# The Effect of Housing on Portfolio Choice: House Price Risk and Liquidity Constraint (Appendix)

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## 1 Life-Cycle Non-Capital Income Profile

Through following procedure, I calculate the life-cycle labor income profile. First, I use the almost the same sample from KLIPS which I use for fixed effect regressions in the paper. One difference is that I additionally include households who are renters or *Jeonse* tenants and have other real estate assets twice higher than their *Jeonse* deposit or rent deposit. These households were removed from the empirical analysis as they do not represent the renters and *Jeonse* tenants properly, I include them here as I want more information to consistently estimate the life-cycle profile of labor income.

With this sample, I regress the logged non-capital income ($Y$) on age dummy variables for each year (2009-2019). Then, I averaged out all the estimates across the years. Finally, I regress the averaged estimates on age from 30 to 64 dummy variables on the fifth order age polynomial, while averaging out the estimates on ages after 64 for estimating retirement income. Then, I calculate the fitted values which are represented below in Figure 1.

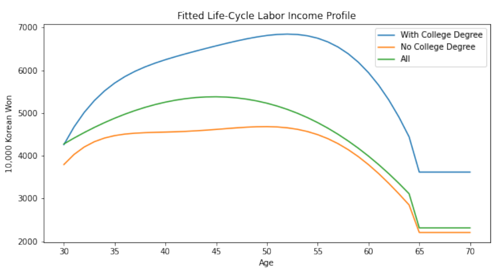


Figure 1: Calibrated Life-Cycle Income

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Here, by averaging out, I controlled each year's fixed effect. In addition, I assume that households' individual characteristics are averaged out. With following calibrated labor income profile, I calculate the growth rate $[g_i]_{i=1}^{i=35}$ (log difference), and use them to solve the model in the main paper.

# 2 Calibration for Exogenous Processes

## 2.1 First Moments

For housing return process and stock return process, I use national stock index and national housing price index from KOSPI and Korea Real Estate Board. I calculate the log of yearly mean return for them, and I calculate the $\mu$, $\mu_h$, $\sigma_\epsilon$, and $\sigma_h$.

## 2.2 Correlations across Return Processes

To calculate out the correlation between labor income process, stock return process, and housing return process, we need each component's aggregate shocks. For housing return and stock return, following Vestman (2019), I use aggregate indices for both, and calculate the log of yearly mean return. For the labor income process, following Vestman (2019), I calculate the following component.

$$resid1_{it+1} = log(Y_{it+1}) - log(Y_{it}) + g_{it+1} \tag{1}$$

$$AggLab1_t = \frac{\sum_{i=1}^{i=N_I} resid1_{it} * SW_{it}}{\sum_{i=1}^{i=N_I} SW_{it}} \tag{2}$$

Here, $AggLab1$ represent the aggregate shock as idiosyncratic shocks goes away by averaging out for each year. As the second method, similar to that of Cocco (2005), I regress following regression.

$$\begin{aligned} log(Y_{it}) =& \alpha_i + \gamma_t \beta_1 Age + \beta_2 Age^2 + \beta_3 Age^3 + \beta_4 Age^4 + \beta_5 Age^5 \\ &+ \beta_6 Education + \beta_7 NumOfMember + \epsilon_{it} \end{aligned} \tag{3}$$

After that, by calculating the fitted value $log(\hat{Y}_{it})$, I calculate following residuals.

$$resid2_{it+1} = log(Y_{it+1}) - log(Y_{it}) + log(\hat{Y}_{it+1}) - log(\hat{Y}_{it}) \tag{4}$$

$$AggLab2_t = \frac{\sum_{i=1}^{i=N_I} resid2_{it} * SW_{it}}{\sum_{i=1}^{i=N_I} SW_{it}} \tag{5}$$

Then, I calculate the weighted mean according to the survey weight $(SW_{it})$ for each year. Following Figure 2 is the plot for $AggLab1$, $AggLab2$, $log(R)$, and $log(R^H)$.

