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Using Threshold Estimation Technique to Measure Housing Wealth Effect in Different Income Levels

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In this study, we estimate the housing wealth effect of households with different income levels. Since we expect the housing wealth effect to vary based on the different income levels, we use the threshold estimation technique developed in Hansen (1999) instead of imposing an exogenous criterion to divide the sample by income level. This econometric technique is developed for panels with individual-specific fixed effects. Therefore, we apply this econometric method on the findings in the existing literature to estimate the housing wealth effect, while considering the heterogeneity in different income categories. We obtain individual level data from the 2012 to 2016 Korea Household Finance and Welfare Survey (KHFWS) and find statistically significant threshold income levels, thus indicating households show different behaviors based on the threshold income. We provide the groundwork for future research to identify the target group who maximizes their wealth effect, which has housing policy implications.

Keywords

Real Estate; Wealth Effect; Threshold Estimation; Income Levels

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1. Introduction

As real estate assets account for a large proportion of household wealth, government-stipulated housing policies that stimulate the overall economy cause fluctuations in the price of real estate assets which directly impact the consumption level of individual households. Thus, governmental officials exploit the housing wealth effect through various housing policies to increase household consumption thus resulting in approximately a 25% increase in residential housing prices in South Korea since the 2008 global financial crisis (GFC). According to extensive studies by Thaler (1990), Levin (1998), Bertaut and Starr (2000), and Case et al. (2005), residential real estate wealth substantially influences the overall consumption level in a given household. The relationship between housing wealth and consumption can be explained by the wealth effect which is when an increase or decrease in housing price subsequently increases or decreases the overall consumption in a given household respectively due to increase in perceived wealth. Most of the previous findings have concluded that the magnitude of the wealth effect from real estate is more influential than other assets, such as stocks and bond. These findings are consistent with the statistical fact that a total of 25% of the overall wealth are weighted on real estate assets and two-thirds of the middle-income group in the U.S. invest in real estate asset as well (Bertaut and Starr (2000) and Aladangady (2017)). This is an even more important research topic for countries that place a higher weight on national assets, specifically in real estate, which is the case for South Korea. According to the Korea Bureau of Statistics (2016), 70% of the household assets in South Korea is in real estate.

This implies that the wealth effect of residential real estate is a critical issue in both the academia and for policymakers who are concerned about the economic impacts from the residential real estate market in South Korea. However, there have been consistent findings in the literature that document the effect of real estate price changes on consumption. The income hypothesis by Friedman (1957) or the life cycle hypothesis defined in Ando and Modigliani (1963) which are used interchangeably attributes two primary reasons behind the wealth effect. First, the individual household is exposed to financial liquidity constraints and thus the increase of housing price alleviates the financial constraints in a given household due to the increased collateral value (Hall 1978; Hall and Mishkin 1982; Lustig and Van Nieuwerburgh 2010; Campbell and Cocco 2007). Second, increases in housing price reduce the need for precautionary savings as individual households perceive an overall wealth increase (Campbell and Cocco 2007). Due to this perceived increased wealth and reduced pressure to save money, individual households will tend to increase their overall consumption.

However, there is also a controversial debate on the effects of changes in real estate prices on consumption. The common-factor hypothesis indicates that an increase in housing price will increase taxes as a cost of residential housing and

thus also increase rent, thus affecting the costs of other goods of renting households (Levin 1998; Attanasio 2009; Carroll et al. 2011). On the other hand, there are extensive empirical findings on the presence of a housing wealth effect and thus our research is premised upon a positive wealth effect as the literature groundwork.

In terms of the magnitude of the wealth effect, Khalifa et al. (2013) argue that there is a systematic difference in the wealth effect among different income groups which is especially apparent in the higher and lower income groups. Carroll (2000) finds that consumption behavior varies across the different household income levels. Higher income households with higher income distributions behave substantially different than other income groups. Consequently, we expect the housing wealth effect to be different for the higher and lower income groups, and need to determine how to divide the sample along income level. It is generally acceptable in South Korea to split income groups based on the classification provided by the Korea Bureau of Statistics in which individual incomes are arranged by 20% increments in descending order for a total of five different income groups. We find that it would be difficult to interpret the different wealth effects for all possible existing income levels if we simply compare the coefficient of different groups that are classified based on simply descending order of income.

Thus we adopt the threshold estimation technique developed in Hansen (1999) instead of imposing an exogenous criterion to divide the sample by income level. This econometric method is developed for panels with individual-specific fixed effects. By controlling the fixed effects, it is possible to control the effect of omitted unobservable variables that are individual-specific. Accordingly, the contribution of this paper is to use the threshold estimation model which was not previously used in the literature, to estimate the housing wealth effect, while taking into consideration the heterogeneity of the behavior of those in different income categories. Furthermore, the model adopted in this study allows us to test whether the threshold model describes the relationship between jumping variables or structural breaks in the relationship between different variables. If we assume that variables have a linear relationship with the independent variables, then it would be difficult to determine the jumping variable or structural break if the dependent sample variable does not have a linear relationship with the dependent variables. In considering the non-linear characteristics of the observed sample, we might expect to find two or three income groups when identifying the housing wealth effect.

