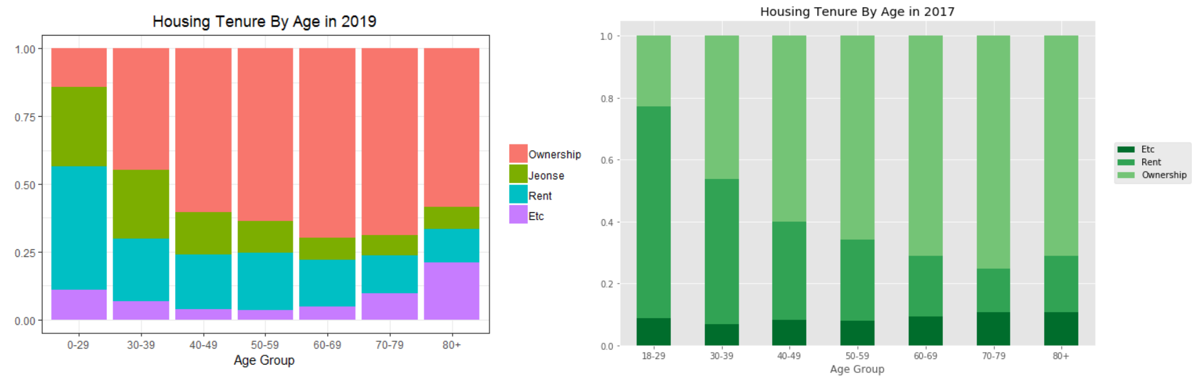


Figure 2: Housing Tenure Distribution in South Korea (Left) and the U.S. (Right)

of Household Finances and Living Conditions (hereafter SHFLC). We can see that the *Jeonse* contract does account for a significant portion of housing tenure types in Korea. Also, young households in Korea start as renters while saving money for a *Jeonse* deposit down payment. After they save enough amount of money for *Jeonse* deposit down payment, they transition to *Jeonse* contract while saving more money. After that, most of the households transition to homeownership. Especially, this life-cycle pattern implies that the crowding out effect of housing on stock holdings will be more pronounced among young households who have small saving and try to purchase a house by using mortgage.

4 Model

To understand the mechanism behind the joint life-cycle decision on housing tenure choice, stock market participation, and implied crowding out effect, based on Vestman (2019), Yao and Zhang (2005), and Cocco (2005), I present a quantitative life-cycle model where households endogenously choose whether to rent, make a *Jeonse* contract, or purchase a house. In addition, households decide how much to consume, save, and invest in risky assets. Labor income process, risky asset return process, and housing return process are exogenous in this model, which makes this model a partial equilibrium model.

4.1 Demographics and Risks

Households start their lives at 30 and die for sure at 100. In the model, one period (a) corresponds to 2 years which is a conventional rent and *Jeonse* contract periods. Consequently, households will solve 35-periods problem which corresponds to 70 years. At every period, they face the mortality risk, which makes them die next period with probability π_a. Accordingly, $1 - \pi_a$ means the probability that households survive and continuously solve the household problem in the next age $a + 1$ conditional on that the households have survived until age a.

4.2 Labor Income Process

Following Yao and Zhang (2005), the labor income process has an age-dependent deterministic growth rate of $[g_a]_{a=1}^{a=35}$. In addition, its growth rate is under identically and independently distributed Gaussian shock, denoted as ν_{a+1}. On the top of that, we include two other shocks which are ϵ^o_{a+1} and n^o_{a+1} which are perfectly correlated to ϵ_{a+1} and n_{a+1}. These are for generating correlations between labor income growth, stock return, and housing return, which is a structure also used in Vestman (2019). In the following formula where Y_{a+1} is the labor income (or can be interpreted as non-capital income) level, we have a full characterization of the labor income process.

$$log(Y_{a+1}) - log(Y_a) = g_{a+1} + \nu_{a+1} + \epsilon^o_{a+1} + n^o_{a+1}, \text{ for } a = 0, 1, ..., 34 \quad (1)$$

Unlike the specification in Cocco (2005), this process allows only transitory shock to the growth rate of labor income, i.e. permanent shock to labor income level. Lastly, I assume that households retire at age of 64 which are most common retirement age in Korea. Once the household retires, they only receive λ portion of the labor income which they received right before the retirement, and thereafter receive the same amount as retirement pension until their demise.

$$Y_{17} = \lambda Y_{16} \quad (2)$$

$$Y_{a+1} = Y_a, \quad a \geq 17 \quad (3)$$

4.3 Stock Returns

Stock returns are assumed to follow normal distribution with constant risk premium μ. Specifically, R_{a+1} is the gross stock return that households will experience at age of $a+1$. R_f is the gross risk free rate, and μ is the log risk premium. Stock return innovation ϵ_{a+1} follows i.i.d. normal distribution with mean zero. Note that ϵ_{a+1} is perfectly correlated with ϵ^o_{a+1} in labor income growth rate process, which will generate correlation between labor income growth and stock returns. Following formula fully characterizes the stock return process in the model.

$$log(R_{a+1}) - log(R_f) = \mu + \epsilon_{a+1} \quad (4)$$

4.4 Housing Returns

Housing return is assumed to be similar to that of a stock. However, as in the labor income process above, to assume the correlation between stock return and house price growth rate, we include additional term ϵ^H_{a+1} which is perfectly correlated with ϵ_{a+1}. Specifically, P^H_{a+1} is the unit house price that households face at age of $a+1$, μ_H is mean housing return, and housing return shock n_{a+1} follows i.i.d. mean zero normal distribution. So the following characterizes the housing return process.

$$log(P^H_{a+1}) - log(P^H_a) = \mu_H + n_{a+1} + \epsilon^H_{a+1} \tag{5}$$

4.5 Bequest Motive

Whenever households die, it is assumed that their descendants spend their remaining asset, and the households get utility from their descendants' utility. This is a common feature that appears in most of the life-cycle models to match the saving behaviors of old households. X_{a+1} represents the asset that was left to the descendants, α_f represents the annuity factor, and $\alpha_f X_{a+1}$ accordingly represents the money that descendants receive every period for T_b periods. Consequently, α_f is a function of T_b given the interest rate R_f. I assume that the bequeathed wealth will always be invested in 50-50 portion in risky and risk free assets. Then, every period, this money is optimally used by the descendants, who have the same Cobb-Douglas utility functions over consumption and housing. Consequently, the utility that households receive from bequeathing is the following. This approach is similar to that of Yao and Zhang (2005).

$$\sum_{k=1}^{T} \beta^k (\alpha_f X_{a+1}(1-\omega))^{1-\omega} (\frac{\alpha_f X_{a+1}\omega}{\tau P^H_a})^{\omega} \tag{6}$$

4.6 Preference

Given the specifications above, we define the household's finite horizon problem formally. Households have Cobb-Douglas preference over a non-durable consumption good C_a and durable housing good H_a where ω denotes the expenditure share for the housing good. Households have CRRA utility function over the combined consumption.

4.7 First Stage Problem

At the beginning of each age period, households solve the first stage problem regarding the housing tenure choice. Depending on whether households purchased the house in the previous period or not (also whether they received moving shock or not), households solve either the owner's problem or non-owner's problem.

4.7.1 Owner's Problem

For the owner, state variables are cash-in-hand X_a which is the sum of net wealth and contemporaneous labor income (or also can be understood as non-capital income), labor income Y_a, quantity of housing that was purchased in the previous period H_{a-1}, and the unit price of housing good P_a^H. In addition, I assume that households have information about what the probabilistic structures of stock and housing return processes, and labor income shock processes. Also, households know the deterministic future life-cycle profile of labor income growth rate. Owners who chose to buy a house in the previous period and did not get the exogenous moving shock solve the following problem:

$$\widehat{V}_a(X_a, H_{a-1}, Y_a, P_a^H) = \max(\bar{V}_a(X_a, Y_a, P_a^H), V_a^s(X_a, H_{a-1}, Y_a, P_a^H)) \tag{7}$$

Here, they can sell the house and move back to non-owner's problem, or they solve stayer's problem by deciding to stay. Here, $\widehat{V}_a$ denotes the optimal utility that households can achieve as an owner at age a. Similarly, $\bar{V}_a$ represents the optimal utility of a non-owner, and V_a^s is the optimal utility that households can achieve by staying in the previously purchased house. By choosing the maximum value between these two value functions, households effectively choose which housing tenure to be in.

4.7.2 Non-Owner's Problem

Non-owners who chose to rent or to enter a *Jeonse* contract and moving owners who chose to sell solve the following problem.

$$\bar{V}_a(X_a, Y_a, P_a^H) = \max(V_a^r(X_a, Y_a, P_a^H), V_a^j(X_a, Y_a, P_a^H), V_a^b(X_a, Y_a, P_a^H)) \tag{8}$$

Here, $V_a^r(X_a, Y_a, P_a^H)$ means the optimal value that households can achieve under the constraint that households must rent. $V_a^j(X_a, Y_a, P_a^H)$ and $V_a^b(X_a, Y_a, P_a^H)$ represent the counterparts for *Jeonse* contract and purchasing. Again, by choosing the maximum value among these three value functions, households effectively choose which housing tenure to be in.

4.8 Second Stage Problem

After households solve the first stage problem, depending on their housing tenure choice (rent, *Jeonse*, purchase, stay), they solve the second stage problem where they choose the optimal level of consumption, housing value, saving, and risky asset share. Problems solved by households with different housing tenure types are enumerated below.

4.8.1 Renter's Problem

Households who decide to rent a house solve the following problem.

$$
\begin{aligned}
V_a^r(X_a, Y_a, P_a^H) &= \max_{C_a, H_a, A_a, \alpha_a} \frac{(C_a^{1-\omega} H_a^{\omega})^{1-\sigma}}{1-\sigma} + \beta E_a[(1-\pi_a)\bar{V}_{a+1} + \pi_a \alpha_3 (\frac{X_{a+1}}{(P_a^H)^{\omega}})^{1-\sigma}] \\
s.t \qquad & X_a \geq A_a + C_a + \tau P_a^H H_a + 1[\alpha_a > 0]\gamma Y_a \\
& X_{a+1} = A_a R_f + \alpha_a A_a (R_{a+1} - R_f) + Y_{a+1} \\
& \alpha_a \in [0,1],\ A_a \geq 0,\ C_a \geq 0,\ H_a \geq 0
\end{aligned}
$$

C_a represents non-durable consumption, H_a represents the quality of house to live in, A_a represents the amount of saving, and α_a represents the share of financial saving invested in risky financial assets. Since this is the problem solved by households who decide to rent a house for this period, they are expected to solve non-owner's problem and expected to get $\bar{V}_{a+1}$ next period. τ is the rent to price ratio.

One thing to note here is the stock market participation cost γ. One time stock market participation cost has been used in many papers such as Haliassos and Michaelides (2003) and Gomes and Michaelides (2005) to explain the fact that many households do not participate in stock market. However, one time stock market participation cost often fail to explain the intermittent stock market participation studied in Fagereng et al. (2017) and Brandsaas (2018). So, I use a per-period stock market participation cost specification.

Lastly, I use stock market participation cost proportional to the income Y_a. Once households invest in stock market, they often spend time in investing by checking brokerage accounts or finding new information, which supports the proportional participation cost used here with opportunity cost interpretation. These type of participation costs can be found in numerous papers such as Alan (2006), Ball (2008), and Gomes and Michaelides (2008).

4.8.2 *Jeonse* Tenant's Problem

Households who decide to make a *Jeonse* contract solve the following problem.

$$
\begin{aligned}
V_a^j(X_a, Y_a, P_a^H) &= \max_{C_a, A_a, H_a, \alpha_a} \frac{(C_a^{1-\omega} H_a^{\omega})^{1-\sigma}}{1-\sigma} + \beta E_a[(1-\pi_a)\bar{V}_{a+1} + \pi_a \alpha_3 (\frac{X_{a+1}}{(P_t^H)^{\omega}})^{1-\sigma}] \\
s.t. \qquad & X_a \geq A_a + C_a + (\delta_J + \phi_J)\bar{J} P_a^H H_a + 1[\alpha_a > 0]\gamma Y_a \\
& X_{a+1} = A_a R_f + \alpha_a A_a (R_{a+1} - R_f) + Y_{a+1} + P_a^H H_a \bar{J}(1 - (1-\delta_J) R_M) \\
& \alpha_a \in [0,1],\ A_a \geq 0,\ C_a \geq 0,\ H_a \geq 0,\ X_a \geq \delta_J \bar{J} P_a^H \underline{H}
\end{aligned}
$$

Note that value function form is the same as that of a renter except the budget constraints. From the budget constraint, we see that households have to pay for housing service in a different way. $\bar{J}$ represents the ratio of *Jeonse* deposit to house price, and δ^J denotes the down-payment ratio for using *Jeonse* mortgage. Lastly, ϕ_J is the transaction cost for *Jeonse* contract. So, unlike renters, they pay the substantial amount of money to the landlord. I add additional constraint that cash-in-hand X_a should be larger than the down payment for *Jeonse* deposit of minimum quality housing $\underline{H}$. Consequently, we have $X_a \geq \delta_J \bar{J} P_a^H \underline{H}$.[3] Even for the lowest quality of housing, average *Jeonse* deposit is in the size of multiple of average worker's annual incomes, which is the reason why many households cannot choose *Jeonse.*

Another thing to note is that, in the law of motion of net wealth, households receive back the exactly same amount of *Jeonse* deposit they paid in previous period, which means there is no house price risk to *Jeonse* renter. Here, our mortgage structure is continuous refinancing. To make model tractable, it is assumed that, after one period, households pay the interest under the rate R_M and receive the down-payment they paid and decide to refinance or not depending on their next period housing tenure choice.