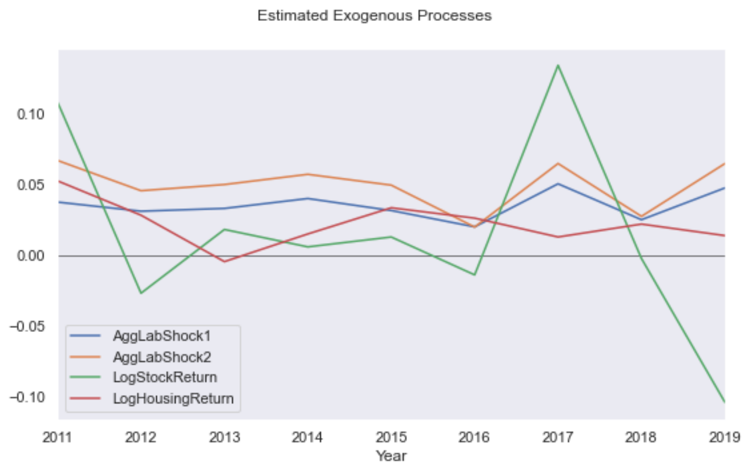



Figure 2: Estimated Exogenous Processes

It is interesting that $AggLab1$ and $AggLab2$ share very similar trajectories throughout the years. If I calculate the Pearson correlations between these processes, none of them are statistically significant as noted in Table 1.

| | AggLab1 & Stock | AggLab1 & Housing | AggLab2 & Stock | AggLab2 & Housing | Stock & Housing |
|---|---|---|---|---|---|
| Correlation | 0.114546 | -0.222892 | 0.179976 | 0.021417 | 0.22599 |
| P-Value | 0.752693 | 0.535934 | 0.618808 | 0.953171 | 0.53013 |

Table 1: Exogenous Process Correlation Structures

Consequently, I set all the correlations as zero as in Fagereng et al. (2017) and Brandsaas (2018).

## 3 Downpayment Constraint for the Normalized Model

According to Korea Real Estate Board, the median price of all types of apartments in 2015 is estimated as 25,194.5, while the median *Jeonse* deposit size of all types of apartments in 2015 is estimated as 17,953.4. [1] On the other hand, median household yearly income with 3 household members after tax is 3507.5. As one period is 2 years in the model, it corresponds to 7,015. With calibrated downpayment ratio for *Jeonse* and purchase in the main paper (0.416,

[1] Here, 1 means 10,000 Korean Won which is \$8.52 in 2015 average exchange rate.

0.482), we can calculate as following for *Jeonse* tenant.

$$X_a \geq \delta_J \bar{J} P^H \underline{H} \tag{6}$$

$$\frac{X_a}{Y_a} \geq \frac{\delta_J \bar{J} P^H \underline{H}}{Y_a} \tag{7}$$

$$\frac{X_a}{Y_a} \geq 0.416 * 17,953.4/7,015 = 1.064 \tag{8}$$

Also, with the same method, for home purchaser, we calculate following.

$$X_a \geq \delta P^H \underline{H} \tag{9}$$

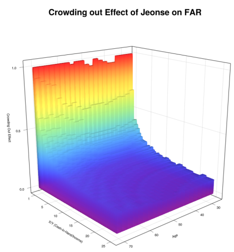
$$\frac{X_a}{Y_a} \geq \frac{\delta P^H \underline{H}}{Y_a} \tag{10}$$

$$\frac{X_a}{Y_a} \geq 0.482 * 25,194.5/7,015 = 1.7304 \tag{11}$$

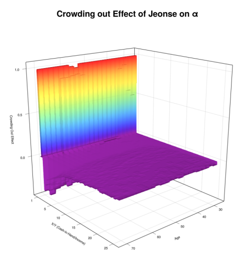
# 4 Crowding Out Effect Graphs

## 4.1 High Correlation between Stock Return and Housing Return

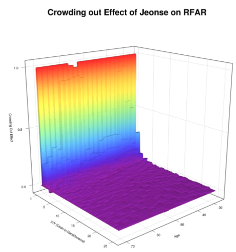
Here I use the baseline calibration with only $\rho_{hs}$ set as 0.3 which is higher than that of original value.