Based on the existing literature on the housing wealth effect, we ask the following research question in our study. Has there been a housing wealth effect in South Korea in the recent decade? If we can find the significant coefficient of household consumption on changes in home price, we can confirm the existence of a wealth effect and determine whether it is a possible positive or negative wealth effect based on one of two contradicting theories: the life cycle or common-factor hypothesis. Thus, we can conclude that the housing policy

has to stimulate household consumption to recover from the downturn of the housing market during the GFC. This study also compares an existing possible housing wealth effect between the consolidated metropolitan statistical area (CMSA) and non-CMSA of Seoul. Since half of the population lives in the CMSA of Seoul with higher income occupations such as high technology and finance, insurance, and real estate, and the other regions are those with a middle class based job or industry that offers mid-range incomes, we expect to establish a more accurate housing policy if we consider these differences in the housing wealth effect of the two regions. In a comparison between the CMSA and non-CMSA of Seoul, we also expect a different response to the wealth effect. Since the average household income in the CMSA of Seoul is higher than that of the non-CMSA, this would reflect the level of the wealth effect. In addition, this implies that households in the CMSA and non-CMSA of Seoul have different compositions in their financial and real estate assets that reflect the different responses to the wealth effect.

This study also endeavors to adopt the threshold estimation technique to control the effect of omitted unobservable variables that are individual-specific such as expected future income or inherited assets that have an impact on both current consumption and wealth. We also reflect the non-linear characteristics of the sample observations with two or three income groups when identifying the housing wealth effect.

We apply the threshold estimation technique on the Korea Household Finance and Welfare Survey (KHFWS) yearly data over the period of 2012 to 2016, when a series of policies implemented by the government to stimulate the housing wealth effect took place. Generally, our results indicate that the housing wealth-consumption relationship can be positively related when homeowners have a positive expectation about future economic conditions.

We establish the three following hypotheses. The first hypothesis is a non-linear relationship between consumption and income. If we can identify a significantly different housing wealth effect in two different income threshold groups using the threshold method, then we can demonstrate that the relationship between consumption and income is a non-linear relationship. The second hypothesis is that the housing wealth effect between the high and the low-income groups is significantly different from each other. The third hypothesis is that there is a difference in the wealth effect between the CMSA and non-CMSA, thus reflecting different household formation based on income level and asset structure.

This study contributes to the literature on the housing wealth effect and provides some important implications for policymakers. While there have been a number of studies that have examined the relationship between housing wealth and consumption in South Korea, they do not consider the different income levels. Thus we show the presence of a housing wealth effect in different income levels in South Korea by using the threshold estimation technique proposed in Hansen

(1999). Our study is organized as follows: Section 2 is the literature review. Section 3 describes the data and method, and Section 4 presents the estimated result of our threshold method. Section 5 concludes and provides the limitations of the study.

2. Literature Review

Recently, several studies have attempted to examine the impact of changes in housing wealth on consumption behaviors. Several studies on the housing wealth effect have found a positive correlation between housing wealth and consumption through macro-level data. Girouard and Blöndal (2001) find that a positive wealth effect is correlated with consumption among 16 OECD countries since 1970. They also find that the marginal propensity to consume (MPC) residential assets in the long run shows a significant housing wealth effect with a marginal propensity of 0.12 in Canada and 0.048 in the United States. Benjamin et al. (2004) demonstrate an 8 cent increase in consumption for each dollar increase in housing wealth in the U.S. in 2001, as compared to only a 2 cent increase for each dollar increase in financial wealth by using aggregated quarterly data from 1952Q1 to 2001Q4. Case et al. (2005) find that housing wealth has a statistically significant effect of 0.06 on household consumption compared to 0.03 from stocks with regard to asset value changes. They attempt to correlate increases in housing, financial wealth and consumer spending during the period of 1982–1999 for the U.S. and from 1975 to 1999 for other OECD countries.

While some studies utilize macro level data, several other studies also show consistent results with micro-level data for the housing wealth effect. Most use a panel of state-level data such as The Panel Study of Income Dynamics (PSID). Hoynes and McFadden (1994) apply individual household data by using the PSID for 112 metropolitan statistical areas (MSAs) and examine whether households modify their non-housing savings behavior in response to housing prices. They show that a 10 percentage point increase in housing price results in a 2.28 percentage point or 37% increase in household savings. However, non-housing savings do not show any statistically significant changes. Engelhardt (1996) examines the relationship between house price appreciation and the saving behaviors of homeowners from 1984 to 1989 by using the PSID and shows that the MPC against home price appreciation for owner-occupied housing is about 0.03% for the median saver household and 0.14% for the mean saver household. However, this housing wealth effect shows different effects on renter households. Mayer and Engelhardt (1996) find that increasing housing prices substantially reduce consumption as renters save for a larger sum of money for the down payment to buy a house. Campbell and Cocco (2007) show a statistically positive housing wealth for older homeowners, with an elasticity of consumption as high as 1.7 as opposed to younger renters by using individual household data from the UK Family Expenditure Survey (FES) between 1988

and 2000 classified by cohort group. They also find predictable changes in house prices lead to predictable changes in consumption because increases in the collateral value of housing may reduce borrowing constraints. Aladangady (2017) find a causal effect between MPC and homeowners and renters in terms of housing wealth, and show that an increase of $1 in home value leads to $0.047 increase in their consumption; however a negligible effect is found with renters by using geographically linked micro level data from the Consumer Expenditure Survey (CES) and land use regulations and MSA-level housing data during 1986-2008.

