Housing Investment in Urban China: Evidence from Chinese Household Survey[♦]

Yujin Cao[♣], *Jidong Chen*[♣], *Qinghua Zhang*[♠]

December 15, 2016

Abstract

What explains the rapidly increasing housing investment demand in China? This paper conjectures that higher expected housing capital gains drive higher investment demand. Due to the financial frictions prevalent in China, such demand takes place not only through households' owning multiple houses, but also through their owning a larger primary living residence if they are constrained from buying multiple houses. We develop a simple framework to study how expected capital gains impact households' housing investment decisions when subject to financial constraints. Our empirical findings, based on 2010 and 2011 household survey data, are consistent with our theoretical predictions. Specifically, we find that (1) households are more likely to own multiple houses when expecting higher capital gains; (2) the primary housing demand of those households who are constrained from owning multiple houses increases with the expected capital gains; while (3) the primary residence demand of those who are not constrained does not increase with the expected capital gains. Furthermore, we find that wealthier households are more sensitive to changes in expected capital gains. Specifically, the marginal effect of capital gains on housing investment is higher for wealthier households. This links the booming housing market to widening income inequality which is a typical growth pain in a developing country like China.

JEL Code: O12, O18, R1, R21

Key Words: Housing investment, Financial Friction, Expected Capital Gains, Chinese Housing Market

♦ We would like to thank the editor and two reviewers for very useful suggestions and comments. We would also like to thank Hongbin Cai, Jimmy Chan, Edward Coulsen, Shihe Fu, Vernon Henderson, Yi Lu, Mingzhe Tang, Matthew Turner, Jianfeng Wu, Siqi Zheng, Guozhong Zhu, and seminar participants at Business School of Beijing Normal University, Fudan School of Economics and Wenlan School at Zhongnan University of Economics and Law for helpful comments and suggestions. Zhang acknowledges support from China's Natural Science Foundation Grant #71273017. Any remaining errors are our own. The views expressed in the paper are those of the authors and do not necessarily represent those of the authors' affiliated institutions.

♣ Institute of Economic Research, National Development and Reform Commission. Email: caoyujin777@126.com.

♣ Business School, Beijing Normal University. Email: gdongchen@gmail.com

♠ Guanghua School of Management and IEPR, Peking University. Correspondence: zhangq@gsm.pku.edu.cn

1 Introduction

The privatization reform of the housing sector in 1998 triggered the rapid development of real estate markets in urban China. Since the early 2000s, the unit price of residential housing across 35 major Chinese cities has been growing at an average annual rate of 9.29%[1]. In particular, for those cities whose price levels were in the top 90 percentile in 2002, the average housing price increased from 5,168 RMB per square meter in 2002 to 25,564 RMB per square meter in 2013, an average increase of 15.6% per year. Furthermore, the housing price appreciation has accelerated in recent years, reaching an annual rate of 18.7% between 2006 and 2013 for those top 90 percentile cities.

This fast growth in housing prices could be driven by rising demand. On the one hand, the privatization reform released huge consumption demand for housing services which were previously filled by old and uncomfortable subsidized housing provided by work units. The massive urbanization process also brings out tremendous consumption demand as well. On the other hand, households in China often buy extra-large primary living houses and/or buy a second or a third house for investment purposes. Such investment demand causes wide concern because it may lead to overly hot housing markets and increase the risk of housing bubbles. This is especially relevant in a fast-growing economy like China's where real estate investment accounts for approximately 22% of the total fixed asset investment of the whole economy. Therefore, a better understanding of both the driving force behind housing investment and its available channels bears important policy implications.

This paper studies housing investment in urban China. We show that higher expected capital gains drive higher investment demand. Due to the financial frictions prevalent in China, such demand takes place not only through households' owning multiple houses, but also through their owning a larger primary living residence if they are

[1]The calculation is based on the quality-controlled housing price indices released by Tsinghua University's Hang Lung Center for Real Estate.

constrained from buying multiple houses. There have been few works in the literature that study both of these channels of housing investment and provide empirical evidence.

There has been substantial research on China's urban housing markets (e.g., Wu, et al., 2012 and Wang and Zhang, 2014). However, there are few studies on housing investment demand based on micro-level data (especially household survey data) in the literature except for Gan (2014) and Coulson and Tang (2013). Both of the above-mentioned papers focus on just one channel of investment, i.e., owning multiple houses. Moreover, they do not study expected capital gains—a key driving force behind housing investment.

This paper fills in the gap by studying both the driving force behind housing investment and its available channels based on 2010 and 2011 household survey data of China. Specifically, we address three main questions. The first question is how much the expected capital gains influence housing tenure choices. The second question is, when there are higher expected capital gains with financial friction, whether households increase housing investment through the channel of owning multiple housing units or through the channel of owning a larger primary living residence. The third question is which group of owners has a greater capital-gain effect on housing investment. Since sensitivity to expected capital gains is a prominent feature of housing investment, the answers to the above questions will help provide evidence of both the magnitude and composition of housing investment.

