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Why does the propensity to home ownership vary?: Focusing on the role of borrowing constraints in Korea

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Why does the propensity for home ownership vary?:

Focusing on the role of borrowing constraints in Korea

Abstract

The propensity to own (rather than to rent) primary residence tends to vary across geographical areas, over time, and among consumer cohorts. This study investigates why that is the case by focusing on the role of borrowing constraints in residential mortgage lending in Korea. In particular, a discrete tenure choice model is established, based on which effects of both wealth and income constraints as indicated by the maximum loan-to-value (LTV) ratio and that of debt-to-income (DTI) ratio are estimated. Using the household-level micro data from Korea, we report that: the lending restrictions exhibit negative effects on the propensity to own, which are also shown to increase for younger borrower cohorts. Despite the fact that the residential mortgage lending sector of the country experienced a substantial growth during our study period (2006 to 2014), the effects of the wealth constraints increased over time, which we interpret as a possible outcome of the more binding lending restrictions combined with the location-based regulatory controls. Using the empirical findings, we provide a preliminary result of our analysis on the optimal LTV level by age cohort.

Key words: Housing and mortgage demand, tenure choice, and borrowing constraints

1. Introduction

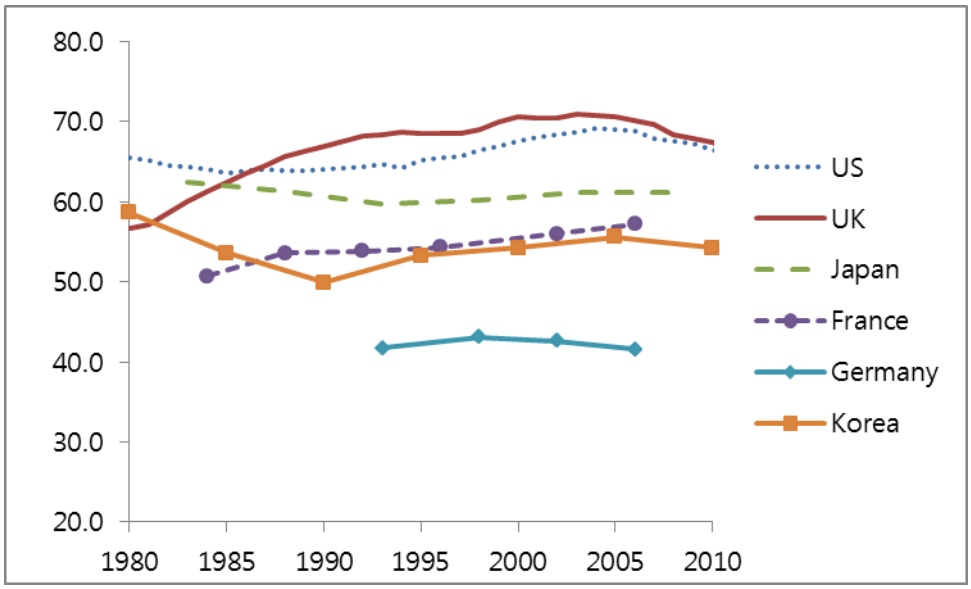
The owner occupancy rates (OOR) for primary residence, the share of those households who reside in the properties they own, vary widely across time and space: to illustrate, while OORs in the U.S. and UK almost reached to almost 70 percent before the Global Financial Crisis (GFC), that in Germany has been hovering around 40 percent; Korea and Japan are in between with OORs being around 50 percent and 60 percent, respectively; and, even in a given country, OORs fluctuate quite widely over time, e.g., OOR in the U.S. rising by more than 10 percentage points between 1980 and 2000 from less than 60 percent to 70 percent. Academic studies document various market and institutional factors as the underlying determinants to such variations, based on both macro-indicators such as home ownership rates (Haurin and Rosenthal (2007), Voigtlander (2009), and Andrews and Sanchez (2011)) and micro-indicators of the propensity to own (Ohtake and Shintani (1994), Pitkin and Myers (1996), Sinai and Souleles (2008), Lindenthal and Eicholtz (2010), and Lee and Kim (2013)).

One particular determinant that has long been receiving a fair amount of attention from academia is the role of borrowing constraints (Linneman and Wachter (1989), Linneman et al. (1998), Gyourko et al. (1999), Dieleman et al. (2003), Gabriel and Rosenthal (2005), Dawkins (2005), and Boehm and Scholttman (2009)). The main hypothesis being exposited by this strand of the literature is that a high likelihood of credit rationing, caused by income constraint, by wealth constraint, or by other creditworthiness issues, will reduce the propensity to own, ceteris paribus all other conventional determinants such as relative prices of owning vs. renting (for residential property of a given set of locational and structural attributes), household income, lifecycle and other demographic characteristics. The above studies report the findings that tend to support this credit rationing hypothesis – the higher the likelihood of borrowing constrained for a given household in terms of loan-to-value (LTV) ratio or debt-to-income (DTI) ratio, the lower the propensity to own given all other relevant factors being constant - based on the data from the U.S. or from a small number of European countries.

Given this backdrop, this study aims to investigate and document the effects borrowing constraints in an emerging market context, with a micro-level household data from Korea and, in so doing, to institute several enhancements in performing the empirical analyses: that is, first, a constant-quality housing is assumed, based on which relative costs of owning vs. renting are computed; second, differential effects of the constraints across different consumer cohorts (i.e., different age and income groups) are estimated to elaborate cohort-specific extents of how restrictive those lending restrictions are; and, the interactive effects of the wealth constraint (measured via LTV) and of income constraint (via DTI) are examined. Our results

show that: the LTV and DTI constraints exhibit negative correlations with the propensity to own, that is, ceteris paribus, the more restrictive they are, the lower the likelihood to own; their effects are fairly stable in the study area over the period between 2006 and 2014; and, the two constraints are shown to interact each other such that the restrictiveness in one constraint influences the effect of the other on the consumer decision to own.

Figure 1: The trends in home ownership rates in selected countries



Source: Kim et al. (2013)

Our results that all the usual determinants of the propensity to own show the expected signs with statistically-significant coefficients: that is, the higher the permanent income, the larger the family size, the older the age cohort, the propensity to own gets higher; on the other hand, the higher the user cost (or relative cost of owning), the lower the propensity becomes. However, contrary to our expectation, the two latter year cohorts (2010 and 2016) show the lower propensities own, ceteris paribus, compared to the 2006 cohort, even though the residential mortgage market in Korea experience a substantial growth during the time period. As a possible reason for the last result, we conjecture that the market-wide lending restrictions through LTV−DTI caps along with the location-driven regulations might have lowered the propensity for average consumer over the same time period.

As expected, the two borrowing constraints tested show binding effects on the propensity to own: that is, compared to the unconstrained households, both the moderately- and highly-constrained households exhibit the lower propensities, which is similar for both income constraints and the wealth constraints; But, as

indicated by the regression coefficients, the magnitudes of the wealth effects are far larger than those of income constrains. Furthermore, when interacted with the age cohorts, it is also shown that the wealth constraints have a larger impact on the young borrowers. Using our empirical results, we provide a preliminary analysis on the optimal LTV level by age-cohort by exploiting the fact that the two constraints are correlated through the underlying variables used.