Khalifa et al. (2013) use the threshold estimation method to demonstrate the housing wealth effect for different income levels in the U.S. Unlike previous studies, they focus on the heterogeneity of the household income to estimate the effect of changes in housing wealth on the consumption behavior of households by using the PSID for the waves of 2001, 2003 and 2005. Moreover, they use the threshold estimation technique developed by Hansen (1999), which is an econometric tool for non-dynamic panels with individual-specific fixed effects. They find two significant thresholds for income - $74,046 and $501,000. The housing wealth of households with an income less than $74,046 is significant with a coefficient of 0.010602. Those with an income between the two thresholds have a coefficient of .028224 which is significant as well. However, the coefficient for households with an income over $501,000 is not significant. Thus, they conclude that there are two income thresholds that define the response to housing price changes. Dong et al. (2017) examine the wealth effect of housing price versus their financial market on consumption in 35 major Chinese cities during 2003 to 2014 by using threshold estimation. They find a significant wealth effect when the housing-to-price ratio is less than 5.0882 and the financial development indicator is over 1.887.

Unlike previous studies, we contribute to the current literature by using the wealth effect and assuming that different income groups will have a different response. In order to determine the responses of different income groups to changes in housing price, we use threshold estimation. We also link this different wealth effect across different regional based analyses. The housing price also reflects the average income of local residents in that our result provides a different housing wealth effect as shown by the CMSA and non-CMSA of Seoul.

3. Data and Method

3.1 Data

This study uses the Korea Household Finance and Welfare Survey (KHFWS) for the period from 2012 to 2016. The data are published annually by the Korea Bureau of Statistics and include surveyed data of approximately 20,000 individual households including their demographic information along with

economics variables. Table 1 includes descriptions of the variables and the summary statistics adopted in the study. In order to show the housing wealth effects, we use homeowners for our study. We adopt a natural logarithm form of consumption. Income, housing price and demographic variables consist of binary variables as the indicating variables. In order to enhance accuracy, we control extreme outliers in the samples; thus, a total of 2,869 households are examined in this study with bootstrapping repeated 5,000 times in our threshold estimation. Consumption consists of factors such as food and housing, educational, health care and transportation expenses, utilities, etc. Income includes salary, business revenue, and income from property and other types of income, such as retirement pensions. Housing price is defined as the value of the house if sold less the remaining principle of the mortgage. As this is self-reported, the housing price might be approximately 10 percent higher than the appraised value. We also adopt the mortgage balance to control for financial constraints. In our analysis, we trim outliers or omit variables that account for about 2.5% of the top and bottom income variables.

Table 1 shows the mean, standard deviation, and minimum, median and maximum values of the variables in this study.

3.2 Method

We adopt the threshold estimation in Hansen (1999) to examine the housing wealth effect. This method which is based on the fixed-effect model has two advantages. First, threshold estimation avoids potential endogeneity problems by adopting fixed-effects in the panel data which controls for individual attribution. The effects of omitted unobservable variables would be derived from individual-specifics such as expected future income or inherited assets which impact both current consumption and wealth. However, the fixed effect model can control these effects to improve the accuracy of the results. The second advantage is that the threshold points can capture the non-linear characteristics of the observations of the sample with two or three income groups when identifying the housing wealth effect. In other words, if there is no threshold point, the slope of the coefficient for each classified sub-sample group will be the same. Otherwise, we may expect that the coefficient of housing wealth effect in two different sub-samples differentiated by the threshold point will have a significantly different coefficient of the wealth effect. Eq. (1) is a basic equation for the panel data.

$$\begin{aligned} Consumption_{it} = {} & \beta_1 Income_{it} + \omega_1 HP_{it} + \omega_2 Mortgage_{it} + \omega_3 FamilySize_{it} \\ & + \omega_4 Gender_{it} + \omega_5 Education_{it} + \omega_6 MaritalStatus_{it} \\ & + \omega_7 Age_{it} + \omega_8 Age_{it}^2 + \omega_9 TE_{it} + u_i + e_{it} \end{aligned} \tag{1}$$

Table 1 Definition of Variables

Variable	Description of Variable	Mean	Std dev	Min.	Median	Max.
$Consumption_{it}$	Household consumption of perishable goods	2,466	1559.94	40	2,190	14,560
$Income_{it}$	Annual income of household	4,856	3315.57	469	4,220	15,360
HP_{it}	Housing price	32,498	42544.70	75	20,000	1,075,000
$FamilySize_{it}$	Number of family members	3	1.26	1	3	8
$Mortgage_{it}$	Mortgage Balance	9,825	0.00	0	0	254,000
$Gender_{it}$	Gender of the head of the family[1]	0.84	0.37	0	1	1
$Education_{it}$	=1 if highest education of head of the family is college or higher	0.28	0.45	0	0	1
$MaritalStatus_{it}$	=1 if head of the family is married	0.80	0.40	0	1	1
Age_{it}	Age of head of the family	55.63	13.05	20	55	96

[1] The Korea Bureau of Statistic defines the head of a family as a person who is living in the same housing unit and financially supporting the family with her or his income.