4.8.3 Buyer's Problem

Households who decide to buy a house solve the following problem.

$$
\begin{aligned}
V_a^b(X_a, Y_a, P_a^H) = \max_{C_a, A_a, H_a, \alpha_a} \; & \frac{(C_a^{1-\omega} H_a^{\omega})^{(1-\sigma)}}{1-\sigma} + \beta E_a[(1-\pi_a)(\xi \bar{V}_{a+1} + (1-\xi)\hat{V}_{a+1}) + \pi_a \alpha_3 (\frac{X_{a+1}}{(P_a^H)^{\omega}})^{1-\sigma}] \\
s.t \quad & X_a \geq A_a + C_a + (\chi + \delta + \phi_b) P_a^H H_a + 1[\alpha_a > 0]\gamma Y_a \\
& X_{a+1} = A_a R_f + \alpha_a A_a (R_{a+1} - R_f) + Y_{a+1} + P_a^H H_a (R_{a+1}^H (1-\phi) - (1-\delta) R_M) \\
& \alpha_a \in [0,1], \; A_a \geq 0, \; C_a \geq 0, \; H_a \geq 0, \; X_a \geq \delta P_a^H \underline{H}
\end{aligned}
$$

Note that now households expect two types of future value functions in next period. If they do not receive the moving shock, they are expected to solve the owner's problem $\widehat{V}_a$ in next period. On the other hand, if they receive any moving shock, they solve the non-owner's problem $\bar{V}_a$. As a owner, households should pay the maintenance cost χ. In addition, households should buy houses through a mortgage to get a housing service, where δ is the down payment ratio and ϕ is a transaction cost. Here, household wealth in next period depends on the house price realization in next period R_{a+1}^H, which can be interpreted as a house price risk. I add a similar down payment constraint as in the *Jeonse* tenant problem.[4]

[3] In the normalized model, I impose $\frac{X}{Y} \geq 1.064$ based on median household income and median *Jeonse* deposit for apartment in 2015.

[4] In the normalized model, I impose $\frac{X}{Y} \geq 1.7304$ based on median household income and median apartment price in 2015.

One last thing to note is that households actually pay the selling cost ϕ in the next period regardless of whether they get a moving shock and decide to sell. This is for tractability of the model. If households decide to stay in the house they purchased previously also in the next period, they will get compensated for this cost.

4.8.4 Stayer's Problem

If households decide to stay in the house they purchased before, they take H_{a-1} into account as an additional state variable and solve the following problem.

$$
\begin{aligned}
V_a^s(X_a, Y_a, P_a^H, H_{a-1}) = \max_{C_a, A_a, \alpha_a} \frac{(C_a^{1-\omega} H_{a-1}^{\omega})^{(1-\sigma)}}{1-\sigma} + \beta E_a[(1-\pi_a)(\xi \bar{V}_{a+1} + (1-\xi)\hat{V}_{a+1}) + \pi_a \alpha_3 (\frac{X_{a+1}}{(P_a^H)^{\omega}})^{1-\sigma}] \\
s.t \quad X_a \geq A_a + C_a + (\chi + \delta - \phi) P_a^H H_{a-1} + 1[\alpha_a > 0] \gamma Y_a \\
X_{a+1} = A_a R_a + \alpha_a A_a (R_{a+1} - R_f) + Y_{a+1} + P_a^H H_{a-1} (R_{a+1}^H (1-\phi) - (1-\delta) R_M) \\
\alpha_a \in [0,1], \; A_a \geq 0, \; C_a \geq 0
\end{aligned}
$$

Notice that the value function structure is the same with that of the buyer's problem. The only difference is that households get compensated for the selling cost ϕ. In addition, they do not have to pay the buying cost ϕ_b. This captures the benefit of staying in the same house, which comes from getting exempt from the adjustment costs.

4.9 Solution Method

Since this model is a finite horizon problem, we can solve it through backward induction. At the last period, since households surely die, they solve a optimization problem having a trade off between bequest and consumption only, which is a simple one period problem. After solving the last period value functions, we move backward and solve the problem of one period before the last period given these last period value functions. I use the grid method and standard linear interpolation for next period value functions. Shocks are discretized via Gaussian Quadrature. In addition, before actually solving the problem, to reduce the number of state variables, I normalize the value function with $\frac{X_a}{(P_a^H)^{\omega}}$ and choice variables with X_a so that policy variables will be $c_a = C_a/X_a$, $a_a = A_a/X_a$, $h_a = (P_a^H H_a/X_a)$, and $\alpha_a = \alpha_a$ following Yao and Zhang (2005).

5 Calibration

For most of the parameters, I externally calibrate by using data counterpart of the corresponding periods. For example, for π, I use the 2020 Life Table from Statistics Korea. Regarding household preference parameters including discount factor β, concavity of the utility function σ, housing expenditure ratio ω, bequest motives T_b, and stock market participation cost γ, I follow the parameter values used in Gomes and Michaelides (2005), Yao and Zhang (2005), Vissing-Jorgensen (2002), and Gomes and Michaelides (2008).

For other housing tenure relevant parameters such as τ and $\bar{J}$, I use sample average of periods from 2012 to 2018 with the aggregate time series data from Korea Real Estate Board. For δ and δ_J, using Survey of Household Finances and Living Conditions (SHFLC) which is another survey containing a detailed information regarding households' mortgage debt, I collect the households who actually transitioned from rent to *Jeonse* or homeownership through mortgage, and calculate the weighted average of their initial loan-to-value ratios according to the survey weight. Lastly, for ϕ_J, χ, ϕ_b, and ϕ, I use acquisition tax rate, brokerage fee for each housing tenure, and wealth tax law of 2015. For progressive taxes, I use the tax rate for the house price of which the bin containing the largest number of houses' market values in the data.

Moving toward to the asset returns, for R_f, I use rate for average 2-year saving deposit rate across banks from 2012-2018 while for μ, μ_h, σ_ϵ, and σ_h, I use the KOSPI index and national housing price index statistics from Korea Real Estate Board for the period from 2004 to 2018 to calculate as these are about households' expectation, and these longer periods capture the property of exogenous price processes more realistically.

Calibrated Parameters 1		**Value**	**Source**
Discount Rate	(β)	0.96^2	Gomes and Michaelides (2005)
CRRA Parameter	(σ)	5	Gomes and Michaelides (2005)
Housing Expenditure	(ω)	0.2	Yao and Zhang (2005)
Bequest Period	(T_b)	20/2	Yao and Zhang (2005)
Participation Cost	(γ)	2*0.0057	Vissing-Jorgensen (2002) & Gomes and Michaelides (2008)
Calibrated Parameters 2		**Value**	**Source**
Rent to House Price Ratio	(τ)	2*0.035	Korea Real Estate Board (2012-2018).
Jeonse Deposit to House Price Ratio	($\bar{J}$)	0.645	Korea Real Estate Board (2012-2018)
Down Payment Ratio for *Jeonse*	(δ_J)	0.416	SHFLC (2012-2018)
Down Payment Ratio for Home Purchase	(δ)	0.482	SHFLC (2012-2018)
Jeonse Contract Cost	(ϕ_J)	0.003	Brokerage Fee (*Jeonse*) (2015)
House Purchase Cost	(ϕ_b)	0.0165	Acquisition Tax + Brokerage Fee (Purchase/Sell) (2015)
Selling Cost	(ϕ)	0.004	Brokerage Fee (Purchase/Sell) (2015)
Maintenance Cost	(χ)	2*0.003	Wealth Tax (2015)
Calibrated Parameters 3		**Value**	**Source**
Gross Risk Free Rate	(R_f)	1.023^2	Bank of Korea ECOS (2012-2018)
Gross Mortgage Rate	(R_M)	1.047^2.	Bank of Korea ECOS (2012-2018)
Expected Log Risk Premium	(μ)	2*0.012	Bank of Korea ECOS (2004-2018)
Expected Log Housing Return	(μ_h)	2*0.011	Korea Real Estate Board (2004-2018)
Standard Deviation of Labor Income Shock.	(σ_y)	2*0.045	Ahn et al. (2021)
Standard Deviation of Stock Return Shock	(σ_ϵ)	2*0.104	Bank of Korea ECOS (2004-2018)
Standard Deviation of Housing Return Shock	(σ_h)	2*0.013	Korea Real Estate Board (2004-2018)
Correlation between Housing and Stock Return	(ρ_{hs})	0.00	Bank of Korea ECOS / Korea Real Estate Board (2012-2018)
Correlation between Labor Income and Stock Return	(ρ_{ys})	0.00	KLIPS / Bank of Korea ECOS(2012-2018)
Correlation between Housing Return and Labor Income	(ρ_{hy})	0.00	KLIPS / Korea Real Estate Board (2012-2018)
Moving Shock	(ξ)	2*0.04	KLIPS

Table 1: Calibrated Parameters

Regarding the life-cycle labor income profile, I regress the logged non-capital income (which will be defined in more detail in the empirical analysis section) on *Age* dummy variables for each year of data set. Then, I calculate the average of estimates across years. Finally, I fit the fifth order polynomial of Age on the average estimates of Age dummy variables estimated from the initial regressions. From this generated life-cycle labor income profile, I calculate the non-capital income growth rate life-cycle profile ($[\hat{g}_a]_{a=1}^{a=35}$). For the labor income shock, I calculate the average (2009-2016) of estimated variance of permanent income level shock in Ahn et al. (2021) which uses Korea Labor Income Panel Studies (KLIPS) which I also use in the empirical analysis section later. As I have only transitory shocks to growth rate which can be interpreted as permanent shocks to the income level in my model, I use this variance of permanent income shock only. By taking square roots on it, I calculate the standard deviation of the labor income shock. To take account the fact that I do not have a transitory income level shock in my model, when I estimate the life-cycle income profile, I include all types of incomes other than capital incomes. This contains any transfers from family members, governmental agencies, or social welfare programs. This definition of income allows me to think this income process containing all the households' endogenous responses to the transitory shocks to income level. Consequently, using this definition of income rather than conventional labor income for the model allows me to have no transitory income level shock in the model. For the covariance structure among exogenous processes, I use the procedure used in Vestman (2019) and Cocco (2005) with slight modifications[5]. For both of the methods, it turns out that correlations among stock return, housing return and labor income shocks are not statistically significant at all. It might come from the fact that I use only 11 years of observations. However, this statistical non-significance were also observed in several papers such as Fagereng et al. (2017) and Brandsaas (2018). Following them, I set correlations to zero. Lastly, for the exogenous moving probability (ξ), I calculate the portion of homeowners who moved out from their original houses for every year, and I calculate the average of such probability, which gives me 0.044. For the sample selection process that I use for the above calibration procedures, I explain further in the empirical analysis section later as I use the same sample these calibrations and the empirical analysis.

6 Optimal Policies

In this section, I present the households' optimal policies of the first stage problem and the second stage problem to explain how the model works and what the model says about the crowding out effect.

[5]More details are in the Appendix

6.1 Optimal Policies for First Stage Problem

First, we analyze the non-owner's problem where households choose tenure type among rent, *Jeonse* and homeownership. Left subplot in Figure 3 shows the optimal housing tenure policy for non-owner's problem. It is remarkable that these optimal policies can generate housing tenure pattern in Figure 2 if we assume young households that start with low cash-in-hand to income ratio (hereafter $\frac{X}{Y}$) and move to higher $\frac{X}{Y}$ through the net wealth accumulation. We can see that, as households have higher $\frac{X}{Y}$, households' optimal tenure choices move from rent to homeownership. The intuition is following. If we compare *Jeonse* and renting, because *Jeonse* is cheaper than renting in terms of cost for unit housing service[6], it is better to choose *Jeonse*. However, when households have very low saving compared to future labor income, it is better to rent because *Jeonse* forces households to save substantial amount of their assets in *Jeonse* deposit, which hampers the consumption smoothing problem. With low accumulated wealth compared to the upcoming future income, becoming a *Jeonse* tenant will force households to oversave and sacrifice high marginal utility for the current period. In addition, the fact that households need to have enough net wealth for the downpayment prevents households with low $\frac{X}{Y}$ from becoming *Jeonse* tenants or homeowners.