The rest of the paper consists of the following four sections: a critical survey of prior studies (Section 2); the empirical analysis (data and variables, testing model, and results); a policy implication as to the optimal LTV level; and, concluding remarks.

2. Prior Studies: A Critical Review

Theoretical underpinning

In a dynamic sense, household's tenure decision is made in a highly complex utility maximization framework. Following Cho (2017), a representative consumer with perfect foresight maximizes a forward-looking expected utility function with two arguments – housing as a durable good, h, and a non-durable consumption good, c (a numeraire) – subject to a series of constraints:

$$(1) \quad \max_{c,\,h} \; E_t\left[\sum_{i=1}^{\infty}\beta^i u(c_{t+i}, h_{t+i})\right],$$

$$(2) \quad c_{t+i} + R_{t+i}h_{t+i} + s_{t+i} \le y_{t+i} + \sum_j \alpha_{t+i}^j \cdot W_{t+i}^j,$$

$$(3) \quad M_{t+i}^{\star} \le M_{t+i}^{\max}(BC_{t+i}^{LTV},\, BC_{t+i}^{DTI},\, \Phi_{t+i}) \;\; iff \;\; \tau = 1$$

$$(4) \quad l_{t+i} = 0 \;\; if \;\; t+i > \tilde{T}; \; otherwise \;\; l_{t+i} > 0$$

where β is a discount factor. The housing consumption at a given future time period i, h_{t+i}, is a weighted average housing consumption between owning with the propensity to own, τ, and renting with probability (1-τ), i.e., $h_{t+i} = \tau \cdot h_{t+i}^{o} + (1-\tau) \cdot h_{t+i}^{r}$.[1] The optimization is subject to three constraints. First, the budget constraint (equation (2)) consists of three arguments – consumption (, housing rent (R, per-period per-unit rental price of housing service, multiplied by quantity of housing service, h), and saving, s, which should

[1] τ is a latent variable, which is proxied as one if a household owns in empirical study on the tenure choice.

equate labor income ($y_{t+i} = l_{t+i} \cdot w_{t+i}$ with l and w being labor supply and market wage), and return from accumulated wealth from both housing and non-housing assets ($W_{t+i}^{j} = W_{t+i}^{h} + W_{t+i}^{n}$, j = h, n). Assuming no leverage (at this point), the housing wealth is equivalent to per-unit asset price of housing, P^h, multiplied by its quantity, $W_{t+i}^{h} = P_{t+i}^{h} \cdot h_{t+i}$. Second, the tenure decision is influenced by borrowing constraints (equation (2)): that is, given optimal housing demand, h^*, the optimal leverage amount M^*; and, M^* should be less than or equal the maximum loan amount, M^{max}, set by three particular borrowing constraints (BC) – a maximum collateral rate (or a maximum loan-to-value, LTV, ratio), BC_{t+i}^{LTV}, a maximum debt (or mortgage) payment to income ratio (or per-period debt payment-to-income, DTI, ratio), BC_{t+i}^{DTI}, and a ceiling set by the risk appetite of mortgage lenders, Φ_{t+i}, a vector of mortgage underwriting criteria (other than the LTV and DTI limits) such as mortgage products offered, consumer credit ratings, and documentation requirements to verify income, wealth, and employment.[2] Third, there is a labor supply constraint (equation (4)) such that, upon reaching at retirement age, $\tilde{T}$, the labor supply (and, hence, the wage income) becomes zero and the consumer will have to be dependent upon other income sources (e.g., public and private pensions, or self-financing out of accumulated wealth).

Empirical findings

The usual determinants of housing demand include housing price (either asset price or user cost of capital for owning), household income (usually a permanent, rather than transient, income), and a series of demographic variables (e.g., household head's personal attributes such as age, birth-year, marital status, and education level, as well as family size).

$$(5) \quad \tau_i = f(R_i / P_i, I_i, D_i, BC_i),$$

First, the specification of the demographic factor is rather ad hoc with different studies adopting different sets of explanatory variables. Two particular sets of the demographic variables employed are worth noting: namely, birth-year cohorts of household heads, under the premise that, depending on what age group each household head was in different stages of housing price boom-bust cycle in each country, accumulated housing wealth in later year can differ across the cohorts (Ohtake and Shintani (1994), Pitkin and Myers (1996), Sinai and Souleles (2008), Lindenthal and Eicholtz (2010), and Lee and Kim (2013)); and, human capital factors such as educational levels, which can influence permanent income of household heads (Hendershott and Green (1996), and Lindenthal and Eicholtz (2010)).[3] In pursuing an empirical

[22] It is well-documented in the recent literature that these leverage constraints tend to be pro-cyclical, i.e., being relaxed in an ebullient stage of housing market cycle but becoming more stringent in a crisis stage.

[3] In particular, Lindenthal and Eicholtz employed a four-step procedure: (1) estimating a hedonic model to capture implicit price of each property characteristic (i.e., an implicit price of ith property characteristic, pi, estimated from P =

investigation of effects of demographic factors, one should carefully consider various interactive terms between D and other key variables included (e.g., P*D in the case of birth-year cohorts and I*D in the case of education levels).[4]

Second, Voigtlander (2009) investigated the reason why Germany homeownership rate is not high compared to other countries. The relatively low homeownership in Germany is caused by large rental market size, no benefits from owning, less interventions in rents, and stable housing price over a long period. Andrews and Sanchez (2011) studied homeownership rate in some OECD countries, based on household level micro data. The datasets consist of micro data and aggregate data: Age, household size, income, education level (micro data), LTV ratio, tax relief, and rent regulation (aggregate data). It is suggested that homeownership rate is increased with age, especially high in 45-64, positively related with household size, disposable income at a diminishing rate. The household with higher education level is more likely to be homeowner but not always significant. And the homeownership rate is generally lower for immigrant. In aspect of policy, the homeownership is increased with higher LTV ratio and decreased with stricter rent regulation. And tax relief indirectly crowd-out financially constrained household from homeownership.

Third, tenure choice of household is largely omitted, or inadequately reflected, in the housing demand studies, even though there exists a large number of studies on this topic (Linneman and Wachter (1989), Linneman et al. (1998), Gyourko et al. (1999), Dieleman et al. (2003), Gabriel and Rosenthal (2005), Dawkins (2005), and Boehm and Scholttman (2009)). To control the tenure-related difference (in terms of housing expenditure), Mankiw and Weil converted the monthly rents for renters by simply multiplying them by 100. Obviously, one can adopt a more refined control of the tenure-driven difference, either by using a user cost variable or by incorporating a selectivity control factor (e.g., the inverse Mills ratio) in the demand equation. The tenure-driven differences can also be country-specific in that market conditions and institutional attributes tend to differ across countries (e.g., the Chonsei system in Korea). It has long been documented by the above studies that various constraints in borrowing, e.g., caps on loan-to-value (LTV) and debt-to-income (DTI) ratios, influence the propensity to own.