Along with a description of the variables in Table 1, we also consider and control the time effect (TE), where u_i represents unobservable individual effects and e_{it} stands for the error-term of individual households at time t. Then, we proceed per Hansen (1999), in which the first step is to use the ordinary least square (OLS) to find the coefficient of $\beta_i(\gamma_1, \gamma_2)$ in the model. β_i represents a coefficient of the estimated model and $\gamma_1, and\ \gamma_2$ represent each estimated threshold point of the sub-sample.

Then, we find the sum of squared error (S) by incorporating the value of $\gamma_1, and\ \gamma_2$. We find two different values of β_i that reflect the different t value of $\gamma_1 and\ \gamma_2$. Using a likelihood ratio, we estimate $F_1 = \dfrac{S_0 - S_1(\hat{\gamma})}{\sigma^2}$ where S_0 and S_1 are respectively the constrained and unconstrained sum of the squared residuals, $\sigma^2 = \dfrac{1}{n(T-1)} S_1(\gamma)$. The **t**hreshold estimation applies bootstrapping to estimate the asymptotic distribution. After we estimate the significant *p*-value of F_1, we can determine whether we can reject the null hypothesis(H_0) of $\beta_1 = \beta_2$ if the p-value is less than significant at the 1%, 5%, or 10% level. If we reject the null hypothesis, we can further test the null hypothesis in that there are two thresholds. This relationship is as follows:

$$F_2 = \frac{S_1(\gamma_1) - S_2^r(\gamma_2^r)}{\sigma^2} \tag{2}$$

In essence, the threshold estimation is based on the panel fixed model denoted as Model 1 and includes a threshold variable (q_{it})**,** threshold regime (γ) and indicator function (I)**.** In order to determine the number of threshold estimates, we test a null hypothesis in which no threshold exists. If we can find any threshold in the previous hypothesis, then we need to identify the number of thresholds in the model. Next, we test the single and double threshold models to determine the number of threshold estimates. If the likelihood of F_2 arrives at another threshold point, we expect that there is a double threshold point. Otherwise, we use a single threshold estimate. Eqs. (3) and (4) represent single and double threshold models, respectively.

$$\begin{aligned} Consumption_{it} = {} & \beta_1 Income_{it} I\left(q_{it} \le \gamma\right) + \beta_2 Income_{it} I\left(q_{it} > \gamma\right) + \omega_1 HP_{it} \\ & + \omega_2 Mortgage_{it} + \omega_3 FamilySize_{it} + \omega_4 Gender_{it} \\ & + \omega_5 Education_{it} + \omega_6 MaritalStatus_{it} + \omega_7 Age_{it} + \omega_8 Age_{it}^2 \\ & + \omega_9 TE_{it} + u_i + e_{it} \end{aligned} \tag{3}$$

When we are determining which variable should be the threshold variable (q_{it}), we take our hypothesis into consideration in that there should be the presence of different housing wealth effects across the different income levels. Thus, we select income as our threshold variable:

$$\begin{aligned} Consumption_{it} = {} & \beta_1 Income_{it} I\left(q_{it} \le \gamma_1\right) + \beta_2 Income_{it} I\left(\gamma_1 < q_{it} \le \gamma_2\right) \\ & + \beta_3 Income_{it} I\left(\gamma_2 < q_{it}\right) + \omega_1 HP_{it} + \omega_2 Mortgage_{it} \\ & + \omega_3 FamilySize_{it} + \omega_4 Gender_{it} + \omega_5 Education_{it} \\ & + \omega_6 MaritalStatus_{it} + \omega_7 Age_{it} + \omega_8 Age_{it}^2 \\ & + \omega_9 TE_{it} + u_i + e_{it} \end{aligned} \tag{4}$$

4. Empirical Result

4.1 Hausman Test

For the preliminary analysis, a Hausman test is carried out and the result is shown in Table 2. Our model includes a panel and determines which whether the fix-effect or random effect model fits better by adopting the Hausman test. By conducting both the fixed-effect and random effect tests, we find that housing wealth effects are found with both as a 1% increase in housing price is related to a consumption increase that ranges between 2.76% and 7.82%. Besides, a 1% increase in income positively influences consumption with an increase that ranges between 2.71% and 3.9%. According to the Hausman test, the fixed effect is more appropriate than a random effect at a significant p-value of 1%, which we adopt following this result. Since the threshold estimation is based on the fixed effect model, we use the threshold estimation model in Hansen (1999) for the following steps.

4.2 Result of Threshold Estimation

The threshold result of $F_1$and F_2 is presented in Table 3. The single threshold estimation test indicates that we can reject the null hypothesis as there is no threshold estimated at a significant p-value of 1%. Thus, we expect there is at least one threshold. In the double threshold estimation, we find that there is at least double threshold points at the 1% significance level. However, the triple threshold test confirms that we should accept the double threshold estimate. Thus we adopt the double threshold estimate in our analysis. Furthermore, this finding indicates that consumption and income does not have a linear relationship. Rather, they have a non-linear relationship in which three income threshold regimes show different consumption responses, thus suggesting two threshold estimates. In Table 3, we find the first threshold γ_1 and the second threshold γ_2 at 27.6 million Korean won and 67.9 million Korean won respectively (or 24,000 USD and 59,000 USD respectively based on exchange rates at time of study).

