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A Re-evaluation of Housing Wealth Effect in Korea

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한국의 주택 부 효과에 대한 재고찰

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ABSTRACT

This paper attempts to re-evaluate the size of housing wealth effect in Korea. Our focus is on the size of 'genuine' housing wealth effect, i.e., the response of consumption spending by home-owners to the changes in housing wealth.

Two issues show up while we estimate the 'genuine' wealth effects using aggregate time series data: the issues around home ownership and proper measure of consumption. We first argue that it is more appropriate to use non-housing consumption, because housing consumption is in large part not of the choice of home owners but the imputed rents they do not actually choose to pay.

We then proceed to address the issue of home ownership, by examining how much to revise the estimates of housing wealth effect obtained from aggregate non-housing consumption data. We construct two structural models and estimate the share of home-owners' consumption in those models' context. It is found that, if properly revised in light of the estimated consumption shares of home-owners, the magnitude of resulting housing wealth effects are larger than what simple time series regressions imply.

본고에서 우리는 한국의 주택 부 효과의 크기를 재검토한다. 이를 위해 주택가격 상승에 대한 주택 보유자 소비지출의 반응인 '순수한' 주택 부 효과의 크기를 알아보는 데 중점을 둔다.

순수한 주택 부 효과를 측정하기 위해 거시시계열 자료를 이용할 경우, 주택 보유여부와 적절한 소비지출변수의 선정이라는 두 가지 문제가 제기된다. 우리는 먼저 비주택 소비(non-housing consumption)가 보다 적절한 소비지출변수임을 보이며, 그 이유로 주택소비(housing consumption)의 상당 부분이 주택 보유자들의 실제로 지불하지 않는 귀속임대료(imputed rents)임을 제시한다.

이어서 우리는 거시시계열 자료로부터 구한 주택 부 효과의 크기를 얼마나 수정해야 주택보유자에의 순수한 주택 부 효과를 추정할 수 있는가를 살펴본다. 이를 위해 두 개의 구조적 모형을 설정하여, 전체 소비지출 중에서 주택 보유자 소비지출의 비중을 추정한다. 주택 보유자의 소비지출 비중을 감안하여 수정된 주택 부의 효과는, 거시시계열을 이용하여 구한 통상적인 주택 부 효과의 추정치보다 크게 나타난다.

I. Introduction

The last decade witnessed dramatic changes in housing prices in many countries. According to Sutton (2002), housing prices in the U.S. increased by 21% net of inflation from 1995-2001, and the real rates of increases in housing prices reached 42%, 60%, and 70% in the U.K., Netherlands, and Ireland, respectively, during the same period. In this respect, Korea is no exception: during 2001:Q1- 2004:Q2, the nominal and real prices of apartment units in the Seoul metropolitan area rose by 68.8% and 52.1%, respectively.

Such steep rises in housing prices are naturally expected to affect aggregate demand and economic activities. The logic is simple: with housing wealth taking the lion's share of household wealth, a rise in housing prices or housing wealth increases consumption spending via increased consumer confidence, remortgaging against the higher value of housing, and so on. In a standard permanent income model, moreover, higher housing wealth should lead to increases in consumption even when there are bequest motives or borrowing constraints.

In contrast to such clear theoretical predictions, however, empirical evidence on the magnitude of the housing wealth effect is mixed: for example, Case, Quigley, and Shiller (2005) report that the elasticity of consumption with respect to the housing wealth ranges from 0.1 to 0.17 in the panel analyses of 14 major countries, but Girouard and Blondal (2001) estimate the elasticities for the U.S., U.K., and France to be 0.02, 0.06, and 0.08, respectively, which are much lower than in Case, Quigley, and Shiller.

The aim of this paper is to estimate the magnitude of housing wealth effect in Korea. Unlike many previous exercises in the literature focusing mainly on the macroeconomic implications of housing wealth, our interest lies in understanding the 'genuine' form of housing wealth effects, i.e., the response of consumption spending by home-owners, not the aggregate consumption spending, to the changes in housing wealth. Our view here is that the idea of housing wealth effects *per se* is applicable to home-owners, as the logic aforementioned assumes implicitly.

Given that most available data for estimating housing wealth effects are aggregate macro time series, however, the task of estimating the size of genuine housing wealth effects raises two possibly interwoven issues. The first one is the issue of home ownership, around which an intuitive story would go as follows: while home-owners may well perceive housing price increases as an addition to their wealth and therefore increase their consumption, renters planning to purchase their own homes (and home-owners wanting to trade up) may decrease their consumption as they will have to save more for higher down payments and repayments. That being the case, the sensitivity of aggregate consumption with respect to housing wealth will understate the size of genuine housing wealth effects.

The second issue is about using proper measures of consumption in estimating the effects of housing wealth. Here, we note that aggregate consumption in national income accounts comprises non-housing and housing consumption, and that the latter is proxied by what is actually paid by renters living in similar housing units. Higher housing prices, usually accompanied by higher housing rental prices, will induce renters to change their non-housing and housing consumption via the standard substitution and income effects channel. To the extent that most people buy a house to live in, however, the changes in housing consumption by home owners are not of their own choices but artificially imputed on them. That being the case, using aggregate consumption including housing consumption is likely to yield inaccurate estimates of the 'genuine' housing wealth effect we are interested in.

We set off by addressing the second issue using macro time series data. To do so, we estimate the elasticity of housing and non-consumption with respect to gross housing value. Regression results support the presence of significant housing wealth effects on non-housing consumption, while higher housing values tend to significantly lower housing consumption. Up to a caveats discussed later, we interpret these findings as supporting our view that non-housing consumption is a more appropriate measure of consumption spending when using aggregate time series to estimate housing wealth effects.

Even if non-housing consumption is used as the measure of consumption, the remaining issue around the home ownership is to be resolved. After an increase in housing rental price that usually accompany higher housing prices, renters left with less discretionary resources are likely to lower non-housing consumption. Compared to what would result from the regressions with home-owners' consumption only, therefore, the aggregate time series estimates of housing wealth effects will be biased downward, and the size of bias will increase with the proportion of renters' consumption out of total.

That being the case, one natural suggestion would be to separately track down home-owners' consumption and use this information in estimating the 'genuine' housing wealth effect. Unfortunately, no time data series is available of this characteristic. Therefore, we use cross sectional data for home-owners to obtain a set of benchmark estimates for genuine housing wealth effect. We then proceed to estimate the share of home-owners' consumption, and use the results to re-interpret the time series estimates of housing wealth effects. More specifically, we set up two simple structural models of an economy populated by home-owners and renters, and estimate the consumption shares of each consumer group. It turns out that, if revised based on the estimated consumption shares, the size of housing wealth effects is larger than what simple time series regressions tell us and the benchmark estimates from the cross sectional estimation.