On the other hand, if the households have very large asset compared to the future labor income, which means high $\frac{X}{Y}$, using most of their asset for *Jeonse* deposit which corresponds to a risk free asset with housing service as dividends makes their asset position too safe. Given the positive expected return on housing, once households accumulate their wealth enough, purchasing a house is better than living on a *Jeonse* contract. Additionally, households prefer to buy a house because once they move in, unless they move out, they do not have to pay the moving costs which they have to pay every period if they choose to use *Jeonse*. Moving cost proportional to the housing prices becomes non-negligible as households buy more expensive houses. These optimal policies can generate the similar pattern to the distribution of housing tenures in actual data represented in Figure 2. In addition, it quantitatively matches the sample mean of $\frac{Net\ Wealth}{Income}$ ratio for each tenure of actual household survey data presented in 2. 1 period in the model corresponds to 2 years. In addition, cash-in-hand X in the model corresponds to sum of net wealth and contemporaneous labor income. Consequently, $\frac{X}{Y}$ in the model corresponds to $\frac{1}{2} \times \frac{Net\ Wealth}{Income} + 1$ in the data. Based on this relationship, our model predicts that households with $\frac{X}{Y}$ between 1 and 1.5 choose renting, which means in the data, $\frac{Net\ Wealth}{Income}$ of renter should be between 0 and 1 while the actual sample mean of renters' $\frac{Net\ Wealth}{Income}$ is 1.47 which is very close to the model's prediction. Model also predict $\frac{Net\ Wealth}{Income}$ of *Jeonse* tenant should be between 1 and 7 where the sample mean of $\frac{Net\ Wealth}{Income}$ of *Jeonse* tenant is 5.83, and the model predict that $\frac{Net\ Wealth}{Income}$ of homeowners should be larger than 7 where

[6] If a household rent a house, they have to pay $\tau P_a^H H$ which is $0.07 \times P_a^H H$. On the other hand, if a household choose *Jeonse* contract, they have to pay, including the opportunity costs, $\phi_J \bar{J} P_a^H H + (1-\delta_J)\bar{J} P_a^H H(R_M - 1/R_f) + \delta_J \bar{J} P_a^H H(R_f - 1/R_f)$ which is $0.0484 P_a^H H$. Consequently, *Jeonse* is cheaper in unit housing level.

the sample mean of $\frac{Net\ Wealth}{Income}$ of homeowners is 16.82. One thing to note is that, in the data, there are still many renters and *Jeonse* tenants whose $\frac{Net\ Wealth}{Income}$ is very high, which is out of our model predictions. As households live in different areas with different housing markets having different rent to price ratio τ or different *Jeonse* deposit size $\bar{J}$, it is natural that we have some misprediction here. I believe that there are some exogenous forces which affect tenure choices but not in our model.

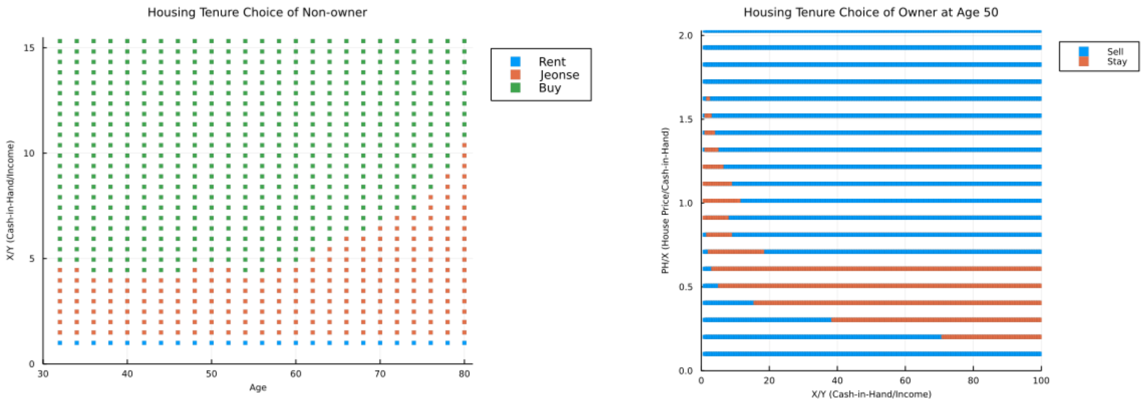


Figure 3: Optimal Housing Tenure Policy

Right subplot of Figure 3 also shows the first stage optimal policy for the owner's problem. This decision is about whether they will move to a new house or stay. As we can see in the figure, optimal policy is defined as a threshold rule. For specific value of $\frac{X}{Y}$, there is an optimal level of housing consumption $\frac{P^H H}{X}$, and even though the current housing consumption level exhibits a minor deviation from that optimal level, households do not adjust their housing consumption to avoid the moving costs. However, once they deviate too much from their optimal housing consumption level, they sell their houses. This pattern is also observed in Grossman and Laroque (1990) and Yao and Zhang (2005), which means my model also captures the crowding out effects discussed in both papers.

6.2 Optimal Policies for Second Stage Problem

Second stage problem is defined for each tenure type. Thanks to the normalization, at each age, we can depict optimal policies as ratios over cash-in-hand as like consumption share $\frac{C}{X}$, housing expenditure share $(\frac{\tau P^H H}{X}, \frac{\delta_J \bar{J} P^H H}{X}, \frac{\delta P^H H}{X})$ for renter, *Jeonse* tenants, and homeowners respectively. In this subsection, rather than thinking about the consumption behavior, we directly jump into the portfolio choices.

To understand model's implications on portfolio choices correctly, carefully defining the portfolio choice variables of the model is very important. Firstly, I define net worth in following ways. For renters, A_a is equal to their net worth W_a^r as they have no any other asset. On the other hand, for *Jeonse* tenants, I define the sum of $\delta_J \bar{J} P^H H_a$ and A_a as their net worth W_a^J as downpayment for *Jeonse* deposit can also be understood as an asset. Lastly, I define the sum of A_a and $\delta P^H H_a$ as net worth W_a^b for homeowners in a similar vein. I consider A_a corresponding to financial asset (or it can be interpreted as asset other than the housing related assets.), and $\alpha_a A_a$ corresponding to risky financial asset (or it can be understood as risky assets other than the housing related assets.)

Then, with the above definitions, I can define three portfolio choice variables for each tenure: 1) ratio of financial assets over net worth $\frac{A_a}{NW_a}$, 2) ratio of risky financial assets over financial assets $\frac{\alpha_a A_a}{A_a} = \alpha_a$, and 3) ratio of risky financial assets over net worth $\frac{\alpha_a A_a}{NW_a}$.

$\frac{A_a}{NW_a}$ shows how net worth is distributed over financial asset versus housing asset. Housing serves not only as a consumption but also as an asset in this model. As we will see, housing assets substitute financial asset out which is the *substitution effect.* $\frac{A_a}{NW_a}$ measures how much of this substitution happens as one channel of the crowding out effect which is related to the *liquidity constraint channel*. Next, $\frac{\alpha_a A_a}{A_a} = \alpha_a$ is a risky asset portfolio weight among financial assets. This measures how much of the risk is taken by households in their financial asset. Yao and Zhang (2005) shows that, in their model, while homeowners at the trigger bound of owning versus renting have lower equity proportion in net worth compared to the renters, homeowners actually hold higher equity proportion in their financial assets compared to the renters. They argue that this comes from the fact that housing return and stock return have low correlation, which gives a portfolio diversification benefit to the homeowners if they hold both housing and stocks which is called as *diversification effect.* This measure allows us to understand better how *diversification effect* works in each tenure. In my context, this can be understood as a part of *house price risk channel* which means the stochastic nature of the return of housing asset. Lastly, $\frac{\alpha_a A_a}{NW_a}$ shows how total crowding out effect turns out to be. By comparing this measure across housing tenures, we clearly see how the total crowding out effect works.

Under an ideal identification condition, different housing tenures should be forcefully imposed to otherwise identical households to see the true causal effect of the housing on portfolio choices. In addition, those crowding out effects should depend on parameters (Φ, Φ_J, τ) defining the characteristics of tenures such as wealth tax, adjustment cost, and rent to price ratio. In addition, characteristics of households and asset return processes (Z) such as correlations across returns of assets, stock market participation costs, and households' belief on asset return processes also affect the crowding out effect size as in Equation 9 and Equation

10.

$$E(PF|\frac{X}{Y}, Age, Renter(\tau), Z) - E(PF|\frac{X}{Y}, Age, Homeowner(\Phi), Z) \tag{9}$$

$$E(PF|\frac{X}{Y}, Age, Renter(\tau), Z) - E(PF|\frac{X}{Y}, Age, Jeonse(\Phi_J), Z) \tag{10}$$

$$PF \in [\frac{A_a}{NW_a}, \frac{\alpha_a A_a}{A_a}, \frac{\alpha_a A_a}{NW_a}]$$

Our model provides theoretical predictions on these crowding out effects as we can forcefully impose the different housing tenures to identical households by comparing the optimal policies for second-stage problems of different housing tenures. Note that, in actual model, only one housing tenure is optimally chosen at each combination of $\frac{X}{Y}$ and Age. So this is a hypothetical exercises which is different from the model simulation. However, on the other hand, as we have some households in the data who do not follow the optimal housing tenure policies in the model, who are likely affected by other exogenous tenure shifters, This practice should provide a good lens for interpreting the data. Below, I present the figures representing optimal portfolio choices, and the resulting crowding out effects. To understand the model's implications on the crowding out effect intuitively, I present the optimal portfolio choices and the resulting crowding out effects 1) across $\frac{X}{Y}$ at the age of 50 and 2) across ages at $\frac{X}{Y}$ equals to 10 which represent the cross-sectional pattern best.

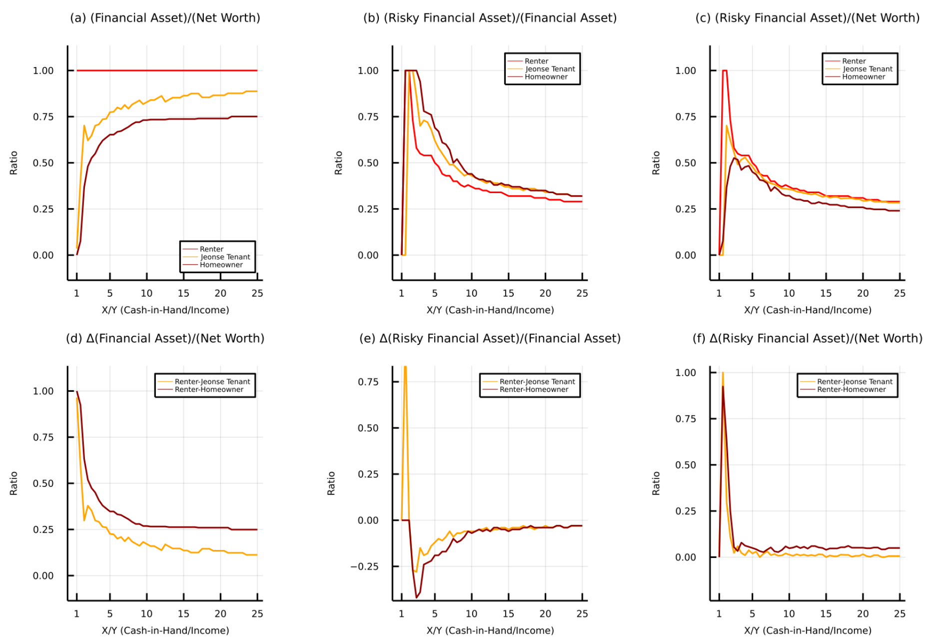


Figure 4: Optimal Portfolio Choices for All Tenures over $(\frac{X}{Y})$ Cross-Section

Firstly, I present the optimal portfolio choices across $\frac{X}{Y}$ for each tenure at the age of 50. In

Figure 4, top row shows the size of each measure while the bottom row shows the difference of each measure of the *Jeonse* tenant and homeowner with that of the renter. Firstly, in (a), we clearly see the *substitution effect* happening by each housing tenure. Because *Jeonse* tenant and homeowners save not only in financial assets (A_a) but also in housing assets $(\delta_J \bar{J} P^H H_a)$ or $(\delta P^H H)$, portion of financial asset in their total net worth is much lower. This *substitution effect* is strongest to the households with the lowest $\frac{X}{Y}$. As households get less liquidity constrained, which means higher $\frac{X}{Y}$, this substitution effect decreases as noted in (d), but not goes to zero. For *Jeonse* tenant, even though households have high $\frac{X}{Y}$, still 13% of their total net worth in the form of *Jeonse deposit* while, for homeowners, 25% of their total net worth in the form of housing asset. This may come from the fact that housing asset is a good investment given our housing return stochastic process parameters with high return and low standard deviation. In addition, it is because these housing tenures force households to save much of their wealth in the form of housing related asset to consume housing services. This *substitution effect* can be understood as coming from *liquidity constraint channel* of housing crowding out effect. It decreases as households get less liquidity constrained, which means higher $\frac{X}{Y}$.
Moving toward to (b), we see $\frac{\alpha_a A_a}{A_a} = \alpha_a$ measure is higher for *Jeonse* tenant and homeowners than renters, which is called as *diversification effect* by Yao and Zhang (2005). As renters have all of their assets in the form of financial asset, investing all of them in the risky financial asset is too risky. However, as *Jeonse* tenants and homeowners have housing assets too, they may take more risks in their financial portfolios. Especially, *Jeonse* deposit corresponds to the risk free asset where the dividend is housing service. Consequently, it is natural that *Jeonse* tenant have higher $\frac{\alpha_a A_a}{A_a} = \alpha_a$ than renter. In addition, as we assume no correlations across housing return and stock return, investing in housing also provide diversification benefit from investing in stocks. Again, as households go to higher $\frac{X}{Y}$, this *diversification effect* also gets smaller as depicted in (e). As the ratio of financial asset over net worth goes up, they have lesser needs to have high portion of equity position in their financial assets. This effect can be interpreted as a part of the *house price risk channel*, and it seems we have a lesson here. Housing price risk crowds out the stock holdings more if the housing return and stock returns are strongly correlated as studied in Yao and Zhang (2005). With low correlation or zero correlation, actually the stochastic essence of housing price induces households to have higher stock weight in their financial assets. However, households also adjust the margin of their stock proportion over total net worth not only through $\frac{\alpha_a A_a}{A_a} = \alpha_a$ but also through $\frac{A_a}{NW_a}$. In the end, we should check $\frac{\alpha_a A_a}{NW_a}$ to see the total crowding out effect. We will dig deeper in the next subsection about how this *diversification effect* changes depending on the correlation structure between assets.