We first develop a simple model to illustrate households' housing tenure choices and investment portfolio decisions when there is a financial constraint. Our model generates three main testable predictions: 1) A household's likelihood of owning multiple housing units increases in response to higher capital gains. 2) For those households who only own their primary residence, their demand for primary housing increases with the expected capital gains. The intuition for this is that those

households are constrained from buying a second house, so their extra investment demand, induced by higher expected capital gains, would be diverted into greater investment in primary housing. 3) Among those who already own more than one housing unit, the demand for primary residence does not increase with the expected capital gains, while the additional demand for other houses does increase with the expected capital gains. This is because those households are less constrained from investing in multiple housing units and are already satisfied with their primary residence. Therefore, as the expected capital gain increases, they will invest more in extra housing units to fulfill their investment purpose. In addition, the theoretical model also demonstrates that the expected-capital-gain effect is stronger for wealthier households. Specifically, an increase in expected capital gain makes a wealthier household more likely to own multiple housing units, or to own a larger residence unit if the tenure status remains unchanged. In other words, for the households with only one housing unit whose tenure status is unaffected by the increased expected capital gain, the increased demand for primary residence is higher among richer households.

To test the main implications, we use both the 2010 household survey data provided by the Institute of Social Science Survey at Peking University and the 2011 China Household Finance Survey provided by the Survey and Research Center for China Household Finance at Southwestern University of Finance and Economics. For our research purposes, we use only the sub-sample of urban households in 19 major cities nationwide for which we have historic housing price information.

We measure households' expectation of future housing capital gains by using the average price growth rate in the three years just before they purchase a primary residence.[2]Our data provides the purchase-year information for households' primary residence. Case (2000) and Piazzesi and Schneider (2009) study households' subjective views about housing and the economic environment using the U.S. survey

[2]For renters, we use the average growth rate in the three years just before the survey year to measure their expectation.

data. Case finds that households tend to hold a more optimistic view regarding housing prices around the peaks of the past housing booms in the U.S. Piazzesi and Schneider show that during the late phase of the last housing boom in the U.S. (after 2004), more households became optimistic about future housing price appreciation after observing that housing prices had gone up for several consecutive years. Consistent with their findings, we assume that households form adaptive expectations of future returns based on the housing appreciation rate prior to the purchase year of the primary residence. As robustness checks, we assign different weights to different years prior to the purchasing year in calculating the expected capital gains in our empirical analysis.

In their study of housing investment, Dusanski and Koc (2007) use the housing price in the survey year to measure the expected return on housing investment, assuming the expected future return has been capitalized into the current housing price. When there are transaction costs[3] in housing markets (such costs are high in China), households cannot freely adjust their housing investments, especially their primary residence. Because of this, expectations formed in the purchase year of the primary residence are likely to be more influential on the demand for a primary residence than the price in the survey year. In addition, because different households may purchase primary residences indifferent years, there are variations in the expected returns calculated based on purchase year even for households in the same city in the same survey year. This enables us to control for a city fixed effect, which addresses many city-specific factors such as the current city-level housing price and rent, and the costs of owning and maintaining houses in the city.

We first study the effect of expected capital gains on households' tenure choices, which is measured in three discrete categories: renters, owners who own just one housing unit and owners who own more than one housing unit. We then investigate

[3]These costs include not only transaction fees and moving costs, but also institutional barriers aiming to prevent speculative transactions.

their housing demand separately, aiming to understand the channels of housing investment. We calculate the housing demand by dividing the housing value by each city's hedonic housing price level as provided by Tsinghua University's Hang Lung Center for Real Estate. The demand measure thus obtained controls for the housing quality factor and is more accurate.

The major findings are: 1) Households are more likely to own multiple houses if the expected capital gains from housing investment are higher; an increase of one standard deviation in the expected capital gains will increase the likelihood of owning multiple housing units by 3.54%. Moreover, the value of housing assets other than the primary residence increases significantly with capital gains.2) For homeowners who own just one housing unit, the expected capital gains have a positive effect on their demand for primary housing; an increase of one standard deviation in the expected capital gains will cause the demand for primary housing to increase by 11.51%. 3) The demand for primary housing among home owners who own multiple housing units does not increase with the expected capital gains. In sum, in response to an increase in expected price, households increase their housing investments not only through owning multiple housing units but also through owning a larger primary residence if they are constrained from owning multiple housing units. The results are consistent with our theoretical predictions.

Furthermore, we find that the capital-gain effect on housing investment becomes much greater for wealthier households who have stronger investment needs and are less likely to be financially constrained. Specifically, among households whose predicted net wealth is above the 50^{th}percentile of all households, the likelihood of owning multiple housing units increases by 7.97% in response to an increase of one standard deviation in expected capital gains. Such an increment is higher than the average effect of the whole sample which, as mentioned above, was 3.54%. Similarly, for households who own just one housing unit, when there is a one-standard-deviation increase in expected capital gains, their subdued investment need will be diverted into

greater demand for a primary residence which will in turn increase by 15.9%. Such an increment is also higher than the effect of the whole sample (i.e., 11.51%).

Related Literature This paper is related to the literature on optimal portfolio choices in the presence of housing (e.g., Flavin and Yamashita, 2002, Fischer and Stamos, 2013, and Corradin et al., 2014).This class of literature studies how a representative household chooses between housing investment and investment in other risky financial assets assuming exogenous house prices. Following Kiyotaki et al. (2011), Sommer et al. (2013), Iacoviello and Pavan (2013), our theoretical framework imposes a borrowing constraint on households. We also emphasize that housing investment takes place not only through households' owning multiple houses, but also through their owning a larger primary living residence if they are constrained from buying multiple houses. That means in our theoretical model, the household can choose to buy either one housing unit or multiple ones.