This paper is organized as follows. In Section 2, we estimate the housing wealth effect in Korea with aggregate time series as well as cross section data, and see if the estimation results are consistent with the concept of housing wealth effects we are interested in. In Section 3, we construct two structural models to estimate the consumption shares of home-owners and renters, and use those results to revise the estimated size of housing wealth effects from the time series data. Section 4 concludes.

II. Measuring Housing Wealth Effect

1. Time Series Results

In trying to estimate housing wealth effects with aggregate time series data, we focus on the long-run relationships (rather than short-run correlations) among consumption, income, and wealth. This estimation strategy stems from the view that the wealth effect is more of long-run nature: a representative consumer's inter-temporal budget constraint dictates that, when one's wealth rises, additional spending will occur over lifetime. Considering the possibility that consumption responds to changes in asset value with a substantial lag or over a long time period, it is more appropriate to estimate the wealth effect from a long-run perspective.

In this context, long-run relationships have previously been estimated by cointegrating regressions: for example, building on Campbell and Mankiw (1989), Lettau and Ludvigson (2000) derive from a representative consumer's intertemporal budget constraint a long-run relationship among consumption, labor income and asset wealth, and show that they should be cointegrated.

Our point of departure is to set up regression equations appropriate for measuring housing wealth effects. To do so, we resort to a simple model in which a representative consumer maximizes utility of the form

$$\left[\omega^{\frac{1}{\varepsilon}} C_1^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega)^{\frac{1}{\varepsilon}} C_2^{\frac{\varepsilon-1}{\varepsilon}}\right], \quad 0 < \omega < 1, \quad \varepsilon > 0,$$

subject to the budget constraint

$$C_1 + \left[P_2 / P_1\right] C_2 = Y + SW + HW .$$

In the utility function above, C_1 and C_2 are non-housing and housing consumption, respectively. The two price terms P_1 and P_2 in the budget constraint are the price of non-housing and housing consumption, respectively. Finally, (Y, HW, SW) denote labor income, housing wealth, and other financial wealth, respectively, all in real terms.

Combining the FOCs for utility maximization with the budget constraint, we obtain log-linear relations by which the two kinds of consumption are represented in terms of the relative price ($P = P_2 / P_1$), labor income (Y), housing wealth (HW), and other financial wealth (SW). Based on these results, we estimate the following equation

$$\log(C_{i,t}) = \beta_0^i + \beta_P{}^i \log(P) + \beta_y^i \log(Y_t) + \beta_h^i \log(HW_t) + \beta_s^i \log(SW_t) + \varepsilon_t{}^i \tag{1}$$

where i =0,1, and 2 denotes the total consumption, non-housing consumption, and housing consumption, respectively.[1]

A few things are worth mentioning in the equation (1). First, the relative price (*P*) is necessary to accurately fathom the size of housing wealth effects: the relative price term in equation (1) controls for the possible substitution effects (between C^1 and C^2) of changes in the price of housing consumption, usually accompany changes is housing prices and housing wealth.[2] Second, as shown in the appendix, while the coefficient β_P for housing consumption is expected to have a negative, that for non-housing consumption can be either positive or negative, depending on the degree of substitution between C^1 and C^2.[3]

When actually estimating the equation (1), we use the following data series:[4]housing consumption series is the imputed rent payments, which is proxied by spending on housing, water, electricity, gas and other fules[5]. Non-housing consumption is calculated as the sum of the other components of household consumption. Both consumption series for C^1 and C^2 are measured in real terms. Real Gross National Income is used for labor income. Income and all consumption series are seasonally adjusted. Housing wealth is constructed as the product of a nationwide housing price index and the linearly interpolated annual series on the number of dwellings, deflated by CPI (seasonally adjusted) to obtain a real series. The value of stock held by individuals available from the flow of funds table is used for other financial wealth and is also deflated by CPI.

For the relative price of housing consumption, two different data series are used. The first one, dubbed P_{def}, is simply the ratio of deflators for housing and non-housing consumption. The second one, more akin to the user costs of housing service and hence dubbed P_{uc}, is constructed to reflect real housing rental cost. More specifically, we multiply the nationwide *chonsei* price index with real interest rate, where the latter is corporate bonds yield rate minus year-on-year inflation rate for CPI.[6] All series, except for the user cost of housing consumption, are transformed into per capita terms.

Table 1 reports the estimation results for the three consumption series.[7] The first

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[1] Steps involved and the resulting log-linear relations are given in the appendix.

[2] We originally resort to a rather ad-hoc version of regression equation (1), leaving the relative price of housing consumption out. An anonymous referee pointed this out and suggested we derive the regression specification from an optimization model. His/her comments are deeply appreciated.

[3] The higher the elasticity of substitution between the two types of consumption is, the more likely the coefficient of P for housing consumption is to be positive.

[4] All data series are obtained from the Economic Statistics System of the BOK, except for the nationwide chonsei price index taken from the Kookmin Bank's real estate database.

[5] Imputed rents may not be appropriate to proxy for housing consumption because, as an anonymous referee points out, imputed rents could fluctuate along with changes in user costs even though the amount of housing stock is constant. However, our intention here is to compare the sensitivities of various consumption data to housing wealth. Thus, we decide to use 'housing consumption' defined as in this section, probably at the risk of using a misnomer.

[6] The OTC rate series for AA- grade corporate bonds with 3-year maturity is used.

[7] ADF statistics for the data series could not reject the null of unit roots. Also, residual based ADF tests support the

<Table 1> Time Series Regression

Consump-tion	Total		Non-Housing		Housing	
Relative Price	P_{def}	P_{uc}	P_{def}	P_{uc}	P_{def}	P_{uc}
Const.	0.638 (1.433)	-0.277 (-1.298)	1.153 (2.078)	0.095 (0.358)	-4.432 (-7.518)	-4.748 (-17.895
P	-0.104 (-2.612)	-0.011 (-1.553)	-0.115 (-2.335)	-0.009 (-1.044)	-0.056 (-1.070)	-0.020 (-2.293)
Y	1.102 (27.372)	1.018 (40.741)	1.131 (22.547)	1.037 (33.314)	0.986 (18.121)	0.920 (29.643)
HW	0.036 (1.525)	0.044 (1.770)	0.110 (3.726)	0.118 (3.810)	-0.322 (-10.207)	-0.311 (-10.126)
SW	-0.009 (-0.464)	-0.015 (-0.750)	-0.022 (-0.914)	-0.030 (-1.205)	0.054 (2.123)	0.056 (2.288)
$\bar{R}^2$	0.993	0.992	0.989	0.989	0.987	0.989