Lastly, moving gears toward to the total effect on $\frac{\alpha_a A_a}{NW_a}$ in (c), we see the crowding out effect clearly exists both for *Jeonse* tenant and homeowners. Two effects in (a) and (b) are combined and generate this pattern. One notable observation is that the crowding out effect is higher for households with low $\frac{X}{Y}$. As households get higher $\frac{X}{Y}$, which means less liquidity constrained, most of the effect goes away. The other notable observation is that while the crowding out effect from *Jeonse* completely goes away with high $\frac{X}{Y}$ which is 0.006, the crowding out effect for homeowners remain even with the high $\frac{X}{Y}$, which is estimated as 0.0497. It seems that *liquidity constraint channel* disappears once households are not liquidity constrained anymore, while the *house price risk channel* remains. For the case of *Jeonse* tenant, even though the financial assets are crowded out by the *Jeonse* deposit, by adjusting $\frac{\alpha_a A_a}{A_a} = \alpha_a$, they achieve the optimal risk exposure. This is the reason why we should check $\frac{\alpha_a A_a}{NW_a}$ to check the total crowding out effect.

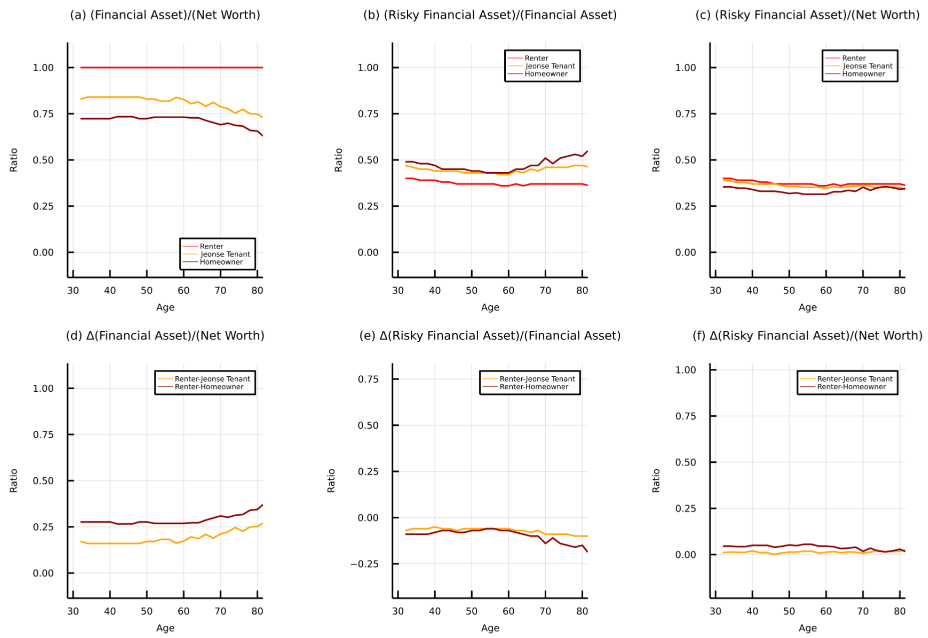
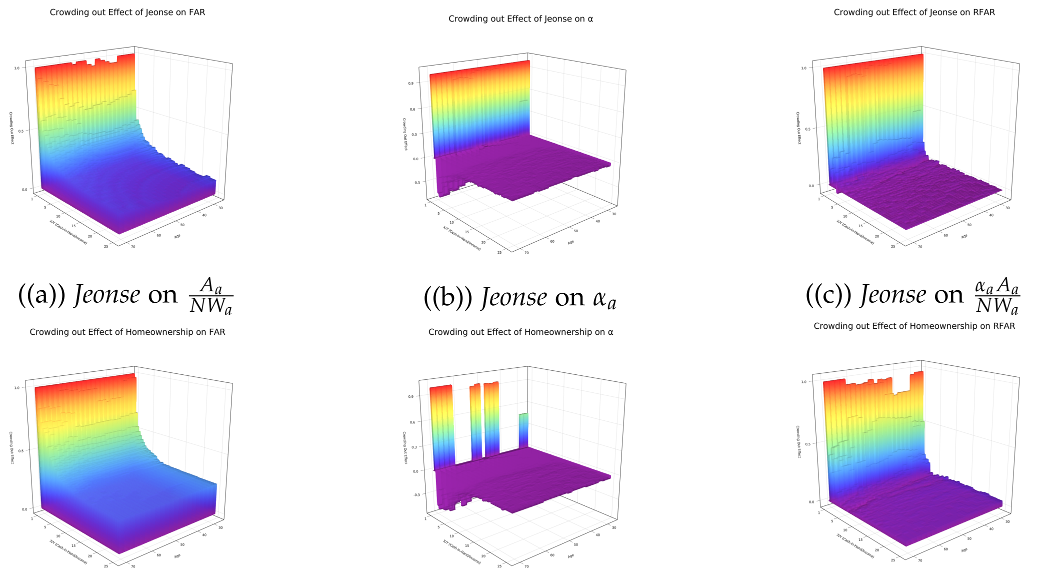


Figure 5: Optimal Portfolio Choices for All Tenures over (Age) Cross-Section

Moving toward to the age cross-section, I present the optimal portfolio choices of all housing tenure with $\frac{X}{Y}$ equals to 10 across all ages. Other than the case of extremely low $\frac{X}{Y}$, we find similar patterns for any $\frac{X}{Y}$. In Figure 5, in (a) and (d), we find that ratio of financial asset over net worth goes down as households get older both for *Jeonse* renter and homeowner. This comes from the fact that housing is not only a kind of asset but also a kind of consumption. Following the consumption smoothing motives, households consume more and save less as they get closer to the end of their life-time. Interestingly, in (b) and (e), we can see that α gets higher as they get older both for *Jeonse* tenants and homeowners. As they have lower financial asset, to achieve the optimal equity exposure level, they try to increase their risky asset ratio among the financial assets. Finally, in (c) and (f), we see the total crowding out effect differ for *Jeonse* tenant and homeowners. For *Jeonse* tenant, given the relative high $\frac{X}{Y}$, there is no *liquidity constraint channel*, which generates zero crowding out effect. However, homeowners show the sustained crowding out effect which goes away only when they get older than 70.

Figure 6 shows the crowding out effects throughout all ages and $\frac{X}{Y}$. We see that the overall patterns that we saw at Figure 4 and Figure 5 appear again across the *Age* and $\frac{X}{Y}$. Crowing out effect from *Jeonse* fades away while crowding out effect from homeownership sustains. We see some exotic optimal policies in 6(e) with low $\frac{X}{Y}$ especially for homeowners and *Jeonse* renters. However, keep in mind that when $\frac{X}{Y}$ is low, because they only have very small portion of A, either having a very high α or very low α do not make much difference in terms of total portfolio choices $\frac{\alpha_a A_a}{NW_a}$.



((a)) *Jeonse* on $\frac{A_a}{NW_a}$ ((b)) *Jeonse* on α_a ((c)) *Jeonse* on $\frac{\alpha_a A_a}{NW_a}$

((d)) Homeowner on α_a ((e)) Homeowner on α_a ((f)) Homeowner on $\frac{\alpha_a A_a}{NW_a}$

Figure 6: Crowding out Effect in Baseline Calibration

In the end, we see that the crowding out effect comes from the nature of the incomplete market. The fact that they have to smooth their consumption and achieve the optimal portfolio while cannot borrow against their future labor income, which is the *liquidity constraint channel*, leads households to endogenously respond to it. Housing structure affects the stock investment behavior by topping additional constraints on it which connect the housing consumption, saving, and portfolio choices on the household's problem. Being a homeowner or *Jeonse* tenant forces households to save substantial amount of their asset in the form of housing to consume a housing service, which exacerbate *substitution effect* meaning strong *liquidity constraint channel.* In addition, as housing has a stochastic return process, it has a *diversification effect* but also restrains the total risk taken by households through the stock investment, which means *house price risk channel*.

6.3 Determinants of Crowding Out Effect

In this subsection, I show how these crowding out effects change depending on the stock market participation costs γ and correlation structure between housing return process and stock return process ρ_{hs}.

These two comparative statics analyses have important meanings. For γ, it is related to the *liquidity constraint channel*. As households have to pay γY participation costs, in the model, if the households do not have enough financial assets A, households have no incentives to participate in the stock market as they cannot get much from participating in stock market compared to the participation cost. Through this, crowding out effect can be affected non-linearly via two channels with the stock market participation cost. First, purchasing a house or making a *Jeonse* contract leads households to put much portion of their wealth in the form of housing asset, which decreases A as we saw above. Given these decreased A, higher stock market participation costs prevent homeowners and *Jeonse* tenants from participating in stock market, which exacerbate the crowding out effect defined in Equation 9 and Equation 10. Secondly, too high participation costs kill every participation even from the renter who is not affected by the *substitution effect*, which makes crowding out effect as zero. This comparative statics can provide us how this intuition works. In addition, assuming the higher stock market participation costs for Korean households compared to the US households seems reasonable based on the historical experiences and the different levels of developments of financial market in Korea and the US.

On the other hand for ρ_{hs}, this parameter affects the *house price risk channel*. In an easy word, negative correlation between housing return and stock return effectively decreases the additional risk from housing when households have both of stocks and housing due to *diversification effect* observed above and also in Yao and Zhang (2005). While our baseline calibration assumes no correlation, I assume high positive correlation in this comparative statics to see how the crowding out effect behaves. Consequently, these two comparative statics analyses will give us how we should think about the crowding out effect present in the data presented in the empirical analysis section.

6.3.1 High Correlation between Stock Return and Housing Return

In this subsection, we present the optimal portfolio choices of households with higher correlation between stock return and housing return processes. While I set correlation ρ_{hs} as zero at the baseline case, here I set correlation as 0.3. Figure 7 shows the optimal portfolio choices at the age of 50 across $\frac{X}{Y}$. Though it is very similar to the Figure 4, it has some notable differences. As we see in (e), α_a of homeowners is similar (and even lower with high $\frac{X}{Y}$) to that of *Jeonse* tenant while homeowners α_a was much higher at the baseline case. Consequently, the resulting crowding out effect in (f) is much stronger and prominent. It can be understood as a decreased benefit of diversification.

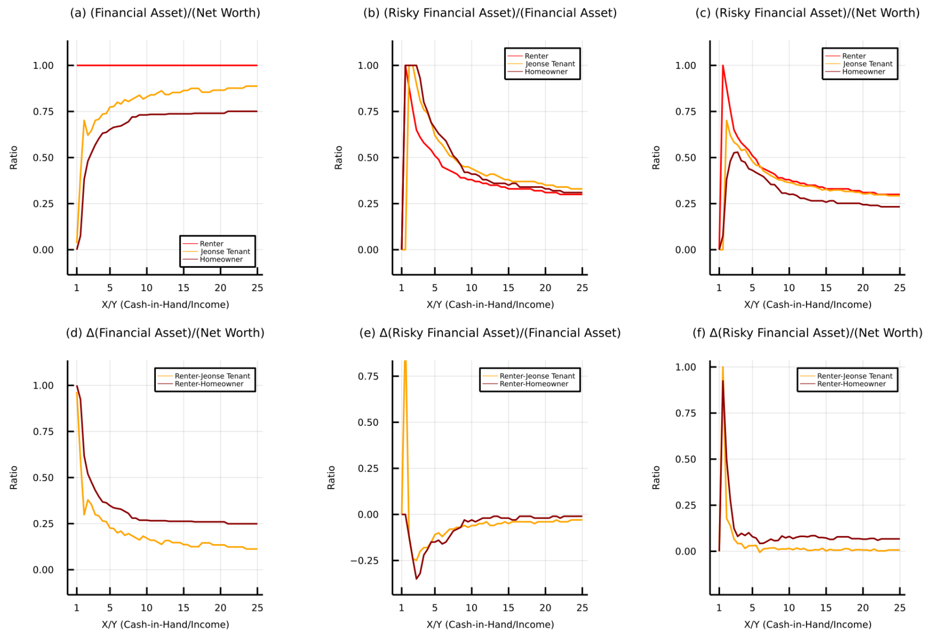


Figure 7: Optimal Portfolio Choices for All Tenures over $\frac{X}{Y}$ Cross-Section with High ρ_{hs}

Moving toward to the optimal portfolio choices of households across ages, we see the similar patterns qualitatively again. Only difference is that the magnitude of the crowding out effect from homeownership becomes larger. Graphs for all $\frac{X}{Y}$ and age are in Appendix.