In addition, we also incorporate another important feature of China's real estate market: the minimum size constraint of housing units. Although these features are not unique to China, together they play a very important role in shaping the pattern of housing market outcomes given China's peculiar institutional background. Our model's inclusion of these three features enriches the applicability of the classical models and helps build an analytical framework that is more suitable for the study of housing markets in China. The latter two features of the above three make the household's optimization problem deviate from the standard convex optimization in housing investment. Technically, now it is the optimization of a non-connected (or non-convex) space. The addition of the financial friction constraint further complicates such an optimization. Luckily, even with such technical challenges, we are able to analytically demonstrate the main results concerning the expected-capital-gain effect.

Few works in the current literature study housing markets with both financial frictions and the choice of owning one or multiple units. Dusanski and Koc (2007) investigate the capital-gain effect on housing demand in the U.S. They show that increases in the expected capital gains positively influence the owner-occupied housing investment. However, neither their model nor their empirical analysis studies the choice of owning multiple houses. Coulsen and Tang (2013) study how various household characteristics influence housing investment through owning multiple housing units. Gan (2015) calculates the housing vacancy rate for different cities using information on owners of multiple housing units. Our paper complements their work by showing that under financial constraints, the investment need may be met by demanding a larger primary residence instead of owning multiple houses. As such, it may lead to misallocation of resources in real estate development as developers may build more large houses than is socially efficient.

This paper also complements the classic literature on household tenure choices and housing demand by studying an important driving factor of housing investment demand, that is, individual households' expectations of future capital gains. For example, Henderson and Ioannides (1983) develop a model of housing tenure choice and in several subsequent papers (1986, 1987) they estimate housing tenure choice and housing demand as joint decisions. Ioannides and Rosenthal (1994) estimate housing tenure status using an ordered probit model and examine both consumption demand and investment demand. However, none of the above works investigate the effect of expected housing capital gains on household demand.

Finally, our paper has broad implications for the relationship between housing markets and wealth inequality. Favilukis (2016) and Zhang (2016) offer a linkage between housing price formation and income inequality. Our empirical analysis provides some micro-level evidence. Our results suggest that wealthier households have stronger investment incentives for housing, which implies that investment motivation among wealthy households will play a key role in the formation of future

housing prices. This links the booming housing market to a widening wealth and income inequality which is a typical growth pain in a developing country like China.

The rest of the paper is organized as follows. Section 2 presents the model and the analytical results. Section 3 describes the data. Section 4 contains empirical analysis. Section 5 concludes.

2 Theoretical Framework

In this section, we build a theoretical model to characterize a household's housing demand and tenure choices. Our model incorporates frictions such as minimum house size and down-payment requirements in the housing market. Under some appropriate assumptions, we characterize the optimal choice and the comparative statics, based on which we derive three testable predictions.

2.1 Model Setup

Following Henderson and Ioannides(1983), we assume that a representative household (henceforth *she* or *her*) lives for two periods. The household's first period utility *c* depends on the consumptions of both a numeraire non-housing good *x* and the primary residence housing services h_c. The second period utility $V(\bullet)$ is a function of the household's net wealth, which depends on her investment decision. Her total utility is thus $u(\mathrm{x}, h_c)+V(\bullet)$.[4] The household has initial wealth $w>0$ in the first period and income $y>0$ in the second period. For simplicity, we assume that the first-period utility is separable in consumption and housing consumption, namely, $u(\mathrm{x}, h_c)=\phi_1(x)+\phi_2(h_c)$.

We assume that $\phi_i(\bullet):(0,+\infty)\to\mathbb{R}$ is a continuously differentiable, strictly increasing

[4]In general, the utility could be written as $u(\mathrm{x}, h_c)+\beta V(\bullet)$, where $\beta\in(0,1]$ is the discount factor. The introduction of β does not qualitatively change the main results of the comparative statics.

and strictly concave function with $\lim_{x\to 0^+}\phi_i'(x)=+\infty$ and $\lim_{x\to+\infty}\phi_i'(x)=0$, for i=1,2. $V(\bullet)$ is a continuously differentiable, strictly increasing and weakly concave function. Throughout the benchmark model, we focus on a quasi-linear environment, i.e., $V(x)=x$.[5]

We use h_I to denote the total amount of housing investment. Throughout the model, we assume that the household can choose to rent a house without owning one, or to own one or more housing units.[6]

(I) To rent a house, a renter chooses numeraire non-housing consumption x, housing consumption h_c and savings q_0 to maximize her two-period utility. In the second period, a renter's total wealth is $(1+r)q_0+y$, where r is the interest rate. Formally, we have

$$\max_{x\geq 0,h_c\geq 0,q_0} u(\mathrm{x},h_c)+E[V((1+r)q_0+y)]$$
$$s.t.\ \ x+sh_c+q_0\leq w$$

(II) To buy house(s), a household faces a first-period budget constraint (Equation (1)) and a liquidity constraint (Equation (2)):

$$p_0h_I+x\leq w+s(h_I-h_c)-q_0,\quad(1)$$

$$(1-\delta)p_0h_I+q_0\geq 0.\qquad(2)$$

The left-hand side of the budget constraint includes the expenditure for total housing investment p_0h_I, and numeraire non-housing consumption x. The right-hand side of

[5] For a more generalized functional form of *V(.)*, we present simulation results in the Appendix demonstrating that the main results still hold in a reasonable parameter space.