Note: Numbers in parentheses are t-values.

panel shows that the estimated elasticity of total consumption with respect to both housing and stock wealth is either statistically insignificant or of the wrong signs. Using different series for the relative price of housing consumption does not alter these results. In contrast, as shown in the second panel, the estimation results for non-housing consumption support the presence of significant housing wealth effect. The elasticity of non-housing consumption with respect to housing wealth is estimated to be sizable amounting to 0.110 and 0.118, depending on which relative price series is used, and in both cases the estimates are statistically significant. When it comes to the size of stock wealth effects, the estimated coefficient of stock wealth turns out to be insignificant, as in the case of the total consumption[8]. The estimated coefficient on the relative price term is -0.115 when P_{def} is used, but the estimated coefficient on P_{uc} is insignificant and negligible. This implies that the non-housing and housing consumption are not close substitutes.

The third panel of Table 1 reports the estimation results for housing consumption. We first note that the estimated coefficients on the relative price terms have signs consistent with the theoretical prediction developed in the appendix, although the coefficient on P_{def} is not significant. It turns out that, however, the estimated coefficients on housing wealth are significantly negative: as discussed in the

presence of cointegration in all regressions.

[8] The larger effect of housing wealth on consumption than of stock wealth is also reported in Case, Quigley and Shiller (2005).

appendix, the predicted sign of housing wealth effects on housing consumption is

<Table 2> Time Series Regression (Consumptions by Type)

Consum.	Durable		Non-durable		Service	
Relative Price	P_{def}	P_{def}	P_{def}	P_{uc}	P_{def}	P_{uc}
Const.	1.506 (0.700)	0.973 (1.012)	-6.471 (-12.516)	-3.986 (-16.316)	2.983 (3.420)	-0.878 (-2.116)
P	0.037 (0.193)	0.070 (2.242)	0.311 (6.713)	0.051 (6.427)	-0.481 (-6.153)	-0.077 (-5.746)
Y	1.428 (7.344)	1.462 (12.989)	0.412 (8.817)	0.665 (23.254)	1.427 (18.090)	1.037 (21.356)
HW	0.261 (2.269)	0.229 (2.055)	0.034 (1.227)	0.003 (0.112)	-0.162 (-3.466)	-0.115 (-2.384)
SW	0.006 (0.064)	-0.016 (-0.176)	-0.008 (-0.335)	0.003 (0.139)	0.081 (2.1148)	0.064 (1.676)
$\bar{R}^2$	0.931	0.936	0.981	0.980	0.977	0.975

Note: Numbers in parentheses are t-values.

positive, once the effects of the changes in the relative price of housing consumption is correctly controlled for. The theoretically unwarranted signs of the coefficients on housing wealth point to the possibility that the relative price series (and probably the housing consumption series as well) has not been constructed properly. That being the case, the coefficients on housing wealth in the second column of the table may not reflect the pure housing wealth effect on non-housing consumption net of any substitution effect. Notwithstanding, the results in Table 1 suggest the presence of strong housing wealth non-housing consumption. This finding also implies that the primary channel of hosing wealth effects on macroeconomy is via non-housing consumption.

The distinction of housing and non-housing consumption in Table 1 is based on the categorization of consumption *by purpose* in the NIA. To understand the effect of housing wealth on consumption along a different dimension, we estimate equation (1) with the following types of consumption categorized *by type*: expenditures on durables, non-durables, and service. The results are reported in Table 2, where the estimated housing wealth effects are conspicuous for expenditure on durables. More specifically, one percent increase in housing wealth tends to increase expenditures on durables by 0.23% to 0.26%, depending on which relative price series is used. For non-durables, the estimated housing wealth effects are not significant. Another interesting finding in Table 2 is that the coefficients on relative price and housing for expenditures for service are both negative, as shown in the last column. This feature, reminiscent of the results for housing consumption in Table 1, is probably due to the

<Table 3> Time Series Regression (Lagged Housing Wealth)

Consump-tion	Total		Non-Housing		Housing	
Relative Price	P_{def}	P_{uc}	P_{def}	P_{uc}	P_{def}	P_{uc}
Const.	0.746 (1.590)	-0.346 (-1.539)	1.405 (2.314)	-0.016 (-0.054)	-5.019 (-7.723)	-4.621 (-15.814)
P	-0.116 (-2.910)	-0.011 (-1.499)	-0.145 (-2.827)	-0.010 (-1.095)	0.018 (0.326)	-0.014 (-1.499)
Y	1.112 (27.283)	1.017 (40.410)	1.155 (21.903)	1.035 (31.644)	0.912 (16.157)	0.927 (28.353)
HW	0.028 (1.178)	0.028 (1.091)	0.097 (3.138)	0.095 (2.853)	-0.306 (-9.2197)	-0.294 (-8.890)
SW	-0.004 (-0.189)	-0.009 (-0.441)	-0.014 (-0.585)	-0.022 (-0.847)	0.049 (1.858)	0.054 (2.101)
$\bar{R}^2$	0.993	0.992	0.988	0.987	0.985	0.986

Note: Numbers in parentheses are t-values.

fact that a sizable portion of service consumption is taken by housing consumption, which in turn comprises spending on housing, water, electricity, gas and other fuels as explained before.

One problem with equation (1) is that the regression specification may be subject to the endogeneity of regressors, especially for housing wealth. To address this, we experiment with estimating equation (1) with the lagged housing wealth instead of the current housing wealth. The results are reposted in Table 3, where the second panel shows that the estimated coefficients on lagged housing wealth for non-housing consumption are slightly lower than those in Table 2. Our interpretation is that using lagged housing wealth helps correct the problem of endogeneity at least partially. Other than this finding, the results in Table 3 are qualitatively not different from those in Table 1.

Going back to the issue of proper measure of consumption for housing wealth effect, our results of time series regression in Table 1 to Table 3 support the use of non-housing consumption in estimating housing wealth effects. Even if one focuses on non-housing consumption, however, there is another reason why one may not obtain precise estimates of housing wealth effects from aggregate time series data. It is because the “genuine” definition of the housing wealth effect is appropriate for home-owners, but aggregate non-housing consumption is the sum of renters' consumption and home-owners’ consumption. For renters, the rise in property price will induce the substitution away from housing consumption toward non-housing consumption, to the extent that higher housing price accompany higher rental price.