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g(Z) where Z is a set of property characteristics); (2) estimating the implicit price equation as a function of income and demographic characteristics, pi = h(zi, A, Y, X) where A and X are age and other demographic characteristics); (3) fitting an income dynamic equation as Y = k(A, A*E) where E represents education level; and, (4) aggregating total housing demand at a given time point as where wa represents weight for a-th age group (up to 14).

[4] In the U.S., the effects of race on housing demand were investigated by a number of studies (de Leeuw (1971) , Carliner (1973), Lee and Trost (1978), Rosen (1979), Ihlanfeldt (1981), Boehm (1982), Goodman and Kawai (1982), Ihlanfeldt (1982), Dynarski (1985), Henderson and Ioannides (1989), and Cooperstein (1989). See Megbolugbe and Cho for a survey of the early studies on this topic.

More on the borrowing constraints

There has been a burgeoning literature on tenure choice, consumer's selection between owning vs. renting for residence need, since the late 1980s. As one of forerunners in this area, Linneman and Wachter (1989) demonstrate that the households' tenure choice is influenced by permanent income, relative cost (i.e., user cost of capital for owning), demographic variables (marital status, size of household, and so on), as well as borrowing constraints (both wealth and income constraints in purchasing or refinancing home mortgage). Subsequent studies use a similar model to further investigate effects of various socio-economic factors on the ownership decisions (Gyourko et al. (1999), Linneman et al. (1998), Megbolugbe and Cho (1996), Goodman and Kawai (1988)).

There are two strands of micro studies from the above first-generation literature. First, a series of studies attempt to explain observed gap in owning propensity between racial groups. (Gabriel and Rosenthal (2005), Dawkins (2005), and Gyourko et al (1999)) For example, Gyourko et al. report that substantial differences in homeownership rates among racial groups (white vs. African American in particular) are explained by the differences in proportions of wealth-constrained households and in locations of residence (central cities vs. suburbs in particular); Gabriel and Rosenthal provide the evidence that household characteristics, rather than borrowing constraints, are dominant factors producing the ownership gaps, and suggest that improving financing options would be less likely to be effective in eliminating the gap; Dawkins finds that location characteristics associated with the supply of affordable owner-occupied housing directly affect the racial gaps in owning.

Second, a number of studies further investigate tenure transition patterns of different consumer cohorts, e.g., from renting to first-time owning, from owning back to renting, from owning low-quality housing to high-quality (i.e., filtering up), and so on. (Boehm and Scholttman (2009) and (2004)), and Dieleman, Clark, and Dierlou (2003) and (1995)) Dieleman et al. (1995), one of the first in this line of research, provide the evidence that age, family status (marital and presence of children), income, and employment status impact transition probabilities of returning to rental tenure and, subsequently, their likelihood of becoming homeowners again; Boehm and Scholttman (2009) and (2004) provide further evidences, by using a more sophisticated econometric model along with two eleven year longitudinal compilations of households from Panel Study if Income Dynamics, that the observed differences in tenure transition probabilities between white vs. non-white households largely disappears once controlling gaps in education, income, net worth and savings.

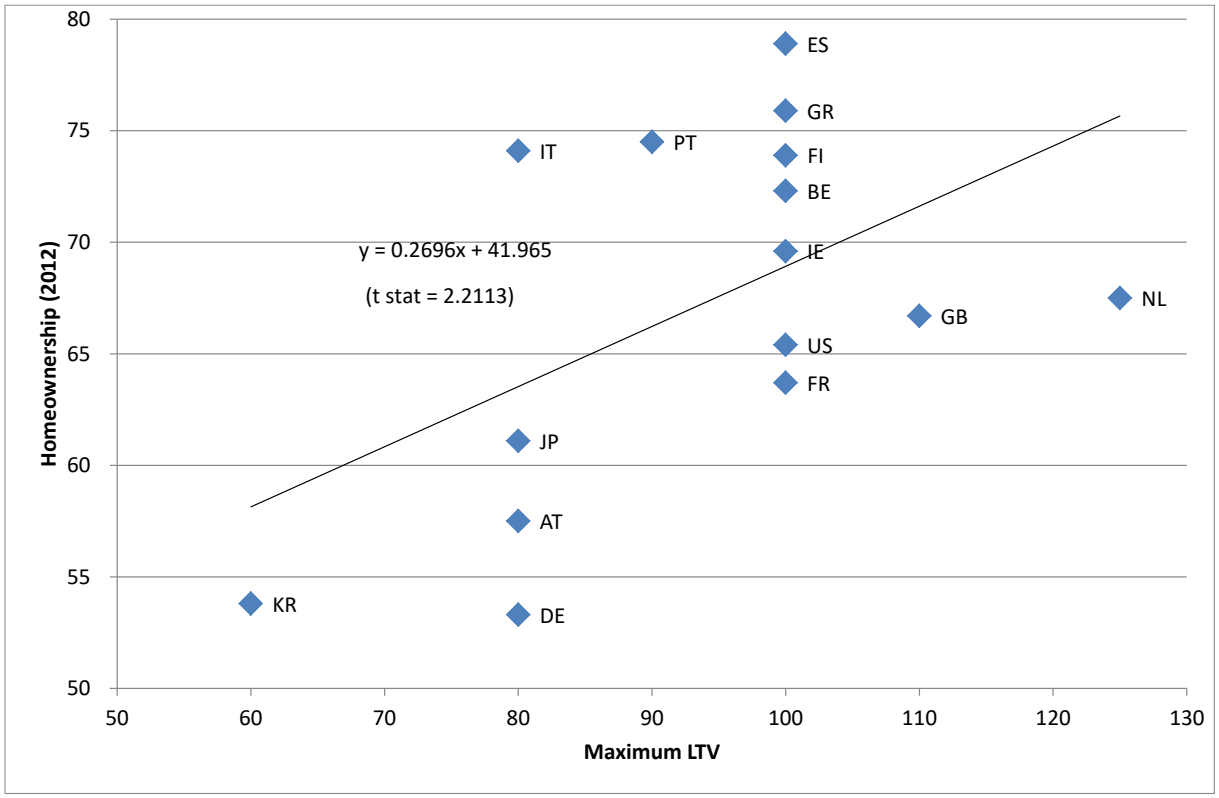
Linneman et al (1997) also studied the impact of borrowing constraints with micro-simulation estimates.

Besides the income and wealth constraints, market variables such as income, household head age, race, marital status, and family size are used. It has similar conclusion with previous study that wealth constraint has a bigger impact on homeownership. The simulation analysis shows the effect of changing wealth constraint is nonlinear and larger at higher LTV level and income ratio. Min et al (2012) did empirical study about the impact of borrowing constraint, specifically in Korea. By using household level micro data with variables of housing price-rental deposit ratio, income, age of household age, and family size, it has a conclusion that income or/and wealth constrained household shows lower tendency of owning and wealth constraint has a stronger impact on homeownership as same as previous studies. In terms of policy simulation, relaxing the LTV ratio will increase more the probability of owning than easing income constraint.