[6] Our model can be extended to capture another option for households: renting a housing unit for residence while owning housing units in other places. Specifically, in the renter's choice we can allow her to also make an investment in owning housing units. However, adding this choice will complicate the analysis without adding further insight into the main predictions of the model.

the budget constraint includes the initial wealth w, the benefit of renting out the houses other than the primary residence $s(h_I - h_c)$,and the money she borrows from the bank $-q_0$.

The liquidity constraint reflects the fact that the initial payment $p_0 h_I - (-q_0)$ for the total housing investment must make up at least δ proportion of the total housing value $p_0 h_I$.[7] Throughout the paper, we assume that $\delta p_0 > s$ so that the requirement of the down-payment ratio is not negligible.

Because real estate developers must build housing units subject to a minimum-size constraint, a homeowner's housing asset must satisfy the feasibility constraint $h_c \geq \underline{h}$, and $h_I - h_c \geq \underline{h}$ if she owns additional houses (i.e., $h_I - h_c > 0$). $\underline{h} > 0$ is the minimum housing size available to buy.

In the second period, she can earn $p_1 h_I$ by selling the owned houses. p_1 as a random variable reflects the future price of the houses. She also needs to pay back the debt $(-q_0)$ to the bank with interest rate r. Therefore, her second period total wealth is $p_1 h_I + (1+r) q_0 + y$.

The household chooses non-housing good x, houses for primary residence h_c, total housing investment h_I, and bank loans q_0 to maximize her expected utility. Hence a house owner's optimization problem becomes:

$$\begin{aligned} &\max_{x \geq 0, h_c, h_I, q_0} u(x, h_c) + E[V(p_1 h_I + (1+r) q_0 + y)] \\ &s.t.\ \ p_0 h_I + x \leq w + s(h_I - h_c) - q_0, \\ &\quad (1-\delta) p_0 h_I + q_0 \geq 0, \\ &\quad h_c \in [\underline{h}, +\infty), \\ &\quad (h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty). \end{aligned}$$

[7] In China, buying a second house involves a higher down-payment ratio. We could incorporate this assumption in the model. However, this would make the optimization problem more complicated.

To make an optimal decision (on whether to be a renter, an owner of one house or an owner of more than one), a household compares the above two optimization problems and chooses the one with the highest utility.[8] We use $\{h_I^*, h_c^*, x^*, q_0^*\}$ to denote the household's optimal choice.

There are three possible types of tenure status in equilibrium. The household can be a renter that does not own any houses, i.e., $h_c^* > 0, h_I^* = 0$. She can also own a single house both for primary residence and investment, without making any other additional housing investments, i.e., $h_I^* = h_c^* \geq \underline{h}$. Furthermore, she can also own a house for her primary residence as well as other houses $(h_I^* - h_c^*)$ as additional investments, i.e., $h_c^* \geq \underline{h}$ and $h_I^* - h_c^* \geq \underline{h}$.

2.2 Characterizing the Tenure Choice and Housing Demand

In Proposition 1, we first characterize how tenure choice (i.e., whether to be a renter, to own just one housing unit, or to own more) is affected by price expectation. In the corollaries following the proposition, we further quantify the effect of expected capital gain and investigate how such an effect is shaped by financial frictions. Then in Propositions 2 and 3, we analyze the effect of price expectation on primary housing demand and investment demand for different types of housing demands.

Proposition 1 (Tenure Choice) A household's status on the tenure choice ladder is increasing in her expected capital gain $E(p_1)$. Specifically, there exist two cutoff points $k_1^* \geq k_0^* \geq (1+r)(p_0 - s)$ (which depend on minimum size $\underline{h}$, household wealth w and the down payment ratio δ), such that with a relatively lower expected capital gain, i.e., with $E(p_1) < k_0^*$, the household is a renter that owns no housing units;

[8] When the two optimization problems induce the same expected utility, we assume that she chooses the one with the highest housing investment.

with a moderate expected capital gain, i.e., with $k_0^* \le E(p_1) < k_1^*$, the household owns only one housing unit as her primary residence, i.e., $h_I^* = h_c^* \ge \underline{h}$; and with a relatively high expected capital gain, i.e., with $E(p_1) \ge k_1^*$, the household owns more than one unit, i.e., $h_I^* - h_c^* \ge \underline{h}$.

(See the Appendix for the proof.)

Proposition 1 demonstrates that a household's status on the tenure ladder is increasing in her expectation of future housing price. Expansion of housing demand takes various forms. Not only may a household choose a larger primary living residence, but she also may choose to own multiple houses. As her expected capital gain increases, she is more likely to be an owner than a renter, and is more likely to own more than one housing unit. The cost of buying a housing unit is p_0, whereas the benefit $\frac{E(p_1)}{1+r} + s$ is derived from the value of selling the unit in the future and the rental gain in the current period. When the expectation of future price is sufficiently low, e.g., $E(p_1) < (1+r)(p_0 - s)$, it is therefore not profitable to buy any housing unit. Thus $(1+r)(p_0 - s)$ is a lower bound of the cut-point k_0^* that separates renters and owners. The following corollary identifies a condition under which k_0^* reaches its lower bound and equals $(1+r)(p_0 - s)$.