6.3.2 High Stock Market Participation Costs

In this subsection, we analyze the case with high stock market participation cost (γ). This change especially can cause the qualitative change of the optimal portfolio choices due to the non-linear effect discussed above. While we set γ as 0.0057 at the baseline case, here we set it as 0.05.

In Figure 9, we see that the crowding out effect pattern is strikingly different. Behavior of $\frac{A_a}{NW_a}$ is very similar to that of the baseline case. However, α_a patterns is now very different. Due to high stock market participation costs, renters only who has $\frac{X}{Y}$ higher than 10.5 participate in the stock market at all. With the decreased A due to housing tenure, if that household is a *Jeonse* tenant or homeowner, they participate in stock market with only $\frac{X}{Y}$ higher than 14. Consequently, it kills out the crowding out effect for households with $\frac{X}{Y}$ lower than 10.5 while suddenly increases the crowding out effect for households with $\frac{X}{Y}$ between 10.5 and 14. Once household equips with $\frac{X}{Y}$ more than 14, the crowding out effect again drops and converges to zero as we saw at the baseline cases.

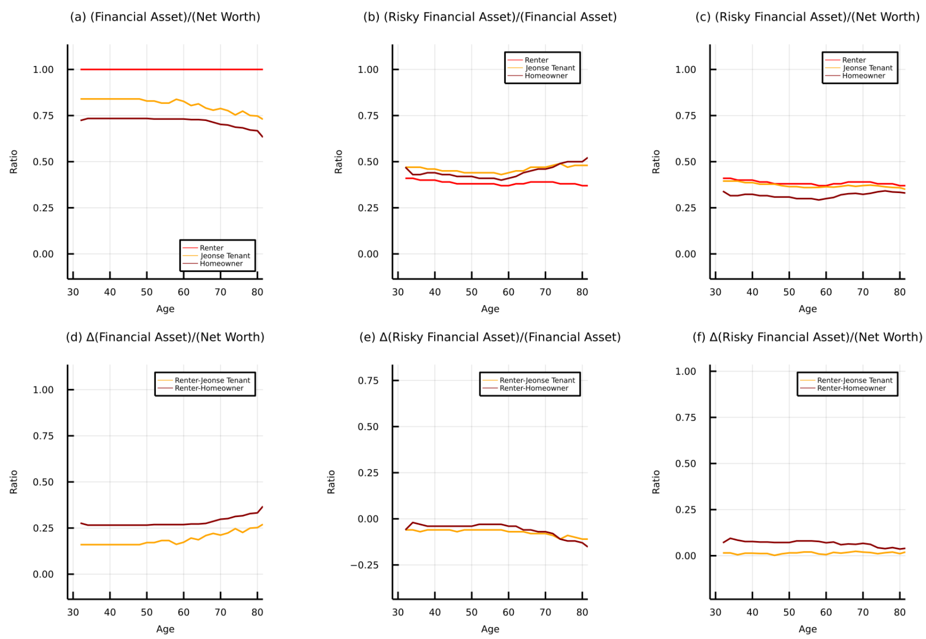


Figure 8: Optimal Portfolio Choices for All Tenures over (Age) Cross-Section with High ρ_{hs}

Such non-linearity strikingly represented in Figure 10. As this is the optimal policies of households with $\frac{X}{Y}$ equals to 10 at different ages, they show zero crowding out effect across any Age. It is very natural to imagine that households should have very different stock market participation costs to each other based on their different peer group, or education level. Consequently, it should be difficult to capture any strong pattern of such effect by exploiting a panel data. In the next section, we try our best to capture the crowding out effect patterns from the households survey panel data.

7 Empirical Analysis

To study whether these patterns of crowding out effect present in the data, I study how renters, *Jeonse* tenants, and homeowners make portfolio choices through the household panel data called Korea Labor and Income Panel Study (hereafter KLIPS.) KLIPS started in 1998 with 5,000 households as initial household samples. All the new households generated from the initial household sample also keep tracked. After the 2009, 1,721 households were added in the sample, and with the another addition of households in 2018, currently 12,134 households are being tracked. This household panel survey sample was constructed to represent the whole Korean population. Every year, between April and September, households in sample get surveyed. It has detailed data on households' demographics, incomes, expenditures, assets, and debts. I made all variables as real variables in price level of 2020 by using the consumer price index.

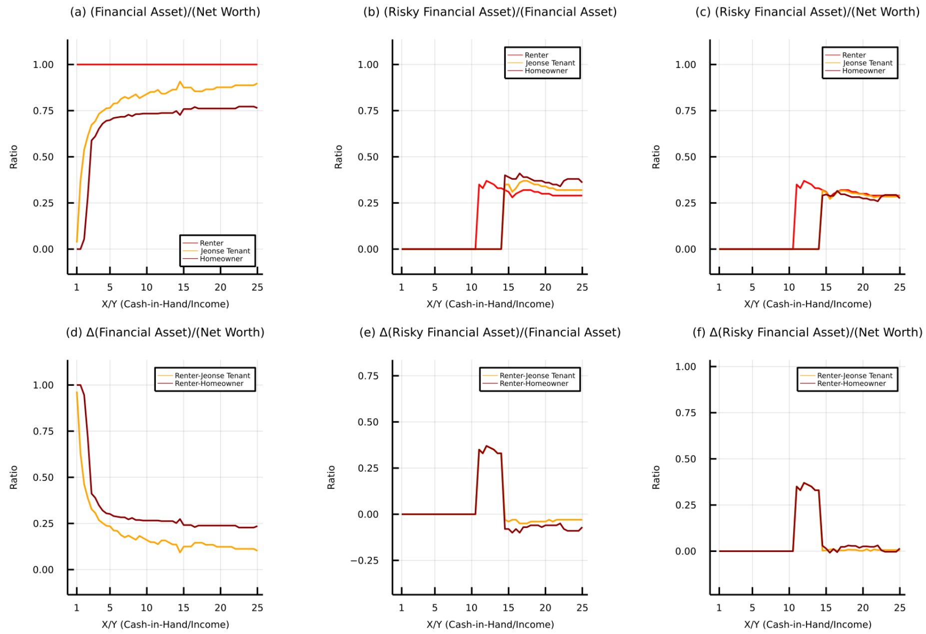


Figure 9: Optimal Portfolio Choices for All Tenures over $\frac{X}{Y}$ Cross-Section with High γ

7.1 Descriptive Statistics

To study the portfolio choices of households properly, coming up with the proper definitions of portfolio variables and balance sheet variables is important. Followings are how I define households' net wealth, financial assets, risky financial assets, liabilities, and households' non-capital incomes. Net wealth (hereafter W) is defined as the sum of financial assets (herefater FA) and real assets (hereafter RA) minus any types of liabilities (hereafter LB). Defining FA requires additional consideration especially when we consider *Jeonse* deposit. *Jeonse* deposit can be interpreted as risk free financial asset which is a kind of collateralized lending with housing services as dividends. On the other hand, *Jeonse* deposit can be interpreted as a housing related asset in the sense that it crowds out any other types of financial assets. I define FA as including bank deposits, mutual funds, stocks, bonds, saving insurances, and private lending but not *Jeonse* deposit or rent deposit. It is to facilitate the comparison of its crowding out effect with that of the model. Among these financial assets, I consider sum of stocks, bonds, and mutual funds as risky financial assets (hereafter RFA). RA include real estate assets including house of living, cars, lands, and any other type of real assets. LB includes any types of borrowings from the bank (including mortgage) and private borrowing from individuals. *Jeonse* deposit and rent deposit are also included in LB if the responding households are landlords. Lastly, non-capital incomes (hereafter Y) includes labor incomes, pensions, social insurance, and other family transfer incomes. I include all types of incomes other than incomes from the housing or financial investments to incorporate the households'

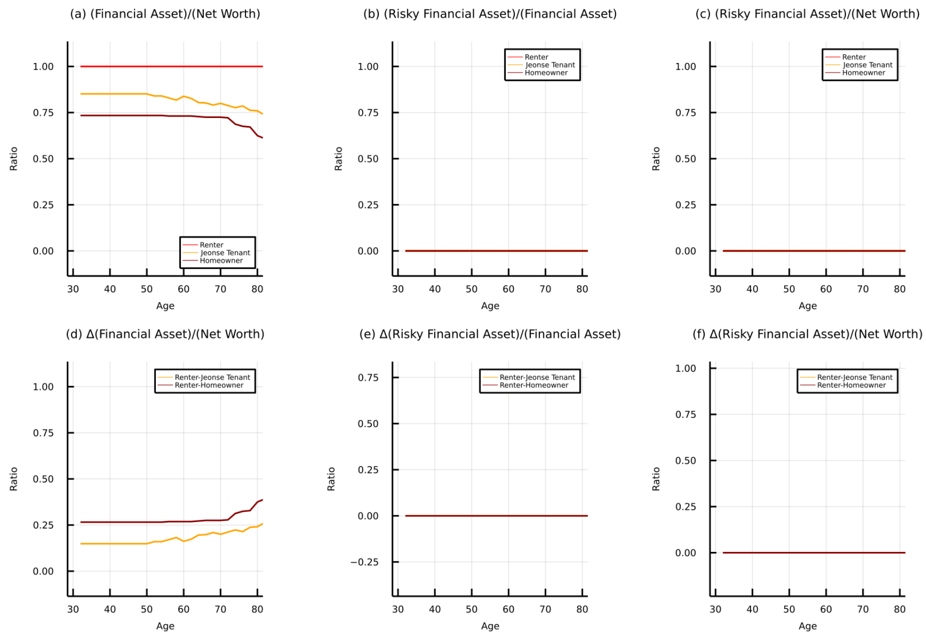


Figure 10: Optimal Portfolio Choices for All Tenures over (Age) Cross-Section with High γ

ability to cope with idiosyncratic labor income shock which is not present in my model.

Based on these assets and liabilities variables, I define portfolio choice variables as following. Financial asset ratio (hereafter FAR) is defined as $\frac{FA}{W}$, while Risky financial asset ratio (hereafter $RFAR$) is defined as $\frac{RFA}{W}$. Additionally, I define the risky financial asset ratios over financial asset (hereafter $Alpha$) as $\frac{RFA}{FA}$. When I study above variables only for households who ever participated in stock market, I put $c-$ in front of these variables to represent 'conditional'. (e.g. $c - RFAR$.) As a participation dummy, I define stock market participation (hereafter SMP) as $1[Risky\ Fin\ Asset > 0]$. Lastly, net wealth to income ratio will be denoted as $(\frac{W}{Y})$ following the definitions made above as a corresponding variable to the model's most important state variable $\frac{X_{model}}{Y_{model}}$. Note that X_{model} in the model is cash-in hand which is a sum of net wealth and contemporaneous labor income. In addition, one period in the model is 2 years. Consequently, the following relationship holds, $\frac{X_{model}}{Y_{model}} = \frac{W_{data}+2Y_{data}}{2Y_{data}}$. Note that FAR corresponds to $\frac{A_a}{NW_a}$, $Alpha$ corresponds to $\frac{\alpha_a A_a}{A_a} = \alpha_a$, and $RFAR$ corresponds to $\frac{\alpha_a A_a}{NW_a}$ in the model. By using each variable, we will compare the model predictions with the data pattern.

Table 2 is the table of summary statistics for the variables of interest. It shows the stark differences across housing tenures. While owners are usually older than renters and *Jeonse* tenants, they also have more net wealth W, more income Y, and higher $\frac{W}{Y}$ ratio, as predicted by our model. Keep in mind that one period in the model is 2 years, which means model's $\frac{X_{model}}{Y_{model}}$ corresponds to $\frac{W_{data}+2Y_{data}}{2Y_{data}} = \frac{1}{2}\frac{W_{data}}{Y_{data}} + 1$ in the data. If we compare each tenure's sample mean $\frac{W}{Y}$ by dividing by 2 and add 1 with $\frac{X_{model}}{Y_{model}}$ in the model's optimal housing tenure policy

	Renters	*Jeonse* Tenants	Homeowner
Fraction of households	0.129	0.228	0.584
Age	45.93	43.59	54.66
Net Wealth (W)	3455.43	13066.38	28364.04
Real Assets (RA)	1903.60	5129.64	29411.29
Financial Assets (FA)	828.52	2143.89	2922.23
Risky Financial Asset (RFA)	137.43	354.83	364.80
Liabilities (LB)	987.38	2816.77	4381.23
Non-capital Income (Y)	3083.27	4303.13	4512.95
Financial Asset Ratio (FAR)	0.2962	0.1897	0.1003
Risky Financial Asset Ratio ($RFAR$)	0.0087	0.0154	0.0096
Risky Financial Asset Ratio over Financial Assets ($Alpha$)	0.0181	0.0595	0.0444
Conditional Risky Financial Asset Ratio ($c - RFAR$)	0.2688	0.1207	0.1083
Conditional Risky Financial Asset Ratio over Financial Assets ($c - Alpha$)	0.5549	0.4654	0.4960
Stock Market Participation (SMP)	0.0326	0.1279	0.0894
Net Wealth over Income Ratio ($\frac{W}{Y}$)	1.4705	5.8382	16.8268
House Price	0	0	23483.21
Jeonse Deposit	0	8310.23	0
Rent Deposit	1538.40	0	0

1 means 10,000 Korean won which corresponds to $8.81 in 2010. I use only 2010 survey to show the data pattern.