Bourassa and Yin (2006) researched tenure choice differences between U.S.A and Australia, focusing on subsidy policies. The variables are housing cost, household characteristics, and subsidy. The result is that the former two variables do not explain differences in homeownership rates. On the other hand, subsidy policies have only a minor impact. Bourassa et al (2013) did research the impact of mortgage interest deduction on the homeownership. It quantifies the effect of mortgage interest deduction and imputed rent taxation and uses relative cost of owning and renting, borrowing constraints, real income, and tastes as variables. It concluded that mortgage interest deduction generally does not improve the homeownership rate as it is capitalized into housing price, especially when supply is inelastic. Hilber and Turner (2010) also studied the impact of mortgage interest deduction on homeownership rate. It also quantifies mortgage subsidy rate, value of regulation, household characteristics, location characteristics, and individual fixed effects. And the conclusion is that when average regulation is restrictiveness the mortgage interest deduction does not have effect, but it has positive effect with relaxed land use control. Furthermore, it has negative effect in more tightly constrained locations and no impact on low income.

What this study aims to contribute

Korea represents an interesting case to study the role of borrowing constraints in that its residential mortgage market has been evolving rapidly since the Asian Financial Crisis in the late 1990s, and that the sector is heavily regulated with both LTV and DTI caps as well as the geographically-driven regulatory controls as well (“speculative zones” in which more restrictive lending limits are applied). Hence, we provide empirical evidences from the emerging market economy with an expanding mortgage lending sector with a series of lending restrictions.



3. Empirical Analyses

Data and Variables

The main data source used is the Korea Housing Survey for three years - 2006, 2010, and 2014, the bi-annual survey on housing characteristics published by the Ministry of Land, Infrastructure and Transport. The home price indexes and average mortgage rates are from Korea Appraisal Board; And all monetary values are translated to the real values as of the end of 2006 based on the consumer price indices (CPI) published by Bank of Korea. The list of all the variables used along with description of each is in Table 1; And summary statistics thereof are in Table 2.

[Table 1: Variable Description]

[Table 2: Summary statistics]

Empirical model and design

Following the estimation procedure by the existing literature, two prior steps before estimating the tenure choice equation (5) are done. First, the permanent income equation is estimated based on the specification below.

$$ln\_h\_inc = f(f_{size}, age, age^2, ln_{wealth}, D_{region}, D_{education}, D_{occupation}, D_{job\ type}, D_{sex})$$

Current income can be biased as it can include a transient component in individuals' earning, and the home purchase ability is likely to be correlated with life-long potential income. To estimate 'e_ln_h_inc' the natural log of household income is regressed on family size, house head age and square of age, natural log of net house wealth, region, degree of education, sort of occupation, type of jobs, and sex of house head, out of which we calculated the natural log of permanent house income, 'ln$\widehat{_h_inc}$'.

Next, the borrowing constraint variables (BC) are constructed, for which the optimal home value (HV*) is estimated to discern constrained vs. unconstrained households. Specifically, the steps taken are as follows. First, the income and wealth constraints variables are built based on the formula below:

$$LC_i^I = \frac{\delta \times I_0}{i \times \alpha_m} \quad \text{and} \quad LC_i^W = \frac{W_0}{1-\alpha_m}$$

δ = *front end ratio (marginal debt payment to income)*

i = *mortgage (interest) rate*

α_m = *LTV ratio*

I_0 = *current income*

W_0 = *current net wealth*

Second, a sub-sample of households is created such that their observed home values are less than the maximum values given the two borrowing constraints defined above - the wealth and income constraints.

$$HV_i \leq BC_i$$

where, $BC_i = \min (LC_i^I , LC_i^W)$

Third, we estimate the HV_i^* equation based on the subsample with those who are not constrained by BC, by regressing the log of home price to the log of permanent income, age of house head, family size, degree of education, sex of house head, type of house, region, occupation of house head, job type of house head, and comparative ratio of ownership cost to rent, $HV_j = \pi(Z_j, \phi, ; v_j)$. The estimation results of the HV equation are shown in Table 4.

$$ln\_h\_price = f(e\_ln\_h\_inc, age, f\_size, D_{education}, D_{sex}, , D_{house\ type}, D_{region}, D_{occupation}, D_{job\ type}, own\_to\_rent)$$

Fourth, we calculated the optimal home value HV_i^* that meets the needs of individual family characteristics assuming they don't have financing constraints. $HV_i^* = \widehat{H_i} = \pi(Z_i, \phi, ; v_i)$, where, Z_i is a set of explanatory variables, ϕ is a vector of regressions, and v_i is random disturbance. The regression is based on households that has no borrowing constraints. ($HV_i < BC_i$).

Finally, the degrees of income and wealth constraint variables (BC_i^I and BC_i^W) for all households are defined as the following three levels – highly constrained (3), moderately constrained (2), and unconstrained (1).

$$BC_i^I = g(HV_i^* - LC_i^I) \quad \text{and} \quad BC_i^W = g(HV_i^* - LC_i^W)$$

Degree of income constraint (degree_gap_i)	$HV_i^* > LC_i^I$	highly constrained =3
	$0.7 \times LC_i^I < HV_i^* < LC_i^I$	moderately constrained=2
	$HV_i^* < 0.7 \times LC_i^I$	unconstrained =1
Degree of wealth constraint (degree_gap_w)	$HV_i^* > LC_i^W$	highly constrained =3
	$0.7 \times LC_i^W < HV_i^* < LC_i^W$	moderately constrained =2
	$HV_i^* < 0.7 \times LC_i^W$	unconstrained =1

Estimation results

The tenure choice equation of the following probit model is estimated, and various different model specifications are tested whose results are reported in Appendix (Table A.1 and A.2).

$$Probit(own = 1) = f(X_i, Degree\_gap\_i, Degree\_gap\_w; \beta) + \varepsilon_i \quad (6)$$

X_i : set of variables

$Degree\_gap\_i$: degree of income constraint

$Degree\_gap\_w$: degree of wealth constraint

(1= unconstrained, 2= moderately constrained 3= highly constrained)

Out of those specification tests, the five model outcomes are shown in Table 6 below as the main results: Model (1) with all the control variables along with two time dummies (one for year 2010, another for year 2016, and 2006 data being the reference group) but without the borrowing constraint variables; Model (2) with all the controls plus both income-constraint and wealth-constraint variables but without time dummies; Model (3) with all the variables in the second model plus the two time dummies; Model (4) the model with the income-constraint and wealth-constraint variables interacted with the age group cohorts and without the income variable; and, Model (5) with the income-constraint and wealth-constraint variables interacted with the year cohorts.