Corollary 1 (Quantifying Tenure-Choice Cut-points)When the minimum size is not sufficiently large, i.e., $\underline{h} \le \min\{h_c^*, \frac{q_0^*}{\delta p_0 - s} - h_c^*\}$, where $\{h_c^*, q_0^*\}$ is a solution of the renter's problem, the lower cut-point reaches its minimum value, i.e., $k_0^* = (1+r)(p_0 - s)$; in addition, we also have $k_1^* > k_0^*$ if

$(\delta p_0 - s)\underline{h} + G(\underline{h}; \delta p_0 - s) < G(0; \delta p_0 - s)$, where

$G(x; A) = \underset{h_c \geq \underline{h}}{Max} \phi_1(w - (\delta p_0 - s)x - \delta p_0 h_c) + \phi_2(h_c) + Ah_c$.[9]

(See the Appendix for the proof.)

The above corollary shows that the cut-point k_0^* that differentiates renters from owners can reach its lower bound and equal $(1+r)(p_0 - s)$, provided that the minimum size is not sufficiently large. In this case, the equation stating that $E(p_1) = (1+r)(p_0 - s)$ serves as a no-arbitrage condition under which the household is indifferent between renting a housing unit and owning one. Furthermore, the corollary also quantifies a condition under which the proportion of owners having exactly one housing unit is not negligible, that is, the two cut-points do not trivially coincide with each other, i.e., $k_1^* > k_0^*$. The following corollary shows the role of financial friction in shaping the tenure choice.

Corollary 2 (Tenure-Choice, Financial Friction and Wealth)

(1) The borrowing constraint pulls the household's status downward along the tenure choice ladder. Namely k_1^* and k_0^* are weakly increasing in the down-payment ratio δ.

(2) The family wealth pulls the household's status upward along the tenure choice ladder. Namely k_1^* and k_0^* are strictly decreasing in the initial wealth w.

(See the Appendix for the proof.)

As the down-payment ratio becomes higher, the household faces a tighter borrowing constraint, so she is more likely to be pulled down along the tenure status ladder. In other words, with an increase in financial frictions, the proportion of households with multiple housing units shrinks; meanwhile the proportion of renters expands. The fact

[9]For example, when $\phi_1(x) = \phi_2(x) = \ln x$, $w < 2$ and δp_0 is sufficiently close to s, the condition $(\delta p_0 - s)\underline{h} + G(\underline{h}; \delta p_0 - s) < G(0; \delta p_0 - s)$ is satisfied.

that k_1^* and k_0^* are increasing in the down-payment ratio δ also suggests that the expected capital gain and the financial friction substitute for each other in determining the housing tenure choice. A household with a relatively higher expected capital gain might not make additional housing investments due to the relatively higher financial frictions. Instead, she may choose to improve her living condition by replacing the original residence with a larger one.

The second part of the corollary indicates that the initial wealth of the household and the financial frictions have opposite impacts on the tenure choice. As household wealth increases, the proportion of those holding multiple housing units increases. This is because an increase in wealth mitigates the distortion induced by financial friction so that the repressed investment demand gets partially released. Given the same increment of expected capital gain as the two cut-points move downward, the household is more likely to move upward along the tenure choice ladder. Specifically, the marginal effect of the expected capital gain on tenure choice is increasing in the wealth. In addition to financial friction and wealth, the minimum size requirement could also distort a household's incentive for investment. An increase in the minimum size requirement may force the household to divert the additional investment demand into buying a larger primary residence[10]. We characterize how the expected capital gain affects the housing demand of such a household in the following proposition.

Proposition2 (Expected-Capital-Gain Effect for Home Owners without Additional Investments) The demand of the house owners who don't have additional investments (i.e., $h_I^* = h_c^* \geq \underline{h}$) is weakly increasing in the expected price $E(p_1)$ and the wealth w. Furthermore, the expected-capital-gain effect is higher for wealthier households, i.e., $\frac{\partial h_I^*}{\partial E(p_1)}$ is weakly increasing in w, provided that $\phi_1''(\bullet)$ and $\phi_1''(\bullet)$ are strictly increasing.

(See the Appendix for the proof.)

[10]In Proposition 4 of the Appendix, we formally characterize how the tenure choice is affected by the minimum size requirement.

If the household has extra investment demand induced by higher expected capital gains, yet at the same time is prevented from buying a second house by requirements for minimum house size and down-payment, she will divert the additional investment demand into buying a larger primary residence. Proposition 2 shows that such a household's demand is jointly affected by her expectation of future price and her initial wealth. An increase of either factor can potentially drive up the residence demand, as long as the increment of the factor is not sufficiently large. According to Proposition 1 (and its corollaries), a sufficiently large increase of either expected price or wealth will make the household invest in another housing unit instead of remaining as *own1*. Furthermore, a wealthier household's response to an increase in expected capital gain is more sensitive. Specifically, the marginal effect of the expected capital gain is higher for wealthier households. It suggests that the expected capital gains and the wealth complement each other in shaping the housing demand.

Although we do not directly model the transition from owner to owner (i.e., selling the current housing unit and buying a large one to live in) in our theory, the comparative statics of the model helps us to understand such a transition. Suppose that originally the exogenous parameters of the model are such that the household owns only one housing unit. According to Propositions 1 and 2, if there is a positive shock (i.e., an increment) to family wealth (e.g., owning a fang-gai housing unit originally can be thought of as a subsidy leading to an increase in wealth), as long as such an increment is not large enough for the household to have sufficient financial ability to afford a second housing unit, she would choose to have a larger demand for primary residence housing. Substantively this can be interpreted as the action of upgrading, that is, selling the original fang-gai housing unit and buying a larger unit for residence. Empirically, we consider the impact of fang-gai housing on housing investment in Section 4.5.2.