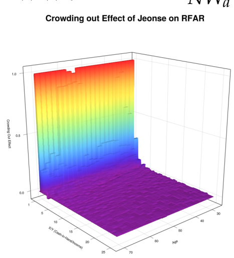

((a)) *Jeonse* on $\frac{A_a}{NW_a}$



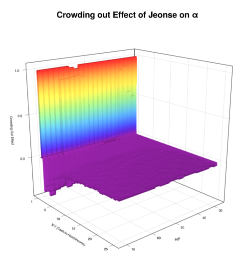

((b)) *Jeonse* on $\alpha_a$



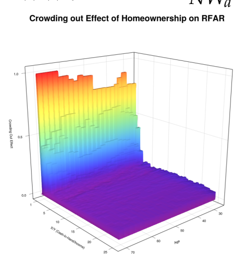

((c)) *Jeonse* on $\frac{\alpha_a A_a}{NW_a}$




((d)) Homeowner on $\frac{A_a}{NW_a}$




((e)) Homeowner on $\alpha_a$

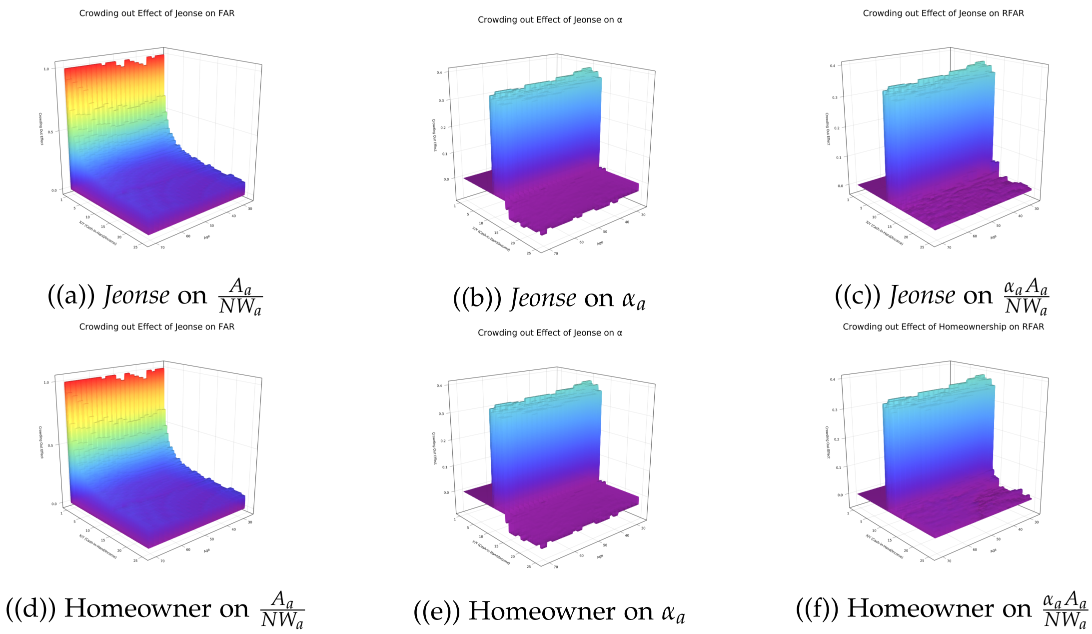



((f)) Homeowner on $\frac{\alpha_a A_a}{NW_a}$

Figure 3: Crowding out Effect With $\rho_{hs} = 0.3$

## 4.2 High Stock Market Paritcpation Costs

Here I use the baseline calibration with only $\gamma$ set as 0.05 which is higher than that of original value.




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

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

Figure 4: Crowding out Effect With $\gamma = 0.05$

# 5 Additional Empirical Analysis

## 5.1 Data Source

In this appendix, I use another well-known household panel data called as Survey of Household Finances and Living Conditions (SHFLC hereafter) from South Korea, an annual panel survey starting from 2012 to 2019. This panel survey tracks about 20,000 households which represent the entire Korean population. In this survey, a household is defined as an economic units where people live together and are financially connected. It has a detailed data on non-durable goods expenditures, housing expenditures, income, wealth, debt, asset allocation, human capital, and household characteristics.

## 5.2 Definitions

Before I proceed, I define some variables. *Disposable Income* means all the regular income that households expect for a year other than capital income, and *Capital Income* is about the capital gain from stock investment or house price increase. So *Non-capital Income* ($Y$) is defined as *Disposable Income* minus *Capital Income*. Then, *Cash-in-Hand* ($X$) is defined as sum of net wealth

($W$) and $Y$. $X/Y$ refers the ratio between two, and it is a data counterpart of important state variable of the structural model developed in this paper. As the most important variable of interest, I define Stock over Net worth ($SW$) as the sum of risky financial asset $(\alpha A)$ over net wealth $(W)$. This will be a variable for measuring the crowding out effect.