Table 6. The main estimation results

(Dependent variable: Tenure status, one if owning;
Pooled sample estimation with 2006, 2010, and 2016 surveys)

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
e_ln_h_inc	0.544***	0.129***	0.141***		0.117***
	(0.0167)	(0.0353)	(0.0241)		(0.0241)
own_to_rent	-0.131***	-0.136***	-0.115***	-0.0881***	-0.111***
	(0.00820)	(0.0254)	(0.00901)	(0.00676)	(0.00915)
f_size	0.0237***	0.135***	0.148***	0.0455***	0.152***
	(0.00599)	(0.0106)	(0.00714)	(0.00423)	(0.00713)

Age		0.0465***	0.0443***		0.0436***
		(0.00110)	(0.000722)		(0.000712)
2.sex		-0.143***	-0.152***	-0.192***	-0.160***
		(0.0324)	(0.0223)	(0.0133)	(0.0225)
2.h_type	-1.590***	-0.849***	-0.866***	-1.056***	-0.895***
	(0.0228)	(0.0420)	(0.0265)	(0.0166)	(0.0261)
3.h_type	-1.064***	-0.282***	-0.479***	-0.772***	-0.512***
	(0.0321)	(0.0552)	(0.0366)	(0.0262)	(0.0360)
4.h_type	-0.589***	-0.00649	-0.127***	-0.384***	-0.140***
	(0.0204)	(0.0305)	(0.0219)	(0.0137)	(0.0221)
5.h_type	-0.648***	-0.217***	-0.313***	-0.438***	-0.324***
	(0.0295)	(0.0482)	(0.0322)	(0.0236)	(0.0323)
6.h_type	-0.798***	-0.226***	-0.356***	-0.585***	-0.367***
	(0.0262)	(0.0463)	(0.0292)	(0.0209)	(0.0295)
7.h_type	-1.107***	-0.576***	-0.569***	-0.815***	-0.595***
	(0.0571)	(0.101)	(0.0656)	(0.0486)	(0.0659)
8.h_type	-1.749***	-0.699***	-0.923***	-1.499***	-0.959***
	(0.0866)	(0.156)	(0.105)	(0.0809)	(0.103)
9.h_type	-1.344***	-1.009***	-1.340***	-1.403***	-1.320***
	(0.192)	(0.333)	(0.238)	(0.131)	(0.235)
10.h_type	-1.361***	-1.091***	-1.182***	-1.415***	-1.183***
	(0.183)	(0.301)	(0.197)	(0.141)	(0.195)
2.degree_gap_i		-0.174***	-0.127***		
		(0.0342)	(0.0232)		
3.degree_gap_i		-0.192***	-0.0868***		
		(0.0404)	(0.0252)		
2.degree_gap_w		-0.999***	-0.843***		
		(0.0401)	(0.0236)		
3.degree_gap_w		-1.810***	-1.711***		
		(0.0378)	(0.0234)		
10.year	-0.315***		-0.338***	-0.361***	
	(0.0138)		(0.0159)	(0.0116)	
14.year	-0.218***		-0.412***	-0.237***	
	(0.0160)		(0.0190)	(0.0132)	

1.y6_degree_gap_w					-
2.y6_degree_gap_w					-0.648***
					(0.0342)
3.y6_degree_gap_w					-1.481***
					(0.0312)
1.y10_degree_gap_w					-0.232***
					(0.0175)
2.y10_degree_gap_w					-1.263***
					(0.0398)
3.y10_degree_gap_w					-2.090***
					(0.0340)
1.y14_degree_gap_w					-0.277***
					(0.0201)
2.y14_degree_gap_w					-1.263***
					(0.0539)
3.y14_degree_gap_w					-2.340***
					(0.0522)
Young	-0.851***				
	(0.0135)				
1.old_gap_w				-	
2.old_gap_w				-0.980***	
				(0.0271)	
3.old_gap_w				-0.794***	
				(0.0119)	
1.young_gap_w				-0.814***	
				(0.0164)	
2.young_gap_w				-1.601***	
				(0.0368)	
3.young_gap_w				-2.108***	
				(0.0232)	
Constant	-1.545***	-2.455***	-2.081***	1.530***	-2.013***
	(0.0739)	(0.205)	(0.137)	(0.0214)	(0.136)

Observations	56,516	24,078	56,516	83,405	56,516

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All the usual determinants of the propensity own show the expected signs that are statistically significant: that is, as shown in Table 6, the higher the permanent income, the larger the family size, the older the age cohort, the propensity to own gets higher; on the other hand, the higher user cost (or relative cost of owning), the lower the propensity becomes; and, contrary to our expectation, the two latter year cohorts (2010 and 2016) show the lower propensities own compared to the 2006 cohort, which is consistent in all three models (Models 1, 3, and 4). As a possible reason for the last result, we conjecture that, although the mortgage market expanded during our study period (which should lower the user cost for average consumer), the market-wide lending restrictions through LTV−DTI caps along with the location-driven regulations ("speculative zones") might have lowered the propensity over time.

As expected, the borrowing constraint variables all show to reduce the propensity to own: compared to the unconstrained households ('1.degree_gap_w' for the wealth constraint, the reference group), both the moderately- and highly-constrained households exhibit the lower propensities (in Model (2), -0.999 for '2.degree_gap_w' and -1.81 for '3.degree_gap_w' for the wealth-constrained households, and -0.174 for '2.degree_gap_i' and -0.192 for '3.degree_gap_i' for the income-constrained households. Similar results are obtained from Model (3), indicating that the results are robust. As indicated by the coefficients, the magnitudes of the wealth effects are far larger than those of income constrains.

When interacted with the age cohorts, it is also shown that the wealth constraints have a larger impact on the young borrowers. That is, in Model (4), the variable ′1.old_gap_w′ is a combination of ′old cohort′ with ′1.degree_gap_w′ (or unconstrained borrowers) is the reference group used; The impacts of wealth constraint in young cohort at all three constraint levels, [-0.814, -1.601, -2.108[, are shown to be higher than those of old cohort, [0, -0.980, -0.794] , based on which we conclude that the wealth constraints tend to make different effects for consumer cohorts with different lifecycle stages, and that they tend to play as a larger binding constraint for young households in their tenure decisions. One result to note is that, for old age cohorts, the mild wealth constraint in fact inflicts a bigger negative impact (the coefficient -0.980) than that of the high constrained (the coefficient -0.794), which may imply that older-age borrowers tend to have a

relatively more extensive social or business network that can mitigate the borrowing constraint. Conceptually, the wealth constraint should be less binding as the net wealth increases, which out data confirms: that is, while the average net worth of the old age cohorts amounts to 181 thousand KRW, that of the young cohorts is only 92 thousand KRW.

Finally, when interacted with the survey years, it is shown that the impact of wealth constraint become larger in 2010 than 2006 compared to the base year of 2006 (1.y6_degree_gap_w in Model (5)). Specifically, the coefficient for ′year10x1.degree_gap_w′ is -0.232, implying that those households with no wealth constraint have the lower propensity to own in 2010 compared to 2006; Between the two latter years, the sizes of impact are similar, [-0.232, -1.263, -2.090] for 2010 vs. [-0.277, -1.263, -2.340] for 2014; As expected, the more constrained, the higher the reduction in the propensity, [-0.648] for the moderately-constrained (2.y6_degree_gap_w) but [-1.481] for the highly-constrained (3.y6_degree_gap_w). In sum, our results indicate that there is no statistically valid evidence on the lowering impacts of the borrowing constraints as the residential mortgage market expands, as in the case of Korea during our study period.