Left with less disposable resources, however, renters will also decrease both housing and non-housing consumptions. Unless the elasticity of substitution between housing and non-housing consumption is sufficiently large, renters' non-housing consumption will decrease. Even if the elasticity is large enough, the responsiveness of renters' non-housing consumption will be significantly lower than that of home-owners.

When using time series data, therefore, one natural suggestion would be to separately track down home-owners' and renters' consumption and to take this information into account in estimating the 'genuine' housing wealth effect. Unfortunately, no time series data is available of this characteristic. In the following subsection, therefore, we use cross sectional data for home-owners to obtain a set of benchmark estimates for genuine housing wealth effect. We then proceed in section 3 to estimate the share of home-owners' consumption, and use the results to re-interpret the time series estimates of housing wealth effects.

2. Cross Section Results

To estimate housing wealth effects from cross sectional data, we use the following regression

$$C_{j,t} = \beta_0 + \beta_y Y_{j,t} + \beta_h HW_{j,t} + \beta_z X_{j,t} + \varepsilon_{j,t} \tag{1}$$

where $(C_{j,t}, Y_{j,t}, HW_{j,t})$ denotes total consumption expenditure, household income, and housing wealth, respectively, of the j^{th} household at period t. The vector X of controls includes lagged dependent variable(LDV), financial wealth(FW), household size(Size), the years of education(Edu), the age of household heads(Age), and the square terms of age(Age^2). All variables are in logarithmic terms except the household size, years of education, age, and square of age. The data series used are taken from the Korea Labor and Income Panel Study (KLIPS) spanning 2000-2004.

Table 4 shows the estimation results for equation (2) for six specifications. In the first four specifications estimated by pooled regressions, we include both the time and region dummies (the estimated coefficients are not reported), in order to control for differing effect of explanatory variables on consumption across different business cycle and regional conditions. In the latter two specifications estimated by panel regressions, only the time dummy is included.

In specification (i), we include as independent variables current housing and financial wealth, where in specification (ii) LDV is also included as a control. For these two specifications, the estimated coefficients on housing wealth are positive and statistically significant. Although the inclusion of LDV in specification (ii) lowers the estimated coefficient on both types of wealth, this does not necessarily mean that the size of housing wealth effects is smaller: the long-run effects of housing wealth on consumption, i.e., 0.057/(1-0.351) = 0.088, is comparable to 0.091 in specification (i). Also, the magnitude of financial wealth effect turns out to be less than half the size of housing wealth effect.

As in the time series regression (1), estimating equation (2) using cross section

<Table 4> Cross Sectional Regressions (total consumption)

	Pooled Regression				Panel Regression	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Constant	2.449 (10.08)	1.465 (6.34)	2.429 (13.09)	1.491 (8.57)	4.710 (7.25)	2.582 (13.41)
LDV	-	0.351 (20.90)	-	0.403 (19.75)	-	-
Y	0.366 (34.91)	0.288 (27.60)	0.335 (25.29)	0.231 (17.71)	0.203 (7.56)	0.324 (23.00)
HW	0.091 (9.22)	0.057 (6.08)	-	-		
HW_{-1}	-	-	0.099 (8.12)	0.060 (5.35)	0.053 (2.10)	0.094 (7.80)
FW	0.040 (7.56)	0.015 (2.87)		-		
FW_{-1}	-	-	0.048 (7.44)	0.028 (4.71)	-0.015 (-1.51)	0.034 (5.41)
Size	0.102 (15.62)	0.052 (8.02)	0.111 (13.33)	0.052 (6.46)	0.038 (1.03)	0.114 (11.77)
Edu	0.110 (11.51)	0.067 (7.28)	0.118 (9.90)	0.063 (5.78)	0.120 (1.76)	0.136 (9.75)
Age	0.032 (7.50)	0.016 (4.01)	0.031 (5.29)	0.013 (2.46)	0.022 (1.02)	0.033 (5.00)
Age^2	-0.000 (-7.70)	-0.000 (-4.11)	-0.000 (-5.94)	-0.000 (-3.03)	-0.000 (-0.93)	-0.000 (-5.54)
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	No	No
$\overline{R}^2$	0.68	0.72	0.69	0.75	0.64	0.68

Note: Numbers in parentheses are t-values.

data can be subject to the endogenity problem.[9] In an attempt to partially lessen this problem, we experiment with using one lags of housing and financial wealth.[10] The specifications (iii) and (iv) correspond to these experiments, where the estimated housing wealth effect is slightly larger than those for specifications (i) and (ii): when we use lagged wealth data instead of the current data, the coefficient on housing wealth changes from 0.091 to 0.099 in the absence of LDV, In the presence of LDV, the long-run coefficient on housing wealth changes from 0.087 to 0.060/(1-0.403)=0.101.

Although the time span of our data is relatively short, we consider two specifications of panel regression, where specification (v) and (vi) employ fixed effects and random effects regressions, respectively. The coefficients on housing wealth in these cases are comparable to those for the pooled regression specifications, except that the housing wealth effect estimated by fixed effect regression is the smallest among the six specifications we used.

In Table 5, we report the estimation results for consumption expenditures on durables, non-durables, and service. Noticeably, the estimated coefficients on housing wealth are significant for all types of consumption, regardless of the current or lagged housing wealth as a regressor. Another interesting finding is that, unlike the time series results in Table 2, the estimated housing wealth effect is now most conspicuous for service both in terms of its size and significance. This discrepancy results because the time series data on service consumption include housing consumption (or its proxy), while the cross section data do not. Therefore, we interpret this finding as supporting our claim in the previous subsection that housing consumption should not be considered when measuring housing wealth effect using macro time series data. We also note in Table 5 that housing wealth has larger effect on durable consumption than on non-durables, similarly in Table 2 for time series results: where current housing wealth is used, the coefficient on housing wealth for durable consumption is 0.097, larger than 0.040 for non-durables.

In summary, the results of cross sectional regressions in Tables 4 and 5 support the presence of housing wealth effects among home-owners: overall, households with 1% higher level of housing wealth spends more on total consumption by around 0.1% in the long-run.

Estimation of Consumption Shares

In the previous section, we emphasized the importance of considering home ownership profiles when one measures housing wealth effects using aggregate time series. One way to address this issue is to revise the time series estimates of housing wealth effects in view of the relative weight on home-owners' consumption. In this section, therefore, we attempt to estimate the share of home-owners' consumption in

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[9] The problem of endogeneity in (2) can be illustrated as follows: to the extent that the permanent income of household is the primary determinants of consumption and housing unit choices, the housing wealth is likely to be endogenous. We thank an anonymous referee for pointing this out.