Table 2 Result of Panel Analysis with Fixed-Effect and Random-Effect Tests

	Fixed-effect		Random-effect	
	Coefficient	Std.	Coefficient	Std.
HP	0.0276***	0.00790	0.0782***	0.00478
Income	0.271***	0.00889	0.390***	0.00685
Family size	0.102***	0.00762	0.122***	0.00463
Mortgage	1.20e-07	4.97e-07	1.84e-07	3.74e-07
Age	0.0298***	0.00542	0.0274***	0.00275
Age^2	-0.000304***	4.79e-05	-0.000303***	2.43e-05
Education	0.0382**	0.0182	0.114***	0.0104
Marital status	-0.0153	0.0251	0.0683***	0.0149
Gender	0.0248	0.0227	0.0259*	0.0147
Time effect	Y		Y	
Observations	13,786		13,786	
R-squared	0.139			
Number of id	2,869		2,869	
Hausman test (Prob>chi2)	0.0000			

Note: Standard errors are in parentheses and *** , **, * denote p<0.01, p<0.05, and p<0.1, respectively.

Figure 1 presents the concentrated likelihood ratio function. The Y-axis represents the likelihood ratio and the X-axis is the first and second threshold estimates, respectively. The estimate for the first threshold (γ_1) = 27.6 million Korean won which is the natural logarithm of the first threshold of 7.9244, and the second threshold (γ_2) = 67.9 million won which is transformed from the natural logarithm of the second threshold of 8.8235.

Thereinafter, we analyze the housing wealth effect based on low, middle and high-income groups. The lower income group is defined as those with $q_{it} \leq$27.6 million Korean won. The middle-income group is defined as 27.6 $< q_{it} \leq$67.9 million Korean won, and shows that a 1% increase in household income will incur an increase of over 29% in consumption. On the other hand, the high income group is defined as 67.9 million Korean won $< q_{it}$ and shows that a 1% increase in household income will incur an increase of 16.9% in consumption. From these results, we conclude that a housing wealth effect has more impact on the low and middle income groups but not the high income group.

Table 3 Tests for Threshold Effect of Housing Wealth [2]

Test for single threshold	
F_1	1262.37
$p-$ value	0.0000
(1%, 5% and 10%)	(21.1307, 15.6645, and 13.1921)
Threshold *(γ)*	8.8235 (67.9 million won)
Test for double threshold	
F_2	985.36
$p-value$	0.0000
(1%, 5% and 10%)	(21.0601, 15.3892, 13.0898)
Threshold *(γ_1)*	7.9244 (27.6 million won/24,000 USD)
Threshold *(γ_2)*	8.8235 (67.9 million won/59,000 USD)
Test for triple threshold	
F_3	631.45
$p-$ value	0.5190
(1%, 5% and 10%)	(938.3478, 851.0345, 790.4605)

Note: Standard errors are in parentheses.

Table 4 shows the result of the threshold estimation for all of the threshold regimes. It can be observed that the housing wealth effect incurs a 1.99% increase in consumption and the income effect incurs a 15% increase in consumption. Consumption increase with more family members (Family size) and a male head of the household. Also, individuals are reluctant to spend money with a higher mortgage balance.

[2] In order to find the threshold, we conduct triple threshold estimations. Using a likelihood ratio, we estimate the significant *p*-value of each model. We reject the null hypothesis (H_0) of $\beta_1 = \beta_2$ if the p-value is less than 1%, 5%, and 10%. In Table 3, we see that the p-value of a single threshold model is less than significant. In other words, there is at least one threshold. Furthermore, we conduct the double threshold test and also find that the p-value is less than significant. From this result, we know that there is at least a double threshold. Finally, we implement a triple threshold test and the p-value is 0.519. We conclude that there is no triple threshold. In summary, we determine the two threshold points to be 27.6 million Korean won and 67.9 million Korean won, respectively.

Figure 1 **Confidence Interval Construction in Double Threshold Model of Housing Wealth**