4. Policy implication: On the optimal LTV level

Using our empirical results, we examine the causal relationship between the wealth constraint and the income constraint to come up with the optimal LTV constraint, by exploiting the fact that the two constraints are correlated through the following relationships:

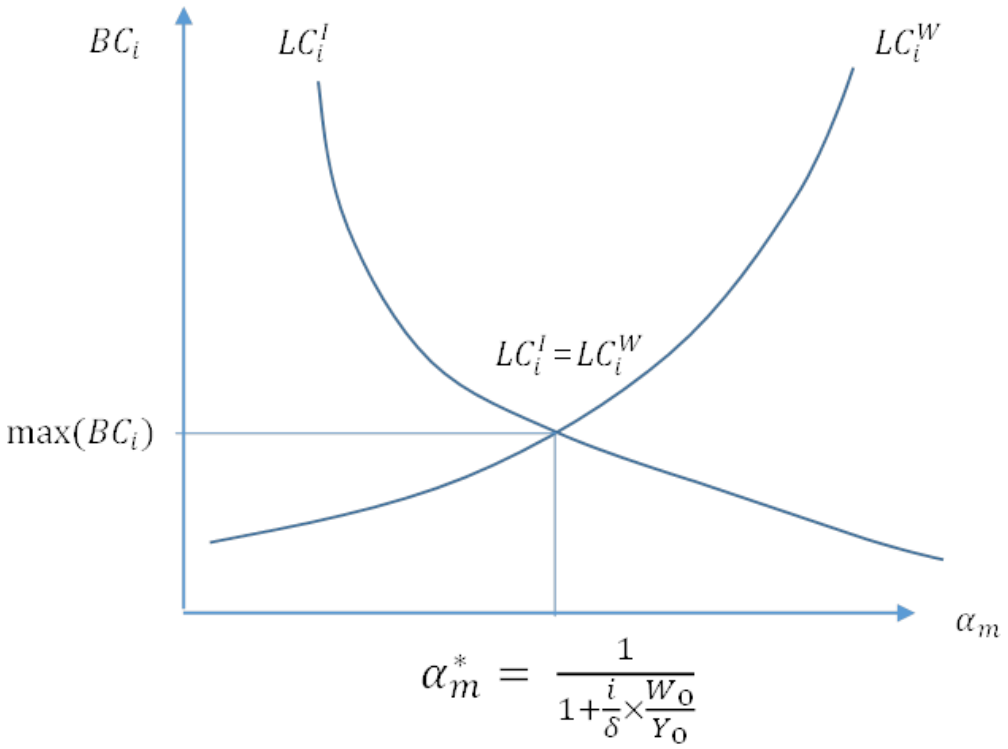
$$BC_i = \min\left(LC_i^I \ , \ LC_i^W\right)$$

$$LC_i^I = \frac{\delta \times I_0}{i \times \alpha_m} \qquad \text{and} \qquad LC_i^W = \frac{W_0}{1-\alpha_m}$$

$$\text{Maximize } BC_i = \text{Maximize } [\min\left(LC_i^I \ , \ LC_i^W\right)]$$

Based on the summary statistics from our testing sample (for mortgage interest rate, household income and wealth, and mortgage payment amount), the optimal levels computed are 0.83 and 0.71 for young- and old-cohort respectively (when the mortgage interest rate is 2.5 percent), which go down to 0.68 and 0.51 when the interest rate increases to 6.5 percent. We plan to perform further analysis on this topic through future research.

Figure 3. Determining the optimal LTV level



		young	old
	average(i)	0.0523	0.0488
	average(mdpr)	0.35	0.35
	average(Inc)	275.06	268.44
	average(wealth)	9246.65	18091.02
@2.5%	LTV* = 1/[1+(i/mdpr) *(W0/Y0)]	**0.83**	**0.71**
	V* = W0 +(mdpr/I)*Y0	13097	21849
@6.0%	LTV* = 1/[1+(i/mdpr) *(W0/Y0)]	**0.68**	**0.51**
	V* = W0 +(mdpr/I)*Y0	10851	19657

5. Concluding remarks

To our knowledge, this study offers the first-ever empirical evidence obtained from a micro household-level data on the effects of borrowing constraints on the tenure decision. Our results indicate that: the lending restrictions exhibit negative effects on the propensity to own, which are also shown to increase for younger borrower cohorts. In addition, despite the fact that the residential mortgage lending sector of the country experienced a substantial growth during our study period (2006 to 2014), the effects of the wealth constraints are shown to increase over time, particularly for the younger borrowers. Although we conjecture that the more binding lending restrictions combined with the location-based regulatory controls in the country would a possible cause, a further theoretical and empirical investigation is warranted for this outcome as well as other related consumer behavior such as the optimal mortgage (or LTV) demand for different consumer cohorts.

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Table 1. Variable Description

Variable	definition
Ownership	Binomial variable (home owner=1, rent = 0)
e_ln_h_inc	Estimated log of permanent income
own_to_rent	Ratio of owner's cost to rent cost (calculated based on individual region and year)
f_size	Family size of household
Age	Age of house head
sex	Sex of house head
degree_gap_i	Degree of income constraint (unconstrained =0, moderately constrained =1, highly constrained =2)
degree_gap_w	Degree of wealth constraint (unconstrained =0, moderately constrained =1, highly constrained =2)
year_degree_gap_w	Combined variable = 'year' X 'degree_gap_w'
h_type	House type
year	Year of survey (2006, 2010, 2014)
young	Young cohort (house head under 40 years old =1)
young_gap_w	Combined variable = 'young' X 'degree_gap_w'
old	Old cohort (house head over 40 years old =1)
old_gap_w	Combined variable = 'old' X 'degree_gap_w'
ln_h_price	Log of house price
region	Region of household (17 regions at city and province level)
education	Degree of education (elementary=1, middle=2, high=3, over university degree=4)
job_type	Type of employment status
occu	Occupation of house head

Table 2. Summary statistics

Variable	Obs	Mean	Std.	Min	Max
1.ownership	83406	0.592919	0.4912931	0	1
h_type					
2	83406	0.1534062	0.3603808	0	1
3	83406	0.0362924	0.1870177	0	1
4	83406	0.4439249	0.4968486	0	1
5	83406	0.0532815	0.2245957	0	1
6	83406	0.0731122	0.2603222	0	1
7	83406	0.0090281	0.0945871	0	1
8	83406	0.0074815	0.0861719	0	1
9	83406	0.0016546	0.0406428	0	1
10	83406	0.0015946	0.0399009	0	1
ln_h_price	48539	9.268668	1.042125	2.995732	12.9088
e_ln_h_inc	56516	5.466616	0.5123307	2.87508	7.143465
Year					
10	83406	0.395655	0.4889939	0	1
14	83406	0.2422488	0.4284466	0	1
Region					
2	83406	0.0661943	0.2486229	0	1
3	83406	0.0543006	0.2266114	0	1
4	83406	0.0582692	0.2342532	0	1
5	83406	0.0409563	0.1981902	0	1
6	83406	0.0420473	0.2006984	0	1
7	83406	0.0337506	0.1805875	0	1
8	83406	0.0038367	0.0618222	0	1
9	83406	0.1758027	0.3806545	0	1
10	83406	0.0414958	0.1994352	0	1