Table 2: Summary Statistics

in Figure 3, we find that model remarkably matches well the each tenure's $\frac{W_{data}}{Y_{data}}$ as I already discussed at the modelling section. Another interesting point is that South Korea shows the really low stock market participation rate compared to the major developed countries. This may come from the fact that Korean stock market valued low with high risk premium due to its geopolitical risks and high dependence on the export. In addition, several financial crisis including East Asia Crisis in 1997 may have led many households to believe that stock market is too risky to participate in. Stock market participation rates presented here is the direct participation rate while not taking the indirect participation through pension fund into account. Lastly, while renters show really low stock market participation, *Jeonse* tenants and homeowners participate in stock market more. On the other hand, renters show the higher FAR, $c - RFAR$, and $c - Alpha$ compared to others while showing the lower $RFAR$ and $Alpha$ compared with *Jeonse* tenant and homeowners. While FAR and $c - RFAR$ are as the model simulation would predicts with higher level of stock market participation costs, $Alpha$ seems to follow the case with the high positive correlation between housing return and stock return.

7.2 Sample Selection

To avoid the abnormality of Great Recession and COVID-19 crisis, I use survey data only from 2009 to 2019 survey years. In addition, to validate the accuracy of the responses, I collect only the households who ever responded more than 4 times because there are several households who respond 1 or 2 times only with missing responses for many questions. Also, I removed households with negative net wealth, and households with yearly non-capital income Y less than 1,200,000 Korean won which is equivalent to $1,057.45 in 2010 exchange rate. Households with too low Y show too high $\frac{W}{Y}$, and some unrealistic portfolio weight which is larger than 100%. Additionally, I removed bottom 1 percent and top 1 percent of households in terms of $\frac{W}{Y}$. Lastly, I removed renters and *Jeonse* tenants whose value of other real estate assets is twice larger than their *Jeonse* or rent deposits. If they have other housing assets, and only temporarily use *Jeonse* or rent contracts, I decide not to consider them as *Jeonse* tenant or renters.

7.3 Housing Tenure and Portfolio Choice

There is a substantial variation across the years especially for stock market participation rate. To see the clearer relationship between housing tenure and households' portfolio choices better, while controlling the region and year fixed effects, I run the following regression where the dependent variable PF_{it} can be one of FAR, $Alpha$, $c - Alpha$, $RFAR$, $c - RFAR$, and SMP.

$$PF_{it} = \beta_J Jeonse_{it} + \beta_O Owner_{it} + RegionTime_{it} + \epsilon_{it} \tag{11}$$

Following figure shows the estimated parameters and confidence interval of β_J and β_O.[7] It clearly summarizes the relationship between housing tenure status and household's portfolio choices while controlling the year and region fixed effects. We clearly see the *substitution effect* in FAR. *Jeonse* tenant shows the -21% lower FAR compared to the renter while homeowners show the -29% lower FAR. *Jeonse* and homeownership seem to predict positive relationships with $Alpha$ and to have some small negative effects on $c - Alpha$. Moving toward to $RFAR$, $RFAR$ is negatively correlated with *Jeonse* and homeownership while being a *Jeonse* tenant predicts 20% lower $RFAS$ conditional on participation, while homeownership predicts 26% lower $RFAS$ conditional on participation. Though we are not controlling other control variables, these patterns seem to fairly consistent to the model's predictions. Interestingly, *Jeonse* tenant status and homeownership seem to have crowding out effects in intensive margin but not in extensive margin showing actually positive relationships. *Jeonse* and Ownership are positively correlated with stock market participation where being a *Jeonse* tenant predicts 2.13% higher stock market participation and Homeownership predicts 1.31% higher stock market participation. These results are similar to the one in Vestman (2019) for extensive margin. Regression in Vestman (2019) uses the moving to homeownership as a treatment in DID set-up with household fixed effect. So there is a little bit of difference with the regression specification here. However, these two regressions are similar in the sense that these do not control the household's wealth or income, and showing the positive relationship between stock market participation and homeownership (also *Jeonse* tenant status.) Though this positive relationship is likely coming from the endogeneity caused by confounders including $\frac{W}{Y}$, it still describe the overall data patterns well.

[7] Standard errors are clustered at the region-time level

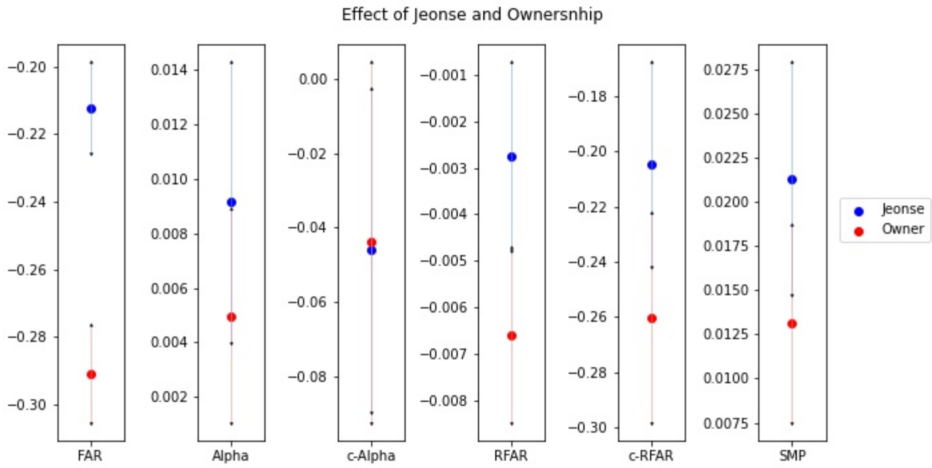


Figure 11: Housing Tenure and Portfolio Choice

7.4 Crowding Out Effect Across $\frac{W}{Y}$

In this subsection, with full control of household characteristics, I try to capture the crowding out effect pattern of each tenure type across $\frac{W}{Y}$ in more details. Here, I state the definitions of crowding out effects to estimate one more time in terms of variables defined in this empirical sections. Because the housing tenure variables are highly correlated with $\frac{W}{Y}$ and Age variables which also affect portfolio choice variables much, which is predicted by our model, controlling $\frac{W_{data}}{Y_{data}}$ and Age_{data} in the regression is important, which is equivalent to controlling $\frac{X_{model}}{Y_{model}}$ and Age_{model} in the model.

$$E(PF|\frac{W}{Y}, Age, Renter(\tau), Z) - E(PF|\frac{W}{Y}, Age, Homeowner(\Phi), Z) \tag{12}$$

$$E(PF|\frac{W}{Y}, Age, Renter(\tau), Z) - E(PF|\frac{W}{Y}, Age, Jeonse(\Phi_J), Z) \tag{13}$$

$$PF \in (FAR, RFAR, c-RFAR, SMP, Alpha, c-Alpha)$$

Also, there are two different ways we see the effect of housing tenure. We can use either dummy variables for *Jeonse* tenure and homeownership like Brandsaas (2018). On the other hand, we can use $\frac{Jeonse\ Deposit}{Net\ Wealth}$ $(\frac{JD}{W})$ and $\frac{House\ Price}{Net\ Wealth}$ $(\frac{HP}{W})$ like Cocco (2005) and Yao and Zhang (2005). To facilitate the comparison across the research, I do both of the specifications below.

$$PF_{it} = \beta U_{it} + \sum_{Q=1}^{5} \gamma_{1Q} Jeonse_{it} [\frac{W}{Y}]_{it}^{Q} + \sum_{Q=1}^{5} \sigma_{1Q} Owner_{it} [\frac{W}{Y}]_{it}^{Q} + \epsilon_{it} \tag{14}$$

$$PF_{it} = \beta U_{it} + \sum_{Q=1}^{5} \gamma_{2Q} \frac{JD}{W}_{it} [\frac{W}{Y}]_{it}^{Q} + \sum_{Q=1}^{5} \sigma_{2Q} \frac{HP}{W}_{it} [\frac{W}{Y}]_{it}^{Q} + \epsilon_{it} \tag{15}$$

$$PF_{it} \in (FAR_{it}, RFAR_{it}, c-RFAR_{it}, SMP_{it}, Alpha_{it}, c-Alpha_{it})$$

I include the interaction terms with housing related variables and $[\frac{W}{Y}]^Q$ which is a dummy variables for being in each $\frac{W}{Y}$ quantile group. I divided all households into 5 groups depending on their quantile groups of $\frac{W}{Y}$. This is because to see whether there is a heterogeneous crowding out effect depending on households wealth level as predicted by the model. U_{it} includes $Log(\frac{W}{Y})$, education level, $Log(Age)$, number of members in the household, year fixed effect, and household fixed effects. These are all variables controlled in Cocco (2005) and Yao and Zhang (2005). I do not control here is whether the household is operating their own business or not and amount of mortgage debt as I have no corresponding information.

These regressions are under endogeneity problems as housing tenure choice and portfolio choice can be affected simultaneously by numerous confounders such as household's risk preference, household's belief about future income, and their current income or wealth. I try to control such factors by individual fixed effects and detailed household's demographics and balance sheet information. As another concern, Beaubrun-Diant and Maury (2016) argues that there is a strong simultaneity and cross-causality effects between homeownership and stock market participation. In addition, dynamic treatment effect is known to bias the estimates from two-way fixed effects. Here I do not try to control such confounding relationships as I have no proper instrumental variables. I proceed under the assumptions that households make housing decisions first and then decide how much to invest in stock market while all the confounding effects are controlled by controlling Age and $\frac{W}{Y}$. Also I assume that all dynamics can be controlled by their wealth variables and age variables. At the least, empirical analysis below can be interpreted as summarizing correlations representing how data look like compared to the model's predictions.[8]

Table 3 is the result for specification in equation 14. We find that $Log(Age)$ has a negative relationship with all portfolio choice variables. This is consistent with the finding in Brandsaas (2018) for stock market participation. In addition, the $Number\ of\ Members$ has the negative signs as also in Brandsaas (2018). As an important state variable, $Log(\frac{W}{Y})$ is estimated having positive effects on most of the portfolio choice variables other than FAR, which is consistent again with the concave relationship implied by the model and the results in Brandsaas (2018). Especially, it shows that high $Log(\frac{W}{Y})$ implies higher SMP. Model with certain level of participation cost predicts such a relationship.

Changing gears toward to the crowding out effects of our interests, we find the consistent crowding out effects of housing from homeowners (σ_{1Q}) on FAR, $RFAR$, $c-RFAR$, and SMP while the crowding out effects coming from *Jeonse* tenure (γ_{1Q}) seems to have effect only on FAR and $RFAR$.

[8] Because model cannot simulate the realistic $\frac{W}{Y}$ distribution in the data without unrealistic features, I just compare the model's optimal policies with the regression results. I proceed assuming that there are some exogenous tenure shifting forces in the data (which means for some $\frac{X}{Y}$ and Age, there can be households with different tenure types), which allows me to compare the regression results with the model's predictions - we do find some overlapped $\frac{W}{Y}$ distribution among renters, *Jeonse* tenants, and homeowners in the data.