[10] While the consumption in year t is the total flow over the year, housing wealth in tear t is its stock value in the mid-year. By using lagged housing wealth, therefore, we can circumvent the problem of explaining the past consumption (over the first half of the year) by the housing wealth as of June.

<Table 5> Cross Sectional Regressions (Consumptions by type)

	Durables		Non-durables		Service	
Constant	0.697 (2.15)	1.292 (2.98)	3.535 (12.57)	3.384 (15.13)	1.339 (3.98)	2.522 (4.62)
Y	0.389 (15.71)	0.359 (11.24)	0.204 (17.08)	0.210 (13.26)	0.304 (20.97)	0.252 (13.45)
HW	0.097 (4.35)	-	0.040 (3.52)	-	0.133 (9.75)	-
HW-1	-	0.071 (2.53)	-	0.076 (5.19)	-	0.136 (7.87)
FW	0.049 (4.19)	-	0.019 (3.13)		0.045 (6.08)	-
FW-1	-	0.033 (2.29)	-	0.022 (2.86)	-	0.060 (6.59)
Size	-0.006 (-0.44)	0.005 (0.28)	0.109 (14.43)	0.101 (10.15)	0.141 (15.58)	0.165 (14.00)
Edu	0.071 (3.51)	0.131 (5.28)	0.076 (6.89)	0.058 (4.10)	0.144 (10.82)	0.151 (9.04)
Age	0.012 (1.21)	0.002 (0.17)	0.007 (1.51)	-0.006 (-0.84)	0.037 (6.22)	0.022 (2.69)
Age^2	-0.000 (-1.08)	-0.000 (-0.02)	-0.000 (-1.22)	0.000 (0.72)	-0.000 (-6.87)	-0.000 (-3.7-)
$\overline{R}^2$	0.21	0.21	0.40	0.43	0.56	0.57

the context of dynamic structural models using macro time series.

We consider two simple infinite horizon models of an endowment economy, both of which are populated by home-owners and renters. In the first model, households maximize lifetime utility defined over non-housing consumption (C_1) and housing consumption (C_2). The sole difference between home-owners and renters in this model is that only the former group has access to the market for housing investment goods. In the second model, renters are further restricted to be "rule-of-thumb" consumers in the sense of Campbell and Mankiw (1989), living on their current income period by period.

Our approach belongs to literature on the estimation of the Euler equation including Campbell and Mankiw (1989), Jappelli and Pagano (1989), and Iacoviello (2004): we first derive optimality conditions for each group of households, combine them into an aggregate Euler equation, and estimate the consumption weight on home-owners.

3. Model (I)

3.1 Home-owners

A representative home-owner maximizes a standard lifetime utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-1/\sigma} u\left(C_{1t}^O, C_{2t}^O\right)^{1-1/\sigma}, \quad 0<\beta<1, \ \sigma>0 \tag{3}$$

for all $t \geq 0$. The home-owner derives utility from non-housing consumption C_{1t}^O and housing service consumption C_{2t}^O, priced at P_{1t} and P_{2t}, respectively. We assume that the instantaneous utility $u(C_{1t}, C_{2t})$ is a CES aggregator of the form:

$$u(C_{1t}, C_{2t}) = \left[\omega^{\frac{1}{\varepsilon}} C^{1\frac{\varepsilon-1}{\varepsilon}} + (1-\omega)^{\frac{1}{\varepsilon}} C^{2\frac{\varepsilon-1}{\varepsilon}} \right], \quad 0<\omega<1, \quad \varepsilon>0 . \tag{4}$$

The representative home owner receives a random real endowment Y_t^O, lends (or borrow) B_t^O in real terms, and receives the real gross interest payment $R_t B_t^O$ in the next period. He also purchases I_t^h units of housing stock priced at Q_t for investment. The housing stock evolves according to $H_{t+1} = I_t^h + (1-\delta)H_t$, where δ is the rate of depreciation for the existing housing stock. He leases H_t units of housing stock at the price of Z_t to a housing service firm, which in turn produces and provides housing service C_{2t} at the price of P_{2t}. Therefore, the budget constraint of a home-owner is

$$Y_t^O + Z_t H_t + R_{t-1} B_{t-1}^O = P_{1t} C_{1t}^O + P_{2t} C_{2t}^O + Q_t (H_{t+1} - (1-\delta) H_t) + B_t^O \tag{5}$$

Solving the maximization problem of the home-owner yields the follo5ing first order conditions for $\left(C_1^O, C_2^O, H\right)$:[11]

[11] If the home-owner's FOC w.r.t. bond is also derived and combined with the other FOCs, the resulting equation becomes a version of the "no-arbitrage" condition. With the consumption of home-owners substituted out in so doing, it is impossible to construct a moment condition involving aggregate consumption by which to estimate the consumption shares of home-owners or renters.

The intuition is as follows: if the home-owners are following inter-temporally optimal decisions, optimality condition involving either housing investment or bond acquisition is redundant. Unlike home-owners, however, renters in the next subsection do not have access to the housing investment, so their dynamic optimality condition w.r.t. the bond is indispensible.

$$\omega^{\frac{1}{\varepsilon}}[u_t]^{\frac{1}{\varepsilon}-\frac{1}{\sigma}}C_{1t}^{O-\frac{1}{\varepsilon}} = P_{1t}\mu_t, \tag{6}$$

$$(1-\omega)^{\frac{1}{\varepsilon}}[u_t]^{\frac{1}{\varepsilon}-\frac{1}{\sigma}}C_{2t}^{O-\frac{1}{\varepsilon}} = P_{2t}\mu_t, \tag{7}$$

$$Q_t\mu_t = \beta E_t\mu_{t+1}Q_{t+1}(1-\delta) + \beta E_t\mu_{t+1}Z_{t+1}, \tag{8}$$

where μ_t is the Lagrange multiplier for the budget constraint. It is worth noting that equations (6) and (7) imply

$$\left[\frac{\omega}{1-\omega}\right]^{\frac{1}{\varepsilon}}\left[\frac{C_{1t}^{O}}{C_{2t}^{O}}\right]^{-\frac{1}{\varepsilon}} = \frac{P_{1t}}{P_{2t}}, \tag{9}$$

which can be used to pin down the elasticity of substitution between the two kinds of consumption.[12]