In the following, we characterize the expected-capital-gain effect for households with multiple housing units.

Proposition 3 (Expected-Capital-Gain Effect for Households with Multiple Units)

(1) The total investment demand h_I^* of the households having multiple housing

investments (i.e., $h_I^* - h_c^* \geq \underline{h}$) is weakly increasing in the expected price $E(p_1)$.

(2) However, the residence demand h_c^* of such households is weakly decreasing in the expected price $E(p_1)$.

(See the Appendix for the proof.)

When the constraints of minimum house size and down-payment requirement do not prevent a household from buying a second house, the household's investment demand increases with the expected capital gains, as suggested by the above proposition. With an increase in the expected capital gain, she is not going to improve the primary residence because she is already satisfied with it. Instead, such a less-financially constrained household will invest more in extra housing units to fulfill her investment purpose.

3 Data

We use the 2010 household survey data provided by the Institute of Social Science Survey at Peking University and the 2011 household finance survey data supplied by the Survey and Research Center for China Household Finance at Southwestern University of Finance and Economics. The 2010 data covers 14,798 households and the 2011 data covers 8,438 households. All households are randomly selected from across the nation, including both rural counties and urban districts.

The 2010 survey data covers 25 provinces in mainland China, excluding Xinjiang, Tibet, Qinghai, Inner Mongolia, Ningxia and Hainan. The 25 provinces represent 94.5% of the total population in China, so the 2010 survey can be deemed to be a representative sample of mainland China. With similar sampling methods, the 2011 survey randomly and uniformly selects 80 municipalities from 2,585 municipalities nationwide. The municipalities in the sample cover 25 provinces in mainland China, excluding Xinjiang, Tibet, Fujian, Inner Mongolia, Ningxia and Hainan. This survey is also a representative sample of mainland China. We combined the two independent data sets by pooling all of their observations together in our regression analysis.

Regarding the housing information that is key to our analysis, the 2011 data includes a

variable indicating whether a household owns a housing unit or not (i.e., if she is a house owner or renter), and another variable representing the total number of housing units owned. The 2010 data includes a variable indicating the status of each household's primary residence unit. For example, the unit can be rented, owned by the household, or provided (by the government, employer, parents, or other relatives or friends) for free. We exclude those housing units provided for free by employers or relatives from our data set because these are not traded in the market. In addition, the 2010 survey asks the households how many extra housing units they own (if any). Notice that both data sets provide information on the purchasing year of each household's primary residence if the household is a homeowner.

For our research purposes, we use a sub-sample that includes only urban households in 19 major cities nationwide for which we have historic housing price information. Specifically, city-level housing price data is provided by Tsinghua University's Hang Lung Center for Real Estate, which reports the *hedonic prices* of residential housing for 35 major Chinese cities from 1998 through 2013.[11] The city coverage is the same as that of the housing price index published by China's National Statistic Bureau. One advantage of knowing this price is that housing quality is controlled for. During this time period, the mean hedonic price is 5,036 RMB. The average annual hedonic price growth rate is 7.76%. The mean of the hedonic price in survey years 2010 and 2011 is 7,783RMB and 8,843RMB respectively. Other city-level data such as the GDP per capita and population growth rate (both for the central city, called *Shixiaqu*) are from the Urban Statistical Yearbook published by China's National Statistic Bureau.

We merge the city-level data with the household survey data using each household's primary residence city and the year she purchased her primary residence. By doing so, we obtain the housing price and growth rate as well as other variables of city aggregate economy for the years around the primary residence purchase year for each homeowner.

[11]Note that 1998 is the year when China launched the privatization reform of housing markets.

There are a small number of households that rent one house while owning another house somewhere else. In our analysis, we exclude this small group because it is special and most of those households are in mega cities like Shanghai, Beijing, Hangzhou, and Shenzhen.[12]The remaining sample size is 2,851.In Table 1-b, for our working sample, we clearly specify the distribution of observations by city from each of the two data sets.[13]

The four statuses in our merged data are mutually exclusive. Note that *rent_own* has been excluded from our sample for analysis in Table 1-c. The table shows the sample distribution by tenure status. For the 2,851households sampled, 60% own only one house, 14.5% own more than one house and 25.5% are renters.

Furthermore, the data contains detailed housing information for homeowners. We know the floor area, purchase value and market value of each homeowner's primary residence, as well as the total number, total area and total market value of all the other housing units or apartments owned by the household if there are any. In particular, the survey data reports the purchase year of each homeowner's primary residence.

The data includes comprehensive information on each household's characteristics, including the survey year, gender, age, education level, Hukou status (urban Hukou vs. rural Hukou)[14] and marital status of the household head, household size, whether an elderly family member (aged over 60) is part of the household or not, whether the household includes a young child (aged below 6) or not, various categories of household income, assets and debts, and the geo-information about the household's current residence (which we refer to as the primary residence) such as the distance to the nearest bus stop and the time to the nearest shopping center.

[12]We will have more discussions and a robustness check in Section 4.5.3 to deal with such type of households.

[13]We did a robustness check by taking into account the differences between the two surveys and controlling the survey year effect in our regressions. Most of the main results are similar.

[14]In China, Hukou refers to the household registration system. If one is registered in the urban areas, she or heis said to have an urban Hukou; otherwise, she or he has a rural Hukou.