$$
\begin{aligned}
Y &= Disposable\ Income - Capital\ Income \\
X &= NetWealth + Y \\
X/Y &= X/Y \\
SW &= \frac{Stock + Future + Bond + Option + Mutual\ Fund}{Net\ Wealth}
\end{aligned}
$$

### 5.3 Sample Selection

Throughout this section, I use a selected sample by several criterion rather than using the whole data set. First, I remove bottom 3% and top 3% in terms of $X/Y$ to remove abnormal observations such as huge negative net wealth. Additionally, I use observations of renters and *Jeonse* renters who do not own any other housing assets. It is common in South Korea that some people live in rented house or *Jeonse* rented house though they have their own houses for various job-related or investment-related reasons. If I also include those observations of renters or *Jeonse* renters who have their own houses, that would be misleading. So I exclude data of households whose housing tenure types are "rent" or "*Jeonse*" but have other housing asset worth more than rent deposit or *Jeonse* deposit. Lastly, I use observations of households who are older than 30. Due to Korean specific law, a person becomes independent household either if he/she get married or become older than 30. Under this condition, if I use data of households younger than 20, that will be selected sample, which do not represent the true data pattern of people of age 20.

### 5.4 Descriptive Statistics

Table 2 summarizes the survey-weighted sample averages of important variables of each housing tenure group in 2015. We can see that, while ownership accounts for the most share of housing tenure, *Jeonse* also accounts for 12.6 % which is economically significant. We can clearly see the increasing pattern of $X/Y$, *Net Wealth*, *Assets*, and *Disposable Income* as we move from Rent to *Jeonse* and to Ownership. Importantly, while stock market participation rate of owners is the highest, the conditional risky asset share of renter (average $SW$ of stock market participants) is the highest.

| | Total | Renter | Jeonse | Owner |
|---|---|---|---|---|
| Ratio | 1.000 | 0.154 | 0.126 | 0.597 |
| Age | 52.77 | 50.26 | 47.61 | 54.33 |
| X/Y | 8.675 | 2.951 | 6.391 | 10.916 |
| Net Wealth | 26169.00 | 4957.26 | 15856.46 | 34405.06 |
| Financial Asset | 8664.99 | 4871.96 | 15643.17 | 7650.85 |
| Risky Financial Asset | 667.64 | 158.40 | 605.60 | 794.94 |
| Other Real Asset | 10812.01 | 1160.13 | 2828.34 | 12992.45 |
| Rent Deposit | - | 2398.155 | 0.00 | 0.00 |
| *Jeonse* Deposit | - | 0.00 | 10722.633 | 0.00 |
| House Living | - | 0.00 | 0.00 | 20834.604 |
| Disposable Income | 4164.35 | 2850.04 | 3716.41 | 4685.44 |
| Stock Market Participation | 0.180 | 0.064 | 0.169 | 0.213 |
| SW | 0.006 | 0.012 | 0.018 | 0.012 |
| Conditional SW | 0.034 | 0.185 | 0.108 | 0.060 |

Table 2: Descriptive Statistics

### 5.5 Life-Cycle Pattern

In this subsection, I show the life-cycle pattern of $X/Y$, $X$, $Y$, housing asset over net wealth ratio, housing tenure, stock market participation rate, $SW$, and $SW$ conditional on participation across age groups and housing tenures. These are all important variables affecting aggregate stock investment. For these moments, I simply calculated average reflecting the sampling weights. As mentioned in Ameriks and Zeldes (2004), controlling cohort effect and year effect is important to capture the pure age effect which is of interest. I ran pooled regressions to control the cohort effects and year effects by cohort-dummy variable and each year's macroeconomic variables such as GDP growth rate, house price growth rate, unemployment rate and stock market return. However, though some of them are statistically significant, they are not economically significant and estimates are similar to weighted sample mean. In addition, age profiles were not statistically significant for renters. Consequently, here I just present the weighted average of variables of interest.

#### 5.5.1 $X$,$Y$, and $X/Y$ over Life-Cycle

Some of the most important variables in the model are $Y$, $X$, and the ratio $X/Y$. Figure 5 shows the average of $X$, $Y$, and $X/Y$ by age and housing tenure status. This figure is an average conditional on age and housing tenure. These are not showing causality, rather it is an equilibrium outcome from households' endogenous choices. For $X$, we can see that concave life-cycle wealth profile which can be observed from other countries' data. As they get closer to the middle ages (50-55), they accumulate the wealth, and it decreases later, as households use their accumulated wealth. We can see the similar pattern for non-capital income $Y$. Interestingly, we can see that the homeowners usually accumulate the multiple times of the wealth while the renters keep having only 2-3 times of their yearly income as a net wealth. For homeowners, this should be driven by bequest motives or uncertainty about their timing of death.