11	83406	0.0395655	0.1949372	0	1
12	83406	0.0460758	0.2096506	0	1
13	83406	0.0452725	0.2079025	0	1
14	83406	0.0478862	0.2135268	0	1
15	83406	0.0488094	0.2154707	0	1
16	83406	0.0477064	0.2131456	0	1
17	83406	0.0238232	0.152499	0	1
owncost_area	48098	7.736621	8.293819	0	184.8678
rent_area	22573	7.203583	8.090777	0.0139615	210.0214
f_size	83406	2.890416	1.331889	1	15
Age	83366	53.37756	15.50594	1	102
2.sex	83405	0.1949164	0.3961387	0	1
ln_h_inc	78525	5.265641	0.8389927	0	9.98276
ln_n_wealth	75793	8.914933	1.487328	0	15.6238
Edu					
2	83252	0.1214866	0.3266938	0	1
3	83252	0.3408447	0.4739961	0	1
4	83252	0.3293374	0.4699755	0	1
job_type					
2	69852	0.1277272	0.3337882	0	1
3	69852	0.1701598	0.3757758	0	1
4	69852	0.1331386	0.3397269	0	1
5	69852	0.1180925	0.32272	0	1
own_to_rent	83406	1.138625	0.7376799	0	2.872797

Occu					
2	61952	0.1110699	0.3142212	0	1
3	61952	0.1870642	0.3899662	0	1
4	61952	0.1644822	0.3707155	0	1
5	61952	0.0845332	0.278188	0	1
6	61952	0.1128131	0.3163668	0	1
7	61952	0.1217878	0.3270432	0	1
8	61952	0.1680979	0.3739562	0	1
9	61952	0.0090877	0.0948959	0	1
Young	83406	0.2136537	0.4098876	0	1
degree_gap_i					
2	83406	0.0747308	0.2629581	0	1
3	83406	0.3350358	0.4720058	0	1
degree_gap_w					
2	83406	0.0480781	0.2139325	0	1
3	83406	0.4550752	0.4979807	0	1

Table 3. Permanent income estimation

$$ln\_h\_inc = f(f_{size}, age, age^2, ln_{wealth}, D_{region}, D_{education}, D_{occupation}, D_{job\ type}, D_{sex})$$

VARIABLES	ln_h_inc
f_size	0.0910***
	(0.00199)
age	0.0381***
	(0.00137)
age2	-0.000438***
	(1.39e-05)
ln_wealth	0.174***
	(0.00211)
2.region	-0.0561***
	(0.00920)
3.region	-0.0954***
	(0.00961)
4.region	-0.0612***
	(0.00918)
5.region	-0.0352***
	(0.0107)
6.region	-0.0392***
	(0.0103)
7.region	0.0695***
	(0.0109)
8.region	-0.117***
	(0.0347)
9.region	-0.0480***
	(0.00657)
10.region	-0.0233*
	(0.0123)
11.region	0.00462

	(0.0112)
12.region	-0.0231**
	(0.0108)
13.region	-0.0588***
	(0.0122)
14.region	-0.0640***
	(0.0125)
15.region	-0.0642***
	(0.0106)
16.region	-0.0819***
	(0.0103)
17.region	0.153***
	(0.0166)
2.edu	0.170***
	(0.0108)
3.edu	0.275***
	(0.0104)
4.edu	0.403***
	(0.0114)
2.occu	-0.0506***
	(0.0114)
3.occu	-0.154***
	(0.0105)
4.occu	-0.176***
	(0.0112)
5.occu	-0.176***
	(0.0126)
6.occu	-0.535***
	(0.0153)
7.occu	-0.175***
	(0.0113)
8.occu	-0.219***
	(0.0117)
9.occu	-0.0441**

	(0.0197)
2.job_type	-0.136***
	(0.00756)
3.job_type	0.0285***
	(0.00713)
4.job_type	0.0803***
	(0.00742)
5.job_type	0.00341
	(0.0360)
2.sex	-0.142***
	(0.00762)
Constant	2.834***
	(0.0355)
Observations	56,273
R-squared	0.533

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Estimation of the optimal housing price equation (HV^*)

$$ln\_h\_price = f(e\_ln\_h\_inc, age, f\_size, D_{education}, D_{sex}, , D_{house\ type}, D_{region}, D_{occupation}, D_{job\ type}, own\_to\_rent)$$

→ estimate '$\overline{\ln\_h\_price}$' based on households with no borrowing constrained

VARIABLES	ln_h_price
e_ln_h_inc	2.262***
	(0.0240)
age	0.0206***
	(0.000361)
f_size	-0.169***
	(0.00400)
2.edu	-0.383***
	(0.0155)
3.edu	-0.536***
	(0.0163)
4.edu	-0.642***
	(0.0198)
2.sex	0.325***
	(0.0127)
2.h_type	0.416***
	(0.0161)
3.h_type	0.496***
	(0.0227)
4.h_type	0.308***
	(0.0111)
5.h_type	-0.0874***
	(0.0144)
6.h_type	-0.0272**
	(0.0139)

7.h_type	0.436***
	(0.0503)
8.h_type	0.234***
	(0.0555)
9.h_type	-1.100**
	(0.435)
10.h_type	-0.897***
	(0.306)
2.region	-0.365***
	(0.0117)
3.region	-0.262***
	(0.0125)
4.region	-0.225***
	(0.0119)
5.region	-0.609***
	(0.0140)
6.region	-0.394***
	(0.0135)
7.region	-0.678***
	(0.0136)
8.region	-0.0925*
	(0.0537)
9.region	-0.184***
	(0.00959)
10.region	-0.743***
	(0.0193)
11.region	-0.755***
	(0.0183)
12.region	-0.681***
	(0.0181)
13.region	-0.819***
	(0.0183)
14.region	-0.771***
	(0.0184)

15.region	-0.653***
	(0.0161)
16.region	-0.431***
	(0.0153)
17.region	-0.996***
	(0.0216)
2.occu	0.0804***
	(0.0137)
3.occu	0.285***
	(0.0134)
4.occu	0.310***
	(0.0146)
5.occu	0.322***
	(0.0161)
6.occu	0.753***
	(0.0250)
7.occu	0.284***
	(0.0147)
8.occu	0.379***
	(0.0157)
9.occu	0.0624*
	(0.0378)
2.job_type	0.299***
	(0.0115)
3.job_type	-0.121***
	(0.00877)
4.job_type	-0.0908***
	(0.0102)
5.job_type	0.128***
	(0.0465)
own_to_rent	-0.0480***
	(0.00374)
Constant	-3.375***
	(0.132)