Table 1-a explains the meaning of the explanatory variables used in the regression equations. Table 2-a presents the summary of statistics for non-homeowners. Table 2-b presents the summary of statistics for homeowners. Compared to non-homeowners, homeowners have higher income and wealth, and are more likely to be married. Their families are larger, and their household heads are older. Homeowners are less educated than renters.[15] In addition, the percentage of households working in the government or in government-related institutions is higher for homeowners than for renters. Tables 2-c and Table 2-d report the summary statistics for homeowners with just one house and for those with multiple houses, respectively.

4 Empirical Analysis

In this section, we study the relationship between housing demand and expected capital gains. We first examine households' (discrete) tenure choices. We then investigate the continuous choice of housing demand by focusing on homeowners. Specifically, we break the owners into two tenure groups: one group consists of those who own only one housing unit (i.e., *own1*) and the other group consists of those who own more than one housing unit (i.e., *own2*). We investigate their housing demand separately, aiming to understand different channels of housing investment.

4.1 Housing tenure choice

4.1.1 Specification

In this part, we examine how a household's tenure choice is related to expected housing capital gains as well as to the household's characteristics. We first run a probit regression on the choice of whether to own a house or not. We then run an ordered probit regression incorporating the choice of owning multiple houses.

[15]In our sample, renters are relatively younger than homeowners. Therefore, they are more likely to enjoy the increased opportunity for college education after the mid-1990s reform. Note that after the mid-1990s, China substantially increased the college admission quota so that more high-school graduates could enter college.

We assume that each household forms an expectation of capital gains based on the weighted average of housing price growth rates in the three years before she purchases her primary residence. For homeowners, the survey data we use provides information on the purchase year of each household's primary residence. The purchase years range from 1998 to 2010. There are a few observations before 1998. We exclude them from the regressions because 1998 is the year when housing privatization reform was launched, which triggered the development of housing markets in a real sense. For non-homeowners, we calculate the expected capital gains as the weighted average of housing price growth rates in the three years before the survey year. Let $p_{t,c}$ denote the hedonic price in year *t* in city *c* where household i's primary residence is located. Let t_i denote the purchase year of household i's primary residence. The expectation of capital gains that household i holds is measured as

$$g_{ic} = 100 \bullet \frac{\sum_{k=0}^{2} (\ln p_{t_i-k,c} - \ln p_{t_i-k-1,c}) / (k+1)^{\varsigma}}{\sum_{k=0}^{2} \frac{1}{(k+1)^{\varsigma}}}, \qquad (3)$$

where g_{ic} is the weighted growth rate of housing prices, $\frac{1}{(k+1)^{\varsigma}}$ is the weighting factor, and k is the time lag from the purchase year. $\varsigma > 0$ means that the weighting decreases as time gets further away from the purchase year. $\varsigma < 0$ means that as time gets further away from the purchase year, the weighting increases. In our main regressions, we choose $\varsigma = 0.1$. We also try different values of ς as a robustness check.[16]

The probit regression specification is as follows:

[16] We try different weights $\varsigma \in [0.05, 0.2]$ to form capital gains expectations and re-run all the regressions. The results all show patterns that are fairly similar to those of our main regressions. Results are omitted from the paper in order to save space, however, they are available upon request.

$$TS_{ic} = \begin{cases} 1, \ if \ \ TS_{ic}^{*} = \alpha + \beta_1 g_{ic} + \beta_2 X_{ic} + \beta_3 Z_{ic} + \beta_4 W_{ic} + u_c + \varepsilon_{ic} > 0 \\ 0, \ otherwise \end{cases} \quad (4)$$

where *i* is the index for individual household and *c* is the index for the household's city of primary residence. TS_{ic} is a dummy variable indicating the tenure status of interest (i.e., *own1 or own2*) for household *i*, and g_{ic} is the household's expectation of capital gains as defined earlier. We control for the city fixed effect u_c in case some city factors simultaneously influence both the expected capital gains and the housing demand of individual households. Other controls are described below.

X_{ic} is a vector of household characteristics that may influence households' housing demand, such as income, wealth, family structure, and household head information. Income is the sum of wage income, rental income, interest income, pension and social security income, gift and other miscellaneous income. Wealth is total assets minus debt. Household total assets include housing assets, financial assets (the sum of bonds, stock shares, funds and bank deposits), insurance compensation to be paid and money lent out. Household debt includes borrowing from banks such as for mortgage loans, borrowing from informal financial sectors, borrowing from friends and relatives and other borrowing. Guided by our theory, the wealth measure as an explanatory variable should be total wealth net of various debts including mortgage. However, there is a potential endogeneity problem. Specifically, housing investment choice may affect net wealth. To deal with this problem, following the literature (e.g., Ioannides and Rosenthal, 1994; Dusanski and Koc, 2007), we first run an OLS regression of wealth on all the exogenous variables in our main regressions including some personal characteristics of the household head, such as age, sex, education, and body height.[17]We then use the predicted wealth *WHAT* as our measurement for family wealth in our main regressions.[18]

[17] Various findings in labor economics suggest that body height can be used to predict labor market performance and earnings (e.g., Persico, Postlewaite and Silverman, 2004, Case and Paxson, 2008).