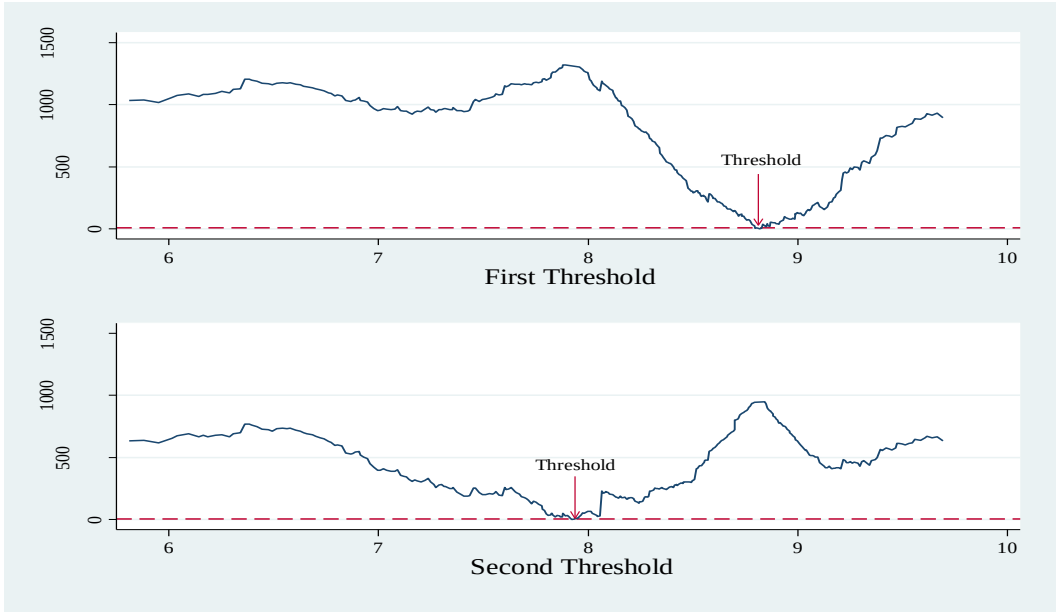

Table 4 Tests for Housing Wealth Effect by Threshold

	Total		Low-income group		Middle-income group		High-income group	
	Coef	Std.	Coef	Std.	Coef	Std.	Coef	Std.
HP	0.0199***	0.00416	0.0485***	0.0152	0.0194	0.0126	-0.0171	0.0174
Income	0.150***	0.00383	0.297***	0.0184	0.295***	0.0231	0.169***	0.0367
Family size	0.0394***	0.00408	0.0956***	0.0211	0.0838***	0.0124	0.0858***	0.0177
Mortgage	-1.07e-06***	1.96e-07	1.10e-06	1.16e-06	-2.34e-06*	1.34e-06	-6.51e-08	6.75e-07
Age	0.0103***	0.00287	0.0171*	0.00986	0.0335***	0.0101	0.0969***	0.0170
Age^2	-0.000121***	2.53e-05	-0.000169**	8.18e-05	-0.000340***	9.51e-05	-0.000951***	0.000160
Education	0.00806	0.00991	0.0662	0.0540	0.0130	0.0260	0.0500	0.0337
Marital status	0.0163	0.0132	0.00996	0.0460	0.0341	0.0469	0.00779	0.0767
Gender	0.0331***	0.0121	-0.0554	0.0399	0.0552	0.0421	0.0517	0.0595
Time effect	Y		Y		Y		Y	
Observations	14,510		4,412		5,904		3,470	
R-squared	0.744		0.106		0.067		0.045	
Number of id	2,902		1,316		1,821		1,127	

Note: Standard errors are in parentheses and *** , **, * present p<0.01, p<0.05, and p<0.1, respectively.

There is a difference in the housing wealth effect among the different income groups. There is a housing wealth effect of 4.85% for the lower income group but much lower or none for the middle and higher income groups. Also, the total housing wealth effect is 1.99%; see Table 4. This is important for policymakers when implementing housing policies with the intention to stimulate the economy because the government should focus more on income groups and regional differences. If the government wants to stimulate the economy through the housing market, they should focus on the lower income groups and help them with housing purchase, for example, income groups that earn less than 27.6 million Korean won as in doing so increases domestic consumption

In this sense, we can confirm the second hypothesis in that the housing wealth effect for both low and high income households is significantly different. This finding suggests that the latter is more inclined to save than the former.

In terms of the relationship between income and consumption, the result implies that the magnitude of the income effect of the low and middle-income threshold regimes is greater than that of the high-income threshold regime, thus indicating that the income wealth effect matters for the low and middle-income groups while the housing wealth effect matters the most for the low-income group. In other words, the effect of housing wealth on the low income threshold regime incurs a significant 4.85% increase in consumption. However, the housing wealth effect for the middle and high income threshold regimes does not incur an increase in consumption statistically. Other demographic factors such as the household family size show a positive impact on consumption, and age is an inverse U shaped relationship with consumption which means that the younger individuals increase their consumption but the elderly reduce consumption. Marital status and education are statistically insignificant.

4.3 Result of Threshold Estimation for CMSA versus Non-CMSA of Seoul.

To better understand the regional housing wealth effect, we differentiate between the CMSA and the non-CMSA of Seoul. Both have economically different characteristics in regional industry and economy. For example, half of the South Korean population lives in the CMSA of Seoul and employed in a mid-income level or industry based jobs, such as information technology (IT) or higher income occupations such as finance, insurance, and real estate (FIRE). For this reason, a comparison of the wealth effect in both the CMSA and non-CMSA of Seoul will help to create more accurate housing policies if the differences in the housing wealth effect of these two regions are taken into consideration.

Table 5 provides the results of threshold testing in the CMSA and non-CMSA of Seoul. We conduct sequential threshold tests and find that the double

threshold estimate has a significant p-value at 1%. We find that the first threshold γ_1 and the second threshold γ_2 are 55.2 million and 99.0 million Korean won respectively (or 47,960 USD and 86,000 USD respectively based on exchange rates at time of study).

From Table 5, we can also find double threshold points at the 1% level of significance for the CMSA of Seoul. The point estimates of the two thresholds are 18.0 million and 49.2 million Korean won, respectively, (or 15,640 USD and 42,000 USD respectively based on exchange rates at time of study).