Observations	30,054
R-squared	0.719

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix: Results of the specification tests

Table A.1. Results of Panel Regression (1)

VARIABLES	(1) ownership	(2) ownership	(3) ownership	(4) ownership
e_ln_h_inc	1.082***	0.141***	0.130***	0.117***
	(0.0206)	(0.0241)	(0.0242)	(0.0241)
own_to_rent	-0.150***	-0.115***	-0.113***	-0.111***
	(0.00854)	(0.00901)	(0.00916)	(0.00915)
f_size	0.0160**	0.148***	0.149***	0.152***
	(0.00647)	(0.00714)	(0.00716)	(0.00713)
Age	0.0580***	0.0443***	0.0444***	0.0436***
	(0.000662)	(0.000722)	(0.000725)	(0.000712)
2.sex	-0.00539	-0.152***	-0.151***	-0.160***
	(0.0203)	(0.0223)	(0.0225)	(0.0225)
2.degree_gap_i		-0.127***	-0.138***	
		(0.0232)	(0.0229)	
3.degree_gap_i		-0.0868***	-0.121***	
		(0.0252)	(0.0248)	
2.degree_gap_w		-0.843***	-0.623***	
		(0.0236)	(0.0344)	
3.degree_gap_w		-1.711***	-1.440***	
		(0.0234)	(0.0320)	
1.y14_degree_gap_w			-0.307***	-0.277***
			(0.0207)	(0.0201)
2.y14_degree_gap_w			-0.666***	-1.263***
			(0.0616)	(0.0539)
3.y14_degree_gap_w			-0.920***	-2.340***
			(0.0570)	(0.0522)
1.y10_degree_gap_w			-0.245***	-0.232***
			(0.0177)	(0.0175)
2.y10_degree_gap_w			-0.634***	-1.263***
			(0.0490)	(0.0398)

3.y10_degree_gap_w			-0.635***	-2.090***
			(0.0401)	(0.0340)
0o.y6_degree_gap_w			-	-
2o.y6_degree_gap_w			-	-0.648***
				(0.0342)
3o.y6_degree_gap_w			-	-1.481***
				(0.0312)
2.h_type	-1.414***	-0.866***	-0.867***	-0.895***
	(0.0233)	(0.0265)	(0.0266)	(0.0261)
3.h_type	-0.985***	-0.479***	-0.484***	-0.512***
	(0.0325)	(0.0366)	(0.0364)	(0.0360)
4.h_type	-0.369***	-0.127***	-0.127***	-0.140***
	(0.0208)	(0.0219)	(0.0222)	(0.0221)
5.h_type	-0.400***	-0.313***	-0.322***	-0.324***
	(0.0308)	(0.0322)	(0.0323)	(0.0323)
6.h_type	-0.512***	-0.356***	-0.362***	-0.367***
	(0.0275)	(0.0292)	(0.0295)	(0.0295)
7.h_type	-1.091***	-0.569***	-0.570***	-0.595***
	(0.0597)	(0.0656)	(0.0661)	(0.0659)
8.h_type	-1.300***	-0.923***	-0.946***	-0.959***
	(0.0989)	(0.105)	(0.104)	(0.103)
9.h_type	-1.177***	-1.340***	-1.329***	-1.320***
	(0.223)	(0.238)	(0.237)	(0.235)
10.h_type	-1.083***	-1.182***	-1.186***	-1.183***
	(0.198)	(0.197)	(0.195)	(0.195)
10.year	-0.361***	-0.338***		
	(0.0145)	(0.0159)		
14.year	-0.410***	-0.412***		
	(0.0170)	(0.0190)		
Constant	-7.605***	-2.081***	-2.092***	-2.013***
	(0.117)	(0.137)	(0.137)	(0.136)
Observations	56,516	56,516	56,516	56,516

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A.2. Results of Panel Regression (2)

VARIABLES	(1) ownership	(2) ownership	(3) ownership	(4) ownership
e_ln_h_inc				0.133***
				(0.0249)
own_to_rent	-0.0881***	-0.0674***	-0.0674***	-0.115***
	(0.00676)	(0.00658)	(0.00658)	(0.00901)
f_size	0.0455***	0.0562***	0.0562***	0.147***
	(0.00423)	(0.00419)	(0.00419)	(0.00715)
age				0.0435***
				(0.00102)
2.sex	-0.192***	-0.193***	-0.193***	-0.155***
	(0.0133)	(0.0132)	(0.0132)	(0.0224)
2.degree_gap_i				-0.127***
				(0.0232)
3.degree_gap_i				-0.0855***
				(0.0252)
2.degree_gap_w				-0.844***
				(0.0236)
3.degree_gap_w				-1.715***
				(0.0237)
young				-0.0265
				(0.0221)
2.h_type	-1.056***	-0.998***	-0.998***	-0.866***
	(0.0166)	(0.0165)	(0.0165)	(0.0265)
3.h_type	-0.772***	-0.712***	-0.712***	-0.479***
	(0.0262)	(0.0258)	(0.0258)	(0.0366)
4.h_type	-0.384***	-0.368***	-0.368***	-0.126***
	(0.0137)	(0.0136)	(0.0136)	(0.0219)
5.h_type	-0.438***	-0.405***	-0.405***	-0.313***
	(0.0236)	(0.0235)	(0.0235)	(0.0322)
6.h_type	-0.585***	-0.555***	-0.555***	-0.356***

	(0.0209)	(0.0208)	(0.0208)	(0.0292)
7.h_type	-0.815***	-0.789***	-0.789***	-0.568***
	(0.0486)	(0.0483)	(0.0483)	(0.0656)
8.h_type	-1.499***	-1.471***	-1.471***	-0.921***
	(0.0809)	(0.0807)	(0.0807)	(0.105)
9.h_type	-1.403***	-1.359***	-1.359***	-1.341***
	(0.131)	(0.126)	(0.126)	(0.238)
10.h_type	-1.415***	-1.348***	-1.348***	-1.183***
	(0.141)	(0.141)	(0.141)	(0.197)
10.year	-0.361***			-0.339***
	(0.0116)			(0.0159)
14.year	-0.237***			-0.412***
	(0.0132)			(0.0190)
1.young_gap_w	-0.814***	-0.778***	-0.778***	
	(0.0164)	(0.0161)	(0.0161)	
2.young_gap_w	-1.601***	-1.521***	-1.521***	
	(0.0368)	(0.0365)	(0.0365)	
3.young_gap_w	-2.108***	-2.036***	-2.036***	
	(0.0232)	(0.0230)	(0.0230)	
0o.old_gap_w	-	-	-	
2.old_gap_w	-0.980***	-0.945***	-0.945***	
	(0.0271)	(0.0271)	(0.0271)	
3.old_gap_w	-0.794***	-0.755***	-0.755***	
	(0.0119)	(0.0117)	(0.0117)	
Constant	1.530***	1.224***	1.224***	-1.985***
	(0.0214)	(0.0187)	(0.0187)	(0.158)
Observations	83,405	83,405	83,405	56,516

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1