We assume that the technology of the competitive housing service firm is $C_2=\eta H$, with $\eta>0$.[13] Then, the zero profit condition in turn gives $Z=\eta P_{2t}$, which is used to substitute out Z in (7). After re-arranging log-linearized versions of equations (6), (7), and (8), we get:

$$\begin{aligned}
&\hat{Q}_t + \Theta_1\hat{P}_{1t} - \frac{1}{\sigma}\hat{C}_{1t} - \Theta_2\hat{P}_{2t} \\
&= \Theta_1 E_t\hat{P}_{1,t+1} - \frac{1}{\sigma}E_t\hat{C}_{1,t+1} - \Theta_2 E_t\hat{P}_{2,t+1} \\
&+ \beta(1-\delta)E_t\hat{Q}_{t+1} + (1-\beta(1-\delta))E_t\hat{P}_{2,t+1}
\end{aligned} \tag{10}$$

Where

$$\Theta_1 = \varepsilon(1-\Xi)\left(\frac{1}{\varepsilon}-\frac{1}{\sigma}\right) - 1,$$

$$\Theta_2 = \varepsilon(1-\Xi)\left(\frac{1}{\varepsilon}-\frac{1}{\sigma}\right)$$

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[12] Since equation (8) holds for renters as well, it holds for aggregate consumption.

[13] In fact, we can further normalize η to be one, without causing any changes in the results that follows.

and Ξ is the ratio $\dfrac{\omega^{\frac{1}{\varepsilon}} C_1^{\frac{\varepsilon-1}{\varepsilon}}}{\omega^{\frac{1}{\varepsilon}} C_1^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega)^{\frac{1}{\varepsilon}} C_2^{\frac{\varepsilon-1}{\varepsilon}}}$ evaluated in steady state.

3.2 Renters

Without access to the housing investment market, a representative renter maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-1/\sigma} u\left(C_{1t}^{\gamma}, C_{2t}^{\gamma}\right)^{1-1/\sigma}, 0<\beta<1,\ \sigma>0 \tag{11}$$

subject to her budget constraint

$$Y_t^r + R_{t-1} B_{t-1}^r = P_{1t} C_{1t}^r + P_{2t} C_{2t}^r + B_t^r \tag{12}$$

where the superscript r denotes renters' choice variables.
The first order conditions for (C_1, C_2, B) are given by

$$\omega^{\frac{1}{\varepsilon}} \left[u_t^r\right]^{\frac{1}{\varepsilon}-\frac{1}{\sigma}} C_{1t}^{r-\frac{1}{\varepsilon}} = P_{1t} \mu_t^{\gamma} \tag{13}$$

$$(1-\omega)^{\frac{1}{\varepsilon}} \left[u_t^{\gamma}\right]^{\frac{1}{\varepsilon}-\frac{1}{\sigma}} C_{2t}^{\gamma-\frac{1}{\varepsilon}} = P_{2t} \mu_t^{\gamma} \tag{14}$$

$$\mu_t^{\gamma} = \beta R_t E_t \mu_{t+1}^{\gamma}. \tag{15}$$

After re-arranging log-linearized versions of (13), (14), and (15), we get

$$\begin{aligned} &\Theta_1 \hat{P}_{1t} - \frac{1}{\sigma} \hat{C}_{1t}^{\gamma} - \Theta_2 \hat{P}_{2t}, \\ &= \hat{R}_t + \Theta_1 E_t \hat{P}_{1,t+1} - \frac{1}{\sigma} E_t \hat{C}_{1,t+1}^{\gamma} - \Theta_2 E_t \hat{P}_{2,t+1}. \end{aligned} \tag{16}$$

3.3 Aggregation

Suppose that the economy is inhabited by $\theta \in [0,1]$ fraction of owner-occupiers and $1-\theta$ fraction of renters, so that the aggregate consumption is determined as

$$C_t = \theta C_t^O + (1-\theta) C_t^\gamma . \tag{17}$$

If log-linearized around steady state, (16) yields

$$\hat{C}_t = \Lambda \hat{C}_t^O + (1-\Lambda)\hat{C}_t^\gamma \tag{17a}$$

where Λ is the steady state share $\theta C^O / C$ of home-owners' consumption.[14] We can further deduce from (9) and (4) that the same share Λ is applicable to the aggregation of C_1 or C_2 individually.

Combining (10) and (16) in view of (17a) gives

$$\begin{aligned} &\frac{1}{\sigma}\left[\hat{C}_{1t} - E_t\hat{C}_{1,t+1}\right] + \Theta_1\left[E_t\hat{P}_{1,t+1} - \hat{P}_{1t}\right] - \Theta_2\left[E_t\hat{P}_{2,t+1} - \hat{P}_{2t}\right] \\ &= \Lambda\left[\hat{Q}_t - \beta(1-\delta)E_t\hat{Q}_{t+1}\right] - (1-\Lambda)\hat{R}_t + \Lambda\left[1-\beta(1-\delta)\right]E_t\hat{P}_{2,t+1}. \end{aligned} \tag{18}$$

4. Model (II)

We consider another endowment economy in which the renters are, on top of the lack of access to the housing investment market, described as the so-called rule-of-thumb consumers: they do not smooth their consumption path in the face of fluctuations in their period-by-period endowment income. The behavior of home-owners in this economy is the same as in Model (I).

In each period, a representative renter solves the static problem of maximizing his period utility

$$u\left(C_{1t}^\gamma, C_{2t}^\gamma\right) \tag{19}$$

subject to the constraint

$$Y_t^\gamma = P_{1t} C_{1t}^\gamma + P_{2t} C_{2t}^\gamma \tag{20}$$

that all his endowment income is consumed in each period.

From the intratemporal optimization condition (9) and the budget constraint (20), we have

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[14] θ and Λ are different even in a steady state because the economy is populated by heterogeneous households.

$$-\sigma\hat{C}_{1t}^{\gamma} = -\sigma\hat{Y}_t^{\gamma} + \sigma\hat{P}_{1t}\left[\Theta_3 + \left(1-\Theta_3\right)\varepsilon\right] + \sigma\hat{P}_{2t}(1-\Theta_3)(1-\varepsilon) \tag{21}$$

where Θ_3 is the renters' share of non-housing consumption expenditure $P_1C_1^{\gamma}/Y^{\gamma}$ in steady state, which is equal to $\frac{\omega P_1^{1-\varepsilon}}{\omega P_1^{1-\varepsilon}+(1-\omega)P_2^{1-\varepsilon}}$.[15]