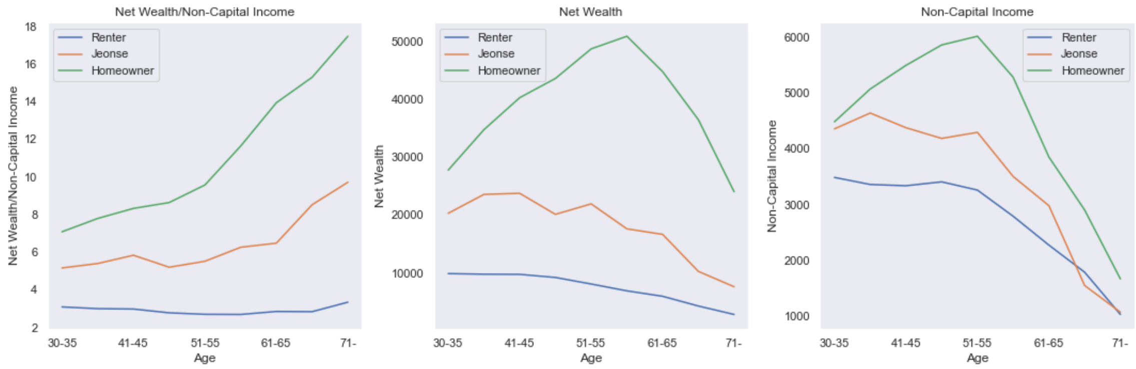



Figure 5: Net Wealth and Non-Capital Income

### 5.5.2 Housing Expenditure and Housing Tenure by Age

This section is about households' decisions regarding housing. In Figure 6, left plot shows the housing asset over net wealth ratio. Housing asset is defined as rent deposit for renters, *Jeonse* deposit for *Jeonse* renters, and as the value of house of living for homeowners. For housing asset ratio, we can see that it is really high when they are young while as they get older it decreases, which reflects the fact that households pay back the debt and accumulate other types of asset as they get older. On the other hand, the ratio of *Jeonse* deposit increases as we move to older age groups, which implies that *Jeonse* deposit is one of the most important asset to some of old households. Right plot shows how the housing tenure distribution evolves as time goes. When the households are young, half of households use rent or *Jeonse* contract, while, as they get older, they are more likely to be homeowners. This should be driven by the liquidity constraint that households experience when they are young.

### 5.5.3 Stock Market Participation Rate and Share of Equity by Age

The last and most important data patterns are stock market participation rate and ratio of risky financial asset $SW$. We can see that homeowners and *Jeonse* renters participate in stock market more than renters. As pointed out in Vestman (2019), this should be driven by the fact that renters have lower assets or they are different in the sense that they have more present oriented preference or higher stock market participation costs compared to the homeowners. In the second graph, we can show that though the renters show the lower stock market

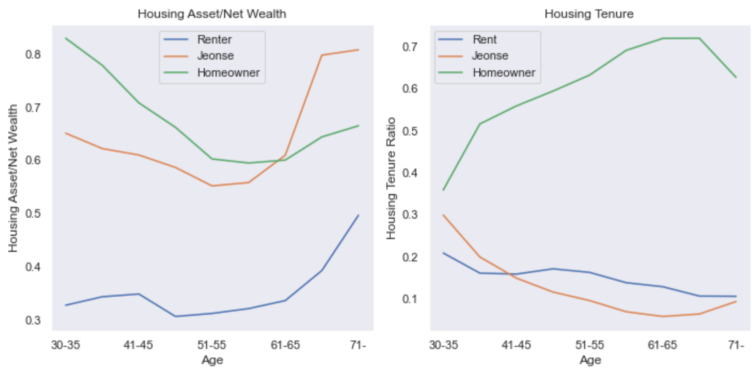



Figure 6: Housing Asset and Housing Tenure Choice

participation rate, they show similar aggregate average of *SW* with *Jeonse* renter or homeowners, which reflects that, conditional on participation, renters invest much more share of their wealth than *Jeonse* renter or homeowners. These endogenous movement will be captured by model developed later.