	FAR	$Alpha$	$c-Alpha$	$RFAR$	$c-RFAR$	SMP
$Education1$	0.4108***	0.1922	-0.3144	0.0584***	-0.0117	0.3951***
	(3.0984)	(1.4493)	(-0.5233)	(2.5818)	(-0.2262)	(4.0079)
$Education2$	0.4078***	0.1939	-0.3071	0.0572***	-0.0093	0.3940***
	(3.1888)	(1.5323)	(-0.5415)	(2.6802)	(-0.1871)	(4.1747)
$Education3$	0.3982***	0.1668	-0.2720	0.0596***	-0.0017	0.3593***
	(3.1936)	(1.3711)	(-0.5122)	(2.7721)	(-0.0339)	(3.7797)
$Number\ of\ Members$	-0.0117***	-0.0032*	-0.0022	-0.0015**	-0.0031	-0.0060**
	(-3.7816)	(-1.6782)	(-0.3820)	(-2.3245)	(-0.9111)	(-2.5073)
$Log(Age)$	0.0177	-0.0371	0.0864	-0.0100*	0.0096	-0.0797***
	(0.5345)	(-1.1400)	(0.6200)	(-1.8180)	(0.7726)	(-3.2685)
$Log(\frac{W}{Y})$	-0.0185***	0.0055**	0.0030	0.0017	0.0057	0.0086***
	(-2.9040)	(2.5559)	(0.4490)	(1.3073)	(0.9271)	(3.7985)
$Owner \times [\frac{W}{Y}]_1^Q$	-0.2985***	-0.0024	-0.0027	-0.0096***	-0.0056	-0.0189***
	(-17.186)	(-0.4052)	(-0.0958)	(-3.9377)	(-0.3953)	(-2.9461)
$Owner \times [\frac{W}{Y}]_2^Q$	-0.3197***	-0.0058	-0.0302*	-0.0110***	-0.0256*	-0.0190***
	(-24.125)	(-1.0591)	(-1.8988)	(-3.6546)	(-1.8158)	(-2.8609)
$Owner \times [\frac{W}{Y}]_3^Q$	-0.3126***	-0.0116*	-0.0257	-0.0140***	-0.0296*	-0.0257***
	(-22.348)	(-1.9127)	(-1.4591)	(-3.7786)	(-1.6826)	(-3.5689)
$Owner \times [\frac{W}{Y}]_4^Q$	-0.3119***	-0.0189***	-0.0272	-0.0153***	-0.0334	-0.0345***
	(-20.579)	(-2.8703)	(-1.5783)	(-3.6464)	(-1.6340)	(-4.4235)
$Owner \times [\frac{W}{Y}]_5^Q$	-0.3041***	-0.0160**	-0.0195	-0.0155***	-0.0343	-0.0327***
	(-16.463)	(-2.0542)	(-0.9226)	(-3.1197)	(-1.3945)	(-3.5877)
$Jeonse \times [\frac{W}{Y}]_1^Q$	-0.1976***	0.0024	0.0070	-0.0027	0.0011	-0.0052
	(-14.213)	(0.4458)	(0.3510)	(-1.1066)	(0.0899)	(-0.9058)
$Jeonse \times [\frac{W}{Y}]_2^Q$	-0.2331***	-0.0004	0.0088	-0.0088***	-0.0155	-0.0022
	(-20.325)	(-0.0698)	(0.5059)	(-2.8967)	(-0.8874)	(-0.2986)
$Jeonse \times [\frac{W}{Y}]_3^Q$	-0.2210***	-0.0023	-0.0127	-0.0089**	-0.0213	-0.0041
	(-17.139)	(-0.3647)	(-0.6592)	(-2.3762)	(-1.0297)	(-0.4704)
$Jeonse \times [\frac{W}{Y}]_4^Q$	-0.2054***	-0.0054	-0.0042	-0.0087*	-0.0222	-0.0113
	(-13.062)	(-0.6107)	(-0.2031)	(-1.8975)	(-1.1578)	(-1.0366)
$Jeonse \times [\frac{W}{Y}]_5^Q$	-0.1759***	0.0105	0.0223	-0.0039	-0.0184	-0.0006
	(-8.5335)	(0.8658)	(0.7312)	(-0.6904)	(-0.7676)	(-0.0468)
No. Observations	60220	43478	4462	60220	6642	60220
R-squared	0.0869	0.0019	0.0049	0.0049	0.0181	0.0026
P-value (F-stat)	0.0000	0.0000	0.2442	0.0000	0.0000	0.0000
Effects	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE

T-statistics are in the parentheses. Standard errors are clustered in household levels. $[\frac{W}{Y}]_1^Q$ means household's $\frac{W}{Y}$ is between 0-20 percents quantile in overall distributions.

Table 3: Regression Specification 1 - $\frac{W}{Y}$ Cross-section

Firstly for FAR, we see the *Jeonse* tenure and homeownership have strong negative effects on FAR, which is also predicted by the model as the *substitution effect.* Interestingly, effect of size from *Jeonse* is much smaller than that of homeownership. In addition, crowding out effect from *Jeonse* (γ_{1Q}) decreases as households are in higher $\frac{W}{Y}$ quantile group while the crowding out effect from homeownership (σ_{1Q}) somewhat decreases or sustains, which is also partially predicted by the model. This should come from the fact that homeownership not only requires larger downpayment (more *liquidity constraint channel*) but also accompanies the *house price risk channel*.

Secondly, moving toward to $Alpha$, we see that coefficients on *Jeonse* (γ_{1Q}) are not significant and even positively estimated. Model predicted higher $Alpha$ for *Jeonse* tenant compared to the renter, and it seems the regression does not capture that channel fully but interestingly not showing any significant negative effect either. For the effect of homeownership on $Alpha$, we saw that, in the model, it heavily depends on correlation structure between housing return and stock return. Because households in our data set should have different houses in different locations (which means different correlation structure between housing return and stock return they face), it is natural to see that we cannot capture the strong patterns of *diversification effect*. However, it seems that it implies, in average, high correlation between housing return and stock return based on our model's prediction so they are negatively estimated.

Most importantly, we see the total crowding out effect from the regressions on $RFAR$ and $c - RFAR$. Most interesting pattern is that, in regression for $RFAR$, the crowding out effect from homeownership (σ_{1Q}) increases as $\frac{W}{Y}$ increases while the crowding out effect from *Jeonse* (γ_{1Q}) decreases and become insignificant as $\frac{W}{Y}$ increases. In the case of the crowding out effect from homeownership on $RFAR$, if households have $\frac{W}{Y}$ corresponding to the lowest 20 percent group of $\frac{W}{Y}$, which is from 0.156 to 1.497 in our sample, the crowding out effect is -0.96%. On the other hand, if households have $\frac{W}{Y}$ corresponding to the highest 20 percent group of $\frac{W}{Y}$, which is from 8.51 to 90.923, the homeownership is estimated to crowd out stock ratio by -1.55%, which is much larger than the effect of lowest 20% group. Quantitatively, it is a little different with that of the model's prediction on this effect for the age of 50 households with high $\frac{X}{Y}$ which was about 4%. I believe that crowding out effect for households in the lower quantile of $\frac{W}{Y}$ is killed due to the stock market participation cost as we saw in Fig 9 while the latter sustained crowding out effect is as the model predicted due to the *house price risk channel*. Considering the sample mean of $RFAR$ among renters in 2010 survey which is 0.87%, its size is economically significant. On the other hand, for the crowding out effect coming from *Jeonse*, we find that the crowding out effects for households with $\frac{W}{Y}$ in 40-60 quantile is estimated as -0.89% while that of households with $\frac{W}{Y}$ in 80-100 quantile with is estimated as having no significant effect. This is also as predicted by the model. Higher $\frac{W}{Y}$ effectively kills the *liquidity constraint channel*, which makes the crowding out effect from *Jeonse* as zero. One interesting feature is that *Jeonse* crowding out effect for lowest $\frac{W}{Y}$ quantile is estimated very low like the case of homeownership. As I elaborated above, high stock market participation cost can effectively kills much of the crowding out effect for households with low $\frac{W}{Y}$ as even renters do not participate in stock market. For $c - RFAR$, though we lose all the significance, we see the same patterns of the signs and the sizes of estimates.

Lastly, for stock market participation, we see that homeownership crowds out stock market participation while *Jeonse* has not significant effect. In Figure 9, we saw that, with some level of stock market participation costs, homeowners and *Jeonse* tenant participate in stock market with only higher $\frac{X_{model}}{Y_{model}}$ compared to the renters due to low level of financial assets A_{model} in the hand. Regressions seems to capture those effects too.

Table 4 is the result for the specification in equation 15. It shows similar patterns that we found in the specification 1. Both homeownership and *Jeonse* tenure show the substantial crowding out effect on FAR while having less significant effect on $Alpha$ and $c - Alpha$. We also see the increasing crowding out effect on $RFAR$ and $c - RFAR$ with higher $\frac{W}{Y}$ from homeownership while seeing decreasing crowding out effect on $RFAR$ and $c - RFAR$ with

	FAR	$Alpha$	$c-Alpha$	$RFAR$	$c-RFAR$	SMP
$Education1$	0.4304***	0.2009	-0.3116	0.0612***	-0.0165	0.3958***
	(3.2779)	(1.5181)	(-0.5214)	(2.7202)	(-0.3420)	(4.0361)
$Education2$	0.4201***	0.2022	-0.3006	0.0596***	-0.0137	0.3941***
	(3.3060)	(1.6013)	(-0.5332)	(2.8075)	(-0.2953)	(4.1978)
$Education3$	0.3984***	0.1750	-0.2646	0.0615***	-0.0060	0.3595***
	(3.2378)	(1.4430)	(-0.5017)	(2.8790)	(-0.1293)	(3.8050)
$Number\ of\ Members$	-0.0230***	-0.0035*	-0.0033	-0.0020***	-0.0042	-0.0066***
	(-6.8950)	(-1.8594)	(-0.5901)	(-3.0063)	(-1.1100)	(-2.7607)
$Log(Age)$	-0.0188	-0.0394	0.0849	-0.0117**	0.0088	-0.0800***
	(-0.5759)	(-1.2116)	(0.6121)	(-2.1243)	(0.7578)	(-3.2991)
$Log(\frac{W}{Y})$	-0.0222***	0.0050***	0.0026	0.0008	0.0017	0.0087***
	(-3.5647)	(3.2060)	(0.4851)	(1.1596)	(0.5428)	(5.0337)
$\frac{HP}{W} \times [\frac{W}{Y}]_1^Q$	0.0111	0.0007	-0.0020	2.659e-05	0.0007	-0.0021**
	(0.8192)	(0.6328)	(-1.0912)	(0.0517)	(0.6870)	(-2.0933)
$\frac{HP}{W} \times [\frac{W}{Y}]_2^Q$	-0.0780***	-0.0011	-0.0106	-0.0015	-0.0041***	-0.0114***
	(-8.7990)	(-0.3175)	(-1.3860)	(-0.7941)	(-3.3328)	(-3.5347)
$\frac{HP}{W} \times [\frac{W}{Y}]_3^Q$	-0.1078***	-0.0086**	-0.0138	-0.0053***	-0.0064***	-0.0217***
	(-11.645)	(-2.4887)	(-1.6341)	(-4.5195)	(-2.6324)	(-6.1812)
$\frac{HP}{W} \times [\frac{W}{Y}]_4^Q$	-0.1308***	-0.0186***	-0.0221***	-0.0071***	-0.0091**	-0.0338***
	(-11.574)	(-4.9443)	(-2.6817)	(-5.6611)	(-2.4979)	(-7.9756)
$\frac{HP}{W} \times [\frac{W}{Y}]_5^Q$	-0.1406***	-0.0163***	-0.0185	-0.0078***	-0.0110*	-0.0349***
	(-7.4822)	(-3.4173)	(-1.5651)	(-4.8216)	(-1.8187)	(-6.3566)
$\frac{JD}{W} \times [\frac{W}{Y}]_1^Q$	0.0135	-0.0003	0.0024	0.0015	0.0033	-0.0022
	(1.0227)	(-0.1716)	(0.5271)	(1.1829)	(0.9680)	(-1.1666)
$\frac{JD}{W} \times [\frac{W}{Y}]_2^Q$	-0.0933***	-0.0033	0.0130	-0.0050***	-0.0065	-0.0084*
	(-5.0732)	(-0.7844)	(0.7186)	(-3.2054)	(-0.8450)	(-1.6516)
$\frac{JD}{W} \times [\frac{W}{Y}]_3^Q$	-0.1132***	-0.0074	-0.0158	-0.0065***	-0.0123	-0.0128*
	(-8.6323)	(-1.3638)	(-1.0341)	(-3.1673)	(-1.2569)	(-1.6947)
$\frac{JD}{W} \times [\frac{W}{Y}]_4^Q$	-0.1187***	-0.0085	0.0041	-0.0058**	-0.0079	-0.0201**
	(-8.3772)	(-0.9658)	(0.1806)	(-2.2915)	(-1.1760)	(-2.2984)
$\frac{JD}{W} \times [\frac{W}{Y}]_5^Q$	-0.1122***	0.0048	0.0299	-0.0051	-0.0110	-0.0146
	(-5.9606)	(0.4257)	(1.0277)	(-1.6076)	(-0.9158)	(-1.3909)
No. Observations	60220	43478	4462	60220	6642	60220
R-squared	0.0649	0.0022	0.0057	0.0044	0.0113	0.0037
P-value (F-stat)	0.0000	0.0000	0.1265	0.0000	0.0000	0.0000
Effects	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE

T-statistics are in the parentheses. Standard errors are clustered in household levels. $[\frac{W}{Y}]_1^Q$ means household's $\frac{W}{Y}$ is between 0-20 percents quantile in overall distributions.

Table 4: Regression Specification 2 - $\frac{W}{Y}$ Cross-section

higher $\frac{W}{Y}$ from *Jeonse.* Lastly, we find that the crowding out effect on SMP not only from homeownership but also from *Jeonse,* which is different from the specification 1. Comparing the result with Yao and Zhang (2005) and Cocco (2005), we see the similar patterns in general, especially for strong significance of effect on $RFAR$ than that of $Alpha$. Overall, we find the evidence of crowding out effect of housing among Korean households as the literature found among other countries. Though the endogeneity concerns could not be fully resolved, data pattern seems fairly consistent to the structural model's prediction. Especially, the presence of crowding out effect of *Jeonse* on FAR, stronger crowding out effect of homeownership compared to that of *Jeonse* on FAR, and the increasing pattern of housing crowding out effect of homeowners on $RFAR$ with higher $\frac{W}{Y}$ with opposite patterns for the *Jeonse tenant* give us more understanding on how each channel of crowding out effect works.