We now combine the log-linearized versions of (10) for home-owners and (21) for renters, with weight of Λ and 1-Λ, respectively. Using $E_t\hat{C}_{1t}^{o} = \frac{1}{\Lambda}E_t\hat{C}_{1t} - \frac{1-\Lambda}{\Lambda}E_t\hat{C}_{1t}^{r}$, we finally have the following equation for aggregate non-housing consumption:

$$\begin{aligned}
\frac{1-\Lambda}{\sigma}E_t\hat{Y}_{t+1}^{\gamma} &= \Lambda\left[\hat{Q}_t - \beta(1-\delta)E_t\hat{Q}_{t+1}\right] \\
&+ \Lambda\Theta_1\left[\hat{P}_{1t} - E_t\hat{P}_{1,t+1}\right] - \Lambda\Theta_2\left[\hat{P}_{2t} - E_t\hat{P}_{2,t+1}\right] \\
&+ \Lambda\left[1-\beta(1-\delta)\right]E_t\hat{P}_{2,t+1} - \frac{1}{\sigma}\left[\hat{C}_{1t} - E_t\hat{C}_{1t+1}\right] \\
&+ \sigma(1-\Lambda)Y_t^{\gamma} - \sigma(1-\Lambda)(\Theta_3 + (1-\Theta_3)\varepsilon)\hat{P}_{1t} \\
&- \sigma(1-\Lambda)(1-\Theta_3)(1-\varepsilon)\hat{P}_{2t} \\
&+ \frac{1-\Lambda}{\sigma}(\Theta_3 + (1-\Theta_3)\varepsilon)E_t\hat{P}_{1,t+1} \\
&+ \frac{1-\Lambda}{\sigma}(1-\Theta_3)(1-\varepsilon)E_t\hat{P}_{2,t+1}.
\end{aligned} \tag{22}$$

5. Estimation

We estimate the (steady state) share Λ of home-owner's consumption using the aggregate Euler equations (18) and (22) for the two models. Involving endogenous expectational errors, those equations are cast into the form

$$E_t\left[M_{t+1}X_t\right] = 0 \tag{23}$$

for a vector X_t of variables dated t and earlier. We apply GMM to the orthogonality condition (23).

To simplify the estimation procedure, we opt to estimate the pair of (σ, Λ). The values of (ω, ε) are fixed at (0.868, 0.454), which are obtained by applying OLS to

[15] We use the budget constraint (19) and the CES aggregator to derive this result.

(9). Ξ is fixed at the sample mean of its data counterpart calculated using the above estimates. The rate of depreciation δ of housing stock is fixed at 0.007, matching the annual rate estimated for the U.S. by Harding et al. (2004), and β is fixed at the conventional rate of 0.99. Finally, Θ_3 is fixed at the corresponding sample average.

We use quarterly Korean data for the period 1987:Q1 to 2003:Q4. The aggregate non-housing consumption C_1 is the same series used for the time series regression in section 2. The price series (P_1, P_2) of non-housing and housing consumption, respectively, are proxied by corresponding implicit deflators available from the national income account, and the housing price Q is the nationwide house price index reported by Kookmin Bank. All price variables are deflated by the CPI. The real interest rate R is the 3-year corporate bond rate adjusted for ex-post CPI inflation. For the endowment Y_t^γ of renters in the second model economy, we use per capita GNI resorting to the assumption that the endowment profile is identical for all households. Since variables in equations (18) and (22) are represented in log-deviations from steady state levels, we use the Hodrick-Prescott filter to construct correspondingly transformed series.

The left panel of Table 6 reports the estimation results for Model (I). In column (1), the second to fourth lags of $(C_1, C_2, P_1, P_2, Q, R)$ are used as instruments, while lags of C_2 not appearing in the moment condition are dropped in column (2). The estimated elasticities of intertemporal substitution imply that the utility function is close to the logarithmic function in both columns, but the estimate 0.769 of Λ in column (2) is higher than 0.659 in column (1). Both parameters are estimated sharply, as reflected in their t-values.

The estimation results for Model (II) are reported in the right panel of Table III. In column (3), the second to fourth lags of $(C_1, C_2, P_1, P_2, Q, R, Y)$ are used as instruments, while lags of C_2 not appearing in the moment condition (8) are again dropped in column (4). The estimates of σ and Λ for Model (II) tend to be lower than those for Model (I): the estimates of σ, ranging at around 0.8 to 0.9, are significantly lower than for Model (I) at a 5% significance level but not at the 1% level. The estimates of Λ, now ranging from 0.61 to 0.64, are not much different from that of Model (I). We believe the slightly lower estimates of Λ in Model (II) better represent the situation that renters are more likely to behave as "rule-of-thumb" consumers, rather than being able to smooth their consumption over time.[16] That being the case, the consumption share of renters latent in the aggregate data series will be better captured by the latter model. It is also worth noting that the estimate of Λ is not very different from a similar estimate in Campbell and Mankiw (1989): they estimate the "mass" of consumers who do not borrow or save to smooth consumption to be in the neighborhood of 0.4. If we view the renters as unable to draw resources from housing wealth to smooth consumption, then our estimates of Λ are comparable to those in Campbell and Mankiw (1989), although our estimates give the consumption share, not the "mass", of constrained households.

[16] In 2000, the home ownership ratio in Seoul was 53.4%, and the weighted average of home ownership ratios in seven major cities was 56.6% if the numbers of households in each city are used as weights. The average home ownership rate nationwide is 61.0%. The estimated share Λ is therefore higher than the "mass" of home-owners, which appears plausible: the consumption of a home owner will be higher than that of a renter.

<Table 6> GMM Estimation of the Euler Equation

	Model I		Model II	
	(1)	(2)	(3)	(4)
σ	1.230 (3.72)	1.267 (3.89)	0.894 (18.81)	0.808 (13.35)
Λ	0.659 (2.91)	0.769 (3.02)	0.613 (2.97)	0.639 (2.19)
Instruments	$C_{1,t-2},\ldots,C_{1,t-4}$	$C_{1,t-2},\ldots,C_{1,t-4}$	$C_{1,t-2},\ldots,C_{1,t-4}$	$C_{1,t-2},\ldots,C_{1,t-4}$
.	$P_{1,t-2},\ldots,P_{1,t-4}$	$P_{1,t-2},\ldots,P_{1,t-4}$	$P_{1,t-2},\ldots,P_{1,t-4}$	$P_{1,t-2},\ldots,P_{1,t-4}$
	$Q_{t-2},\ldots,Q_{t-4}$	$Q_{t-2},\ldots,Q_{t-4}$	$Q_{t-2},\ldots,Q_{t-4}$	$Q_{t-2},\ldots,Q_{t-4}$
	$R_{t-2},\ldots,R_{t-4}$	$R_{t-2},\ldots,R_{t-4}$	$R_{t-2},\ldots,R_{t-4}$	$R_{t-2},\ldots,R_{t-4}$
	$C_{2,t-2},\ldots,C_{2,t-4}$		$Y^r_{t-2},\ldots,Y^r_{t-4}$	$Y^r_{t-2},\ldots,Y^r_{t-4}$
			$C_{2,t-2},\ldots,C_{2,t-4}$	
J – stat.	0.764	0.891	0.753	0.778

Note: Numbers in parentheses are t-values calculated by HAC standard errors of Newey-West (1987). Numbers in the last row are p-values associated with Hansen's (1982) J-test for the model's overidentifying restrictions.