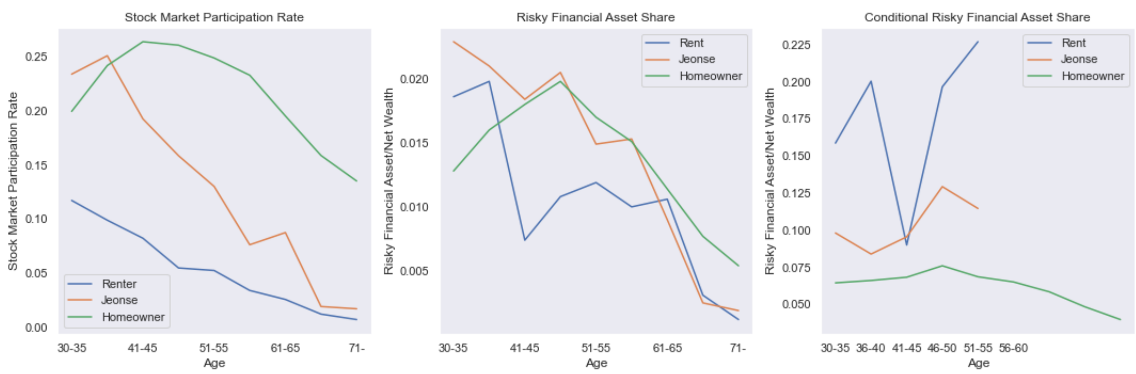



Figure 7: Stock Market Participation Rate and Risky Asset Ratio

## 5.6 Effect of Transition

Lastly, by exploiting the panel dimension, I document how $X$, $X/Y$, stock market participation, and $SW$ change when households transition from one tenure type to another tenure type. Table 3 shows how many households transitioned in data for each possible housing tenure transition. I again calculated weighted averages of these households' corresponding variables. I define 1) rent to *Jeonse* transition, 2) rent to ownership transition, and 3) *Jeonse* to ownership transition as upward transition. As it is common that households transition from rent to *Jeonse* and *Jeonse* to ownership as they get richer, this transition is more likely to be accompanied by positive wealth shock. Below figures are depicting how households' $X$, $X/Y$, stock market participation, and $SW$ change as they transition.

| | Rent to *Jeonse* | Rent to Ownership | *Jeonse* to Ownership |
|---|---|---|---|
| Upward Transition | 765<br>(0.9%) | 516<br>(0.6%) | 977<br>(1.1%) |
| | Ownership to *Jeonse* | Ownership to Rent | *Jeonse* to Rent |
| Downward Transitionax | 450<br>(0.5%) | 291<br>(0.3%) | 1085<br>(1.3%) |

Table 3: Transitioning Households


((a)) $X$ and $X/Y$ ((b)) Stock Market Participation and $SW$

Figure 8: Upwardly Transitioning Households

As we conjectured, most of the upward-transitioning households experience the positive wealth shock, which is shown by the increase not only in $X$ but also in $X/Y$. Interesting patterns appear for Figure 8 (b). Even though they experience the positive wealth shock, they invest less in risky asset in ratio, and some of the households transitioning from *Jeonse* to ownership even exit the stock market. Surely, this does not show the causal effect of housing tenure transition, and housing purchase. However, as this transition usually happen with positive wealth shock which usually incentivizes households to participate in stock market or invest more in stock holdings, I argue that this shows the minimum of the crowding out effect. Importantly, we can see the decreasing pattern of $SW$ for households transitioning from rent to *Jeonse* who is likely to experience only liquidity constraint shocks, and these size of decreases are larger for households who are transitioning to ownership, which is presumably experiencing the crowding out effect coming from both of the liquidity constraint and house price risk channel.

Next, I document the data pattern of households transitioning downward. I define 1) ownership to rent, 2) ownership to *Jeonse*, and 3) *Jeonse* to rent as downward transition. Being opposite to the upward transition cases, downward transitioning households experience negative wealth shock or at least their labor income becomes more important compared to their wealth accumulated. This should incentivize the households to have less risky portfolio.

However, we can see that the stock market participation after the transition increase in all transition cases, and $SW$ also increases except the case of the transition from *Jeonse* to renter


((a)) $X$ and $X/Y$ ((b)) Stock Market Participation and $SW$

Figure 9: Downwardly Transitioning Households

case which might be the case where negative wealth shock effect dominates the crowding out effect as described in Figure 9.

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