7.5 Crowding Out Effect Across *Age*

In this subsection, we study how the crowding out effect changes across the age groups. While other controls are same, we use following regression formulas to see the pattern of crowding out effects.

$$PF_{it} = \beta U_{it} + \sum_{Q=1}^{5} \gamma_{1Q} Jeonse_{it}[Age]_{it}^{Q} + \sum_{Q=1}^{5} \sigma_{1Q} Owner_{it}[Age]_{it}^{Q} + \epsilon_{it} \tag{16}$$

$$PF_{it} = \beta U_{it} + \sum_{Q=1}^{5} \gamma_{2Q} \frac{JD}{W}_{it}[Age]_{it}^{Q} + \sum_{Q=1}^{5} \sigma_{2Q} \frac{HP}{W}_{it}[Age]_{it}^{Q} + \epsilon_{it} \tag{17}$$

$$PF_{it} \in (FAR_{it}, RFAR_{it}, c - RFAR_{it}, SMP_{it}, Alpha_{it}, c - Alpha_{it})$$

Overall, the estimates of control variables are similar, which allows me directly to jump into the crowding out effect estimates across age group. Firstly, regressions on FAR show that crowding out effect on FAR fairly similar across the ages groups for both homeownership and *Jeonse*, which is not like as the model predicts. Model predicted that older households are expected to show the lower crowding out effect on FAR. For $Alpha$, *Jeonse* tenant and homeowners should show higher values based on model's prediction, which means positive estimates getting bigger for the higher age groups. However, again we cannot find any significant effect on it. This seems coming from the heterogeneous correlation structure likely faced by different households. For $RFAR$, we can find that the crowding out effects are estimated as decreasing as households get older, which seems consistent to the model's prediction both for homeowners and *Jeonse* tenants. Similar to the previous regressions, homeownership and *Jeonse* tenure seem to prevent households from participating in stock market, while it is difficult to find any specific patterns across ages.

Table 6 also shows the similar patterns. Interestingly, some of the crowding out effects for $Alpha$ and $c - Alpha$ are estimated as positive which seems consistent to the model. As the crowding out effect on FAR gets larger as they get older, households increase their α_a in the model. This specification gives some support on this model's prediction. We see the decreasing pattern of crowding out effect from homeownership on $RFAR$ while having no significant effect from *Jeonse* tenure on $RFAR$. This seems also following the model's prediction. In the end, as households get older, they are free from the incomplete market nature of their life-cycle.

8 Conclusion

In this research, by using a calibrated life-cycle model with endogenous housing tenure choice and stock market participation, I show how the crowding out effect from *Jeonse*, which only

	FAR	$Alpha$	$c-Alpha$	$RFAR$	$c-RFAR$	SMP
$Education1$	0.4432***	0.1408	-0.4287	0.0670**	-0.0509	0.3231***
	(2.9588)	(1.0767)	(-0.7426)	(2.5595)	(-0.6904)	(3.2528)
$Education2$	0.4320***	0.1474	-0.4154	0.0665***	-0.0487	0.3277***
	(2.9553)	(1.1840)	(-0.7662)	(2.6630)	(-0.6843)	(3.4457)
$Education3$	0.4212***	0.1204	-0.3801	0.0691***	-0.0404	0.2922***
	(2.9355)	(1.0040)	(-0.7505)	(2.7411)	(-0.5616)	(3.0446)
$Number\ of\ Members$	-0.0133***	-0.0029	-0.0028	-0.0013**	-0.0037	-0.0055**
	(-4.2100)	(-1.5470)	(-0.5344)	(-1.9805)	(-1.0347)	(-2.3045)
$Log(Age)$	0.0121	-0.0245	0.1137	-0.0126*	0.0197	-0.0621**
	(0.3159)	(-0.7651)	(0.8539)	(-1.9444)	(1.0051)	(-2.5281)
$Log(\frac{W}{Y})$	-0.0173***	0.0025*	0.0038	0.0003	0.0016	0.0054***
	(-4.1099)	(1.7420)	(0.7239)	(0.3870)	(0.4773)	(3.5948)
$Owner \times [AGE]_1^Q$	-0.3149***	0.0026	0.0355	-0.0125***	-0.0121	-0.0066
	(-25.078)	(0.3917)	(0.8595)	(-4.2543)	(-1.4094)	(-0.7719)
$Owner \times [AGE]_2^Q$	-0.3108***	-0.0125*	-0.0208	-0.0120***	-0.0213*	-0.0269***
	(-24.003)	(-1.8953)	(-1.0639)	(-3.7498)	(-1.9539)	(-3.4756)
$Owner \times [AGE]_3^Q$	-0.2948***	-0.0228***	-0.0264	-0.0116***	-0.0214	-0.0407***
	(-18.582)	(-3.7023)	(-1.5565)	(-3.7965)	(-1.5322)	(-5.6589)
$Owner \times [AGE]_4^Q$	-0.3069***	-0.0195***	-0.0347*	-0.0105***	-0.0284	-0.0384***
	(-16.055)	(-3.1568)	(-1.9517)	(-3.1843)	(-1.5633)	(-5.4960)
$Owner \times [AGE]_5^Q$	-0.3388***	-0.0004	-0.0131	-0.0062*	-0.0226	-0.0142*
	(-15.431)	(-0.0534)	(-0.6062)	(-1.8795)	(-1.1729)	(-1.9331)
$Jeonse \times [AGE]_1^Q$	-0.2334***	0.0065	0.0853	-0.0059*	-0.0005	0.0096
	(-18.248)	(1.0323)	(1.4716)	(-1.8633)	(-0.0428)	(1.1561)
$Jeonse \times [AGE]_2^Q$	-0.2083***	0.0033	-0.0102	-0.0048*	-0.0053	-0.0013
	(-14.313)	(0.4992)	(-0.4808)	(-1.7708)	(-0.5577)	(-0.1496)
$Jeonse \times [AGE]_3^Q$	-0.1944***	-0.0086	0.0031	-0.0066*	-0.0092	-0.0189**
	(-13.091)	(-1.2396)	(0.2108)	(-1.9258)	(-0.6194)	(-2.1538)
$Jeonse \times [AGE]_4^Q$	-0.1810***	-0.0087	-0.0037	-0.0078	-0.0193	-0.0203**
	(-8.4354)	(-1.1493)	(-0.2227)	(-1.4683)	(-0.8083)	(-1.9876)
$Jeonse \times [AGE]_5^Q$	-0.2013***	0.0098	0.0155	-0.0024	-0.0119	-0.0029
	(-8.8016)	(1.1824)	(0.5587)	(-0.7901)	(-0.7186)	(-0.4514)
No. Observations	60220	43478	4462	60220	6642	60220
R-squared	0.0871	0.0028	0.0086	0.0043	0.0137	0.0036
P-value (F-stat)	0.0000	0.0000	0.0058	0.0000	0.0000	0.0000
Effects	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE

T-statistics are in the parentheses. Standard errors are clustered in household levels. $[Age]_1^Q$ means household's Age is between 0-20 percents quantile in overall distributions.

Table 5: Regression Specification 1 - Age Cross-section

accompanies the *liquidity constraint channel*, is different from the crowding out effect from ownership which has both *liquidity constraint channel* and *house price risk channel*. The model tells us that the crowding out effect coming from the *liquidity constraint channel* affects young and low wealth (or liquidity constrained) households expecting more income in the future, while the crowding out effect coming from the *house price risk channel* affects all types of households, and such effect remains even though households accumulate much more wealth. Also, in age cross-section, we see that older households should show the lower crowding out effect as they get less liquidity constrained with fewer future income coming. In addition, we saw that stock market participation cost can non-linearly affect the portfolio choices of households while correlation structure of housing return and stock return also affects the portfolio choices especially affecting the risky financial asset ratio over financial asset. Regression from households' panel data show that the *substitution effects* coming from the *liquidity constraint channel* surely exist for both *Jeonse* tenant and homeowners while the effect of *house price risk channel* on the risky financial asset ratio over financial asset is not recognized much. We do

	FAR	$Alpha$	$c-Alpha$	$RFAR$	$c-RFAR$	SMP
$Education1$	0.4632***	0.2121	-0.4356	0.0706***	-0.0578	0.4149***
	(3.2523)	(1.6095)	(-0.7283)	(2.9310)	(-1.0164)	(4.1932)
$Education2$	0.4358***	0.2146*	-0.4245	0.0690***	-0.0542	0.4146***
	(3.1548)	(1.7094)	(-0.7533)	(3.0330)	(-1.0004)	(4.3815)
$Education3$	0.4130***	0.1877	-0.3879	0.0710***	-0.0471	0.3798***
	(3.0708)	(1.5537)	(-0.7352)	(3.0950)	(-0.8720)	(3.9846)
$Number\ of\ Members$	-0.0271***	-0.0034*	-0.0038	-0.0019***	-0.0043	-0.0067***
	(-7.5246)	(-1.7942)	(-0.7149)	(-2.7832)	(-1.1397)	(-2.7856)
$Log(Age)$	-0.0284	-0.0433	0.1141	-0.0146**	0.0179	-0.0866***
	(-0.7981)	(-1.3412)	(0.8256)	(-2.4693)	(1.3092)	(-3.5407)
$Log(\frac{W}{Y})$	-0.0516***	0.0014	0.0012	-0.0009*	-0.0005	0.0020
	(-12.654)	(1.0996)	(0.2945)	(-1.8518)	(-0.2732)	(1.4654)
$\frac{PH}{W} \times [AGE]_1^Q$	-0.0338***	0.0018	0.0146	-0.0020**	0.0067**	-0.0042
	(-4.9659)	(0.6677)	(0.7602)	(-2.2276)	(2.3416)	(-1.3406)
$\frac{PH}{W} \times [AGE]_2^Q$	-0.0131**	-0.0027	-0.0028	-0.0013***	-0.0001	-0.0072***
	(-2.0845)	(-1.5287)	(-1.1315)	(-3.2479)	(-0.2988)	(-3.5249)
$\frac{PH}{W} \times [AGE]_3^Q$	0.0290	-0.0026*	0.0003	-0.0003	0.0015	-0.0055***
	(1.1486)	(-1.6885)	(0.0935)	(-0.7128)	(0.8111)	(-3.2125)
$\frac{PH}{W} \times [AGE]_4^Q$	-0.0146	0.0006	-0.0135	0.0016	-0.0030*	-0.0053*
	(-1.3474)	(0.1466)	(-1.4445)	(0.7758)	(-1.6961)	(-1.9364)
$\frac{PH}{W} \times [AGE]_5^Q$	-0.0737***	0.0113***	-0.0097	0.0019*	-0.0019	0.0063**
	(-6.5479)	(2.6803)	(-0.8122)	(1.6493)	(-1.0963)	(2.3761)
$\frac{JD}{W} \times [AGE]_1^Q$	-0.0162	-0.0015	0.0741	9.658e-05	0.0011	-0.0027
	(-1.3451)	(-0.6139)	(1.1153)	(0.0427)	(0.3560)	(-0.7815)
$\frac{JD}{W} \times [AGE]_2^Q$	0.0192	0.0027	0.0095	0.0017	0.0070	0.0020
	(1.4248)	(0.9871)	(0.4858)	(1.1370)	(1.0747)	(0.5065)
$\frac{JD}{W} \times [AGE]_3^Q$	0.0002	0.0001	0.0146	0.0019	0.0109	-0.0041
	(0.0162)	(0.0287)	(1.1980)	(0.5748)	(0.9040)	(-0.9143)
$\frac{JD}{W} \times [AGE]_4^Q$	0.0619	-3.736e-05	0.0026	3.614e-05	0.0022	-0.0055
	(1.1850)	(-0.0113)	(0.2816)	(0.0185)	(0.2921)	(-1.4856)
$\frac{JD}{W} \times [AGE]_5^Q$	-0.0143	0.0033	-0.0004	0.0004	-0.0002	0.0015
	(-1.4444)	(1.2145)	(-0.2214)	(1.1040)	(-0.4967)	(1.1865)
No. Observations	60220	43478	4462	60220	6642	60220
R-squared	0.0454	0.0013	0.0063	0.0022	0.0095	0.0022
P-value (F-stat)	0.0000	0.0000	0.0722	0.0000	0.0000	0.0000
Effects	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE	HH/Year FE

T-statistics are in the parentheses. Standard errors are clustered in household levels. $[Age]_1^Q$ means household's Age is between 0-20 percents quantile in overall distributions.

Table 6: Regression Specification 2 - Age Cross-section

see the crowding out effect gets smaller for *Jeonse* tenant if they have higher net wealth to income ratio while the effect does not decrease (or even increase in some cases) for homeowners even though they have higher net wealth to income ratios. This suggests some different natures of the crowding out effect from the *liquidity constraint channel* and the *house price risk channel*. *Liquidity constraint channel* (especially driving the crowding out effect on *Jeonse* tenant) goes away with higher net wealth to income ratio (which effectively means less liquidity constrained) while the crowding out effect from homeownership sustains. Future works may show more clearer identification on this effect using other novel identification strategies, and suggest more accurate quantitative nature of crowding out effects.

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