Table 5 CMSA and Non-CMSA of Seoul Threshold Estimation

	CMSA of Seoul	Non-CMSA of Seoul
Test for single threshold		
F_1	432.22	946.91
$p-$value	0.0000	0.0000
(1%, 5%, and 10%)	(22.2890, 15.5535, 13.1390)	(21.2581, 15.3894, 13.0320)
Threshold *(γ)*	9.1431 (93.5 million won)	8.5011 (49.2 million won)
Test for double threshold		
F_2	231.86	811.81
$p-$value	0.0000	0.0000
(1%, 5%, and 10%)	(20.8859, 14.7286, 12.3384)	(21.2762, 15.5051, 13.2124)
Threshold *(γ_1)*	8.6161 (55.2 million won/47,960 USD)	7.4955 (18.0 million won/15,640 USD)
Threshold *(γ_2)*	9.2003 (99.0 million won/86,000 USD)	8.5011 (49.2 million won/42,000 USD)
Test for triple threshold		
F_3	154.02	711.29
$p-$value	0.5442	0.5032
(1%, 5%, and 10%)	(234.5686, 208.8525, 197.3651)	(1.1e+03, 1.0e+03, 966.5244)

Note: Standard errors are in parentheses

The estimation result in Column (1) of Table 6 shows the housing and income wealth effects of the CMSA of Seoul. The income wealth effect incurs an 11% increase in consumption. Also, a 1% increase in housing price incurs an increase of 3.6% in the CMSA of Seoul. While family size, age, and gender have a significant impact on consumption, other demographic variables such as education and marital status are insignificant to household consumption. In Columns (2) to (4) of Table 6, there is an asymmetric effect on consumption. The low threshold regime has a 7.67% correlation with housing wealth. However, the middle and high income threshold regimes do not show correlation with housing wealth.

On the other hand, the estimation result in Column (1) of Table 7 shows the result of housing and income wealth effects in the non-CMSA of Seoul. The income wealth effect has a 19.3% correlation with consumption. In addition, a 1% increase in housing price incurs a 1.04% increase in consumption. The gap between income and housing wealth effect in the non-CMSA of Seoul is significantly higher than in the CMSA. As with the CMSA of Seoul, gender has a significant impact on consumption. The other demographic variables such as education and marital status have an insignificant impact on household consumption. In Columns (2) to (4) of Table 7, an income effect of consumption is found, but a housing wealth effect is not found in the non-CMSA of Seoul. Table 5 shows the low-income regimes in the CMSA of Seoul (55.2 million Korean won or 47,960 USD) have triple the income level of those in the non-CMSA of Seoul (18.0 million won or 15,640 USD). This difference will contribute to housing policies if policy makers consider the differences in housing wealth effect in the two regions.

5. Robustness Test

For testing the robustness of the wealth effect, we also adopt system dynamic panel data estimation (System GMM) to determine whether the result from the threshold method is supported by System GMM. Blundell and Bond (1998) indicate that the System GMM and the threshold model include lagged levels of the dependent variables as repressors and use as instrumental variables (IV). The advantage of a GMM estimator is that it controls for time-invariant country-specific effects which deal with the endogeneity problem of lagged dependent variables. Furthermore, it could allow a certain degree of endogeneity in the other repressors, and optimally combines information on cross household variation of different levels with that on changes in the within-household variations. The dynamic model for our study is provided in Eq.(5):

$$X_{it} = f\left(y_{it-1}, y_{it-2}, \cdots, y_{it-p}, Z_{it}, u_t\right) \tag{5}$$

where X represents income and housing price, Z represents mortgage, family size, age, marital status and gender, y represents consumption, and u_i represents unobservable individual effects.

Eq.(6) suggests that estimating the wealth effect takes into consideration the lagged independent variables as instrumental variables, which requires the following empirical model:

$$\begin{aligned} &y_{it} = \alpha + \sum\nolimits_s K_s y_{it-s} + \beta X_{it} + \gamma Z_{it} + u_t + e_{it} \\ &s = 1, \ldots, p \end{aligned} \tag{6}$$

where y_{it} is total consumption expenditure, e_{it} stands for an error-term and β is the effect of model structure on performance.

Table 6 Tests for Housing Wealth Effect in CMSA of Seoul

	CMSA of Seoul		Low-income group		Middle-income group		High-income group	
	Coef	Std.	Coef	Std.	Coef	Std.	Coef	Std.
HP	0.0359***	0.00844	0.0767***	0.0223	-0.0119	0.0332	-0.0358	0.0591
Income	0.110***	0.00602	0.269***	0.0224	0.262***	0.0732	0.293*	0.151
Family size	0.0467***	0.00695	0.0932***	0.0198	0.142***	0.0272	-0.0499	0.0691
Mortgage	-1.15e-06***	2.47e-07	1.61e-08	1.08e-06	-8.78e-07	1.31e-06	1.20e-06	1.29e-06
Age	0.00861*	0.00497	0.0131	0.0130	0.0164	0.0273	0.394**	0.180
Age^2	-0.000113**	4.40e-05	-0.000161	0.000112	-0.000109	0.000258	-0.00201***	0.000601
Education	-0.00504	0.0165	0.0222	0.0437	0.0516	0.0556	0.267	0.202
Marital status	0.0251	0.0217	0.0315	0.0551	-0.314**	0.123	0.0772	0.347
Gender	0.0331*	0.0192	-0.0149	0.0498	-0.152*	0.0785	-2.282	1.718
Time effect	Y		Y		Y		Y	
Observations	4,285		2,459		1,207		477	
R-squared	0.762		0.134		0.086		0.093	
Number of id	857		655		444		191	

Note: Standard errors are in parentheses and *** , **, * denote p<0.01, p<0.05, and p<0.1, respectively.