6. Interpretation

In this subsection, we develop an intuitive idea on how much to revise the measure of housing wealth effects estimated with aggregate (across home-owners and renters) time series. To simplify the argument, we assume the following relations

$$C^O = \alpha HW + \varepsilon^O$$
$$C^\gamma = \beta HW + \varepsilon^\gamma \quad (24)$$

where C^O and C^γ are the consumption of home-owners and renters, respectively, and HW is the total housing wealth. If the two consumption series were available, the OLS estimate of α would correspond to the "textbook" definition of the housing wealth effect, while that of β would measure the degree of negative income effect on renters coming from increases in housing prices.

Now suppose that a relation analogous to (12) is estimated for per capita consumption C, which is the weighted sum $\Lambda C^O + (1-\Lambda)C^r$ of two strands of households' consumption. If we denote the resulting estimate by $\hat{\gamma}$, it follows that the OLS estimates $(\hat{\alpha}, \hat{\beta}, \hat{\gamma})$ have the following relation:

$$\hat{\alpha} = \frac{\hat{\gamma}}{\Lambda} - \frac{1-\Lambda}{\Lambda}\hat{\beta}. \tag{25}$$

Equation (25) shows that how well the aggregate estimate $\hat{\gamma}$ reflects the hypothetical "home-owners only" estimate $\hat{\alpha}$ depends on $\hat{\beta}$ and Λ.

Obviously, if Λ is close to one, $\hat{\gamma}$ is not much different from the degree of a genuine housing wealth effect. However, if Λ is substantially smaller than 1, $\hat{\gamma}$ is likely to fall short of $\hat{\alpha}$, the measure of genuine wealth effect. Another reason $\hat{\gamma}$ may underestimate housing wealth effect per se is that $\hat{\beta}$ is significantly smaller than $\hat{\alpha}$. As shown in section 2, the time series regression results in Table I strongly support that $\hat{\beta}$ would be significantly smaller than $\hat{\alpha}$, and possibly even negative.

If we put $\hat{\beta} = 0$, which we think is not much of an extreme assumption for renters, the estimates Λ in Table 1 imply that $\hat{\alpha}$ recovered from the estimates (controlled for the possible endogeneity problem) in the second panel for non-housing consumption in Table 3 ranges around 0.144 on average. The estimates of housing wealth effects thus revised tend to be larger than the cross sectional estimates in Table 4 ranging around 0.1. We may view the number 0.144 as the upper bound of the 'genuine' housing wealth effects we want to estimate.

IV. Conclusion

In this paper, we examine the effects of housing wealth on consumption in Korea. Traditionally, the literature on housing wealth effect has mainly focused on estimating the effects of housing wealth on aggregate consumption. Unlike those previous studies, our interest lies in understanding the 'genuine' housing wealth effects, i.e., the response of consumption spending by home-owners to the changes in housing wealth.

We raise two issues, the one around home-ownership and the other around the proper measure of consumption, that matter in estimating the genuine housing wealth effect using aggregate time series. Dealing with the latter, we argue that it is more appropriate to use non-housing consumption. To the extent that most home-owners purchase housing units to live in, the changes in housing consumption by home owners are not of their own choices but artificially imputed on them.

On top of that, we proceed to address the issue of home ownership. Our strategy is to examine how much to revise the estimates housing wealth effect obtained from aggregate non-housing consumption data. We construct two structural models and estimate the share of home-owners' consumption in those models' context. It is found that, if revised in light of the estimated consumption shares of home-owners, the magnitude of resulting housing wealth effects may be larger than what simple time series regressions tell us.

We believe grasping the size of 'genuine' wealth effect has some macroeconomic implications. Policymakers are usually interested in understanding the effect of housing wealth on aggregate consumption. Seeing that the ratio of home-owners has been steadily increasing, however, estimates of housing wealth effects based on past data and not taking such trend into account may understate the importance of housing wealth for stabilization policy in the present and near future.

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Appendix

In this section, we summarize the steps followed in deriving the regression equation (1) from the utility maximization problem in the subsection 2.1.

The FOCs w.r.t (C^1,C^2) are combined together into

$$C_2 = C_1 P^{-\varepsilon}\left[\frac{1-\omega}{\omega}\right], \tag{A1}$$

where $P = P_2/P_1$.

Combining (A1) and the budget constraint, we get

$$C_1[1+P^{1-\varepsilon}\left[\frac{1-\omega}{\omega}\right]] = Y + HW + SW. \tag{A2}$$

If log-linearized aound the steady state, equation (A2) can be represented as

$$\log C_1 = Const_1 + \Theta_1 \log P + \Psi_1 \log Y + \Psi_2 \log HW + \Psi_3 \log SW \tag{A3}$$

where $Const_1$ corresponds to the steady state around which (A2) is log-linearized, and the coefficients are given by the following steady state values:

$$\Theta_1 = (\varepsilon - 1)\frac{P^{1-\varepsilon}(1-\omega)/\omega}{1+P^{1-\varepsilon}(1-\omega)/\omega},$$

$$\Psi_1 = \frac{Y}{W + HW + SW}, \Psi_2 = \frac{HW}{W + HW + SW}, \Psi_3 = \frac{SW}{W + HW + SW}.$$

Using (A1), we get a similar relation for $logC_2$ given by

$$\log C_2 = Const_2 + \Theta_2 \log P + \Psi_1 \log Y + \Psi_2 \log HW + \Psi_3 \log SW \tag{A4}$$

where $\Theta_2 = \varepsilon\left[\frac{P^{1-\varepsilon}(1-\omega)/\omega}{1+P^{1-\varepsilon}(1-\omega)/\omega} - 1\right] - \frac{P^{1-\varepsilon}(1-\omega)/\omega}{1+P^{1-\varepsilon}(1-\omega)/\omega}.$

Note that the coefficient Θ_1 on *logP* may have either signs for the non-housing consumption (C_1), depending on the magnitude of ε measuring the elasticity of substitution between the two kinds of consumption. In contrast, the coefficient Θ_2 for the housing consumption (C_2) is negative.