Table 7 Tests for Housing Wealth Effect in non-CMSA of Seoul

	Non-CMSA of Seoul		Low income group		Middle income group		High income group	
	Coef	Std.	Coef	Std.	Coef	Std.	Coef	Std.
HP	0.0104**	0.00465	0.0298	0.0200	0.0104	0.0165	0.0131	0.0144
Income	0.193***	0.00496	0.366***	0.0305	0.299***	0.0287	0.185***	0.0233
Family size	0.0337***	0.00489	0.138***	0.0406	0.0857***	0.0165	0.0730***	0.0152
Mortgage	-5.54e-07*	3.10e-07	3.09e-05***	1.06e-05	-9.19e-07	2.21e-06	7.23e-07	5.85e-07
Age	0.00130	0.00342	0.00875	0.0166	0.0463***	0.0122	0.105***	0.0173
Age^2	-3.31e-05	3.02e-05	-9.98e-05	0.000143	-0.000410***	0.000109	-0.00101***	0.000165
Education	0.0156	0.0120	0.225**	0.108	0.0393	0.0402	0.0576*	0.0295
Marital status	0.00765	0.0161	-0.0787	0.0738	-0.0801	0.0568	-0.000766	0.0658
Gender	0.0292*	0.0150	-0.0433	0.0646	-0.0177	0.0524	0.241***	0.0544
Time effect	Y		Y		Y		Y	
Observations	10,085		2,181		3,639		4,026	
R-squared	0.757		0.118		0.073		0.066	
Number of id	2,017		658		1,181		1,094	

Note: Standard errors are in parentheses and *** , **, * denote p<0.01, p<0.05, and p<0.1, respectively.

The results of the System GMM estimations when lagged consumption variables are used as the instrumental variables are presented in Table 8. The results show significant and positive relationships among the independent variables in this study, such as house price, income, family size and gender.

Table 8 Tests for Systematic Estimation of Dynamic Panel Data

Consumption (Dependent Var.)	Total		CMSA of Seoul		Non-CMSA of Seoul	
	Coef	Std.	Coef	Std.	Coef	Std.
HP	0.048***	0.012	0.053**	0.025	0.045***	0.015
Income	0.121***	0.009	0.093***	0.015	0.139***	0.012
Family size	0.110***	0.012	0.106***	0.022	0.113***	0.014
Mortgage	-4.49e-08	5.79e-07	-5.41e-07	0.000	1.17e-06	0.000
Age	0.009	0.009	0.007	0.015	0.009	0.012
Age^2	-0.000*	0.000	-0.000	0.000	-0.000	0.000
Education	0.053*	0.029	0.083*	0.047	0.033	0.037
Marital status	-0.066*	0.038	-0.008	0.062	-0.098**	0.049
Gender	0.075**	0.036	0.037	0.058	0.103**	0.048
Observations	11,608		3,480		8,100	
Number of groups	2,902		881		2,038	

Note: Standard errors are in parentheses and *** , **, * are $p<0.01$, $p<0.05$, and $p<0.1$, respectively.

We find the housing wealth effect measured by System GMM is 0.048 which is a higher estimate than the 0.0199 by using threshold estimation while the income wealth effect measured by System GMM is 0.121 which is close to the 0.15 by using threshold estimation.

This finding is noteworthy, given the fact that System GMM is also consistently supporting our results of threshold estimation method robustly. Furthermore, we report the result from the CMSA and non-CMSA of Seoul in the manuscript, and find a consistently significant coefficient with the same directional sign. Thus we can conclude that the result from the threshold method is consistently robust with the System GMM method.

6. Conclusion

This research builds on fundamental existing models on the housing wealth effect by implementing a systematic process to account for possible asymmetric behavior of two different income groups identified by using threshold estimation. Specifically, we investigate whether there is a threshold regime in the sample distribution of income and regional differences (CMSA and non-

CMSA of Seoul) from 2012 to 2016 which are periods in which a series of policies implemented by the government to stimulate the housing wealth effect took place. We generally find corresponding information on each income variable with the expected directional relationship in the housing wealth effect model, while results from a regional analysis that has similar results for the CMSA of Seoul. The inclusion of our derived threshold estimate measure to the vector of economic and demographic variables has important structural and predictive implications for each income group of a given threshold regime, thus increasing current understanding on the housing wealth effect which empirically support the work in Carroll et al. (2000) in that consumption behavior varies across different household income levels.

Our findings have important implications for policymakers. First, the results suggest that it is important for policymakers to pay close attention to real estate market movements for consumption forecasting. Second, we determine a housing wealth effect in Korea due to different income levels which helps policymakers to recover economically during an economic downturn by focusing on potential target income levels and regional differences. For example, if the government needs to recover the domestic economy by increasing consumption, one of the ways to do so is increase housing wealth by considering income levels and different regions. Higher income households with higher income distributions behave substantially different than the other income groups. Policymakers can thus prepare real estate related policies during an economic downturn by focusing on a potential target. Third, our results may be helpful for policymakers to use subsidies that focus on regional areas and where consumption is high. Fourth, this research can be regarded as a novel approach for examining the housing wealth effect within different income groups. Finally, we recommend that companies in perishable and non-perishable goods and industries promote their products more often when the housing wealth increases during which consumers have higher expectations about their future income. This helps companies to profit from housing wealth.

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