[18]We also did a robustness check and directly use the wealth excluding housing assets as a measure. It does not

Family structure characteristics include family size, whether there are any family members aged over 60 living in the household and whether there are any children aged below 6 in the household. Household head characteristics include age, education, marital status (unmarried, married or cohabiting, divorced or widowed.) and Hukou status (i.e., urban Hukou or rural). We also control for a dummy variable indicating whether the household head works for the government or a government-related institution because government employees may have subsidies or privileges when buying primary residences in China (Fang, Gu and Zhou, 2014).

We use Z_{ic} to denote the hedonic housing price level of household *i*'s primary residence city *c* in the purchase year of the household's primary residence. This factor varies across different households in different cities. It is possible that there are some other city-wide time-varying factors that may influence both an individual household's housing investment demand and the city's housing price growth around the purchase year of the household's primary residence. Therefore, we include two additional controls in our regressions: one is the log of the city's GDP per capita in the purchasing year; the other is the city's population growth rate in the purchasing year. We use W_{ic} to denote the vector of these factors.

We do not include the survey year hedonic housing price or rental price at the city level in our benchmark analysis because we have controlled for the city fixed effect. Other city-level time-invariant cost factors related to owning houses such as taxes and mortgage loan interest are captured by the city fixed effect as well.

In addition to the probit regression, we also run an ordered probit regression following Ioannides and Rosenthal (1994). We break the housing tenure status into three ladders:

---

change the main results, although the significance of the effects becomes weaker.

renter, *own1* and *own 2*. The explanatory variables are the same as those in the previous probit regressions.

4.1.2 Findings

The results are shown in Table 3. In column 2, we can see which factors are important in a household's decision as to whether to purchase a home or not. First of all, the expected capital gains have no significant impact here. The housing price level at the purchase year has a negative effect as expected. Households with higher income, a male head and larger size, and households whose heads work for government-related institutions are more likely to own a house. If a household head is older, the household's probability of owning a house increases, although at a decreasing rate.

The results of the ordered probit regressions are shown in column 1 of Table 3. Higher expected capital gains help households move up the housing tenure status ladder. Combined with the finding from the previous probit regression that expected capital returns have no significant effect on households' decision as to whether to own a house, this suggests that an increase in expected capital returns would increase the likelihood that they own multiple houses. Meanwhile, households with higher income or larger size and households whose heads work for government-related institutions are more likely to have a higher housing tenure status.

4.2 Housing investment of homeowners who only own a primary residence

In this subsection, we investigate one channel of housing investment. This channel is through the primary residence.

4.2.1 Specification and Strategy

The housing demand of homeowners who own just one housing unit is equal to their primary residence. There are 1,907 *own1* households out of 2,344 total homeowners.

This housing demand is a mix of the consumption demand and the investment demand in the sense that it may capture part of the potential investment need that has been subdued by financial constraints as illustrated in the theory section. We will examine how the housing demand of *own1* households responds to changes in expected capital gains, which is indicative of their investment need. We will also check how the responses differ among different wealth groups.

To construct the housing demand measure, we divide the market value of a household's primary housing by the hedonic housing price level of the residence city in the survey year. The demand measure is therefore the housing services demanded with the quality factor controlled.

We examine how housing demand is related to expected capital gains and household characteristics. Our baseline regression is specified as follows:

$$y_{ic} = \alpha + \beta_1 g_{ic} + \beta_2 X_{ic} + \beta_3 Z_{ic} + \beta_4 W_{ic} + u_c + d2010_i + \varepsilon_{ic}, \quad (5)$$

where y_{ic} is the housing investment demand for household i. The explanatory variables and the control variables are the same as those in Equation (2). For example, g_{ic} is a household's expectation of capital gains as defined in section (4.1).We control for the city fixed effect u_c because there may be city factors that simultaneously influence both the expected capital gains and the housing demand of individual households. We also include the survey year effect $d2010_i$ because we have two survey years, 2010 and 2011. (Remember that each year covers different households.)

Because our regression is based only on the sample of *own1* homeowners, we utilize a Heckman selection model to deal with the possible endogenous sample selection problem. Because it is very hard to find a variable that influences the housing tenure choice but not the housing demand, in the first stage selection regression (probit), we

utilize the same set of explanatory variables as in the main regression, following Ioannides and Rosenthal (1994). This means we rely only on the non-linearity of the probit model for identification. We run Heckman regressions and find that the rho is insignificant, suggesting that the sample selection issue is not severe.

4.2.2 Findings

In Table 4, we report the regression results. From column 1, higher expected capital gains increase the housing demand significantly. When the expected return on housing investment increases by one standard deviation (i.e., by 8.85 percentage points), the housing demand increases by 11.51%. It is worth noting that in China's urban housing markets, households face a substantial down-payment ratio requirement[19] along with minimum size constraints for housing units.[20] When expected capital gains increase, households have greater housing investment need. However, if they cannot afford to buy a second house due to the aforementioned financial constraints, they will alternatively buy a larger primary residence unit.

An increase in hedonic housing price level in the purchase year of the primary residence reduces the demand, but its effect is not very significant. Increased household income increases the demand significantly. When the log income increases by one standard deviation (i.e., the log income increases by 1.35 percentage points), the housing demand increases by 10.13%. Increases in household wealth also have a positive effect on housing demand. As for the effects of the other household characteristics, households with larger family sizes demand larger primary residences, as do households with higher education levels. Moreover, households with urban Hukou own 39% larger primary residences on average than those without. This indicates that the Hukou restriction is still a hurdle that reduces rural migration into cities.

[19] The down-payment ratio for purchasing the first housing unit is 20-30%. In order to curb possible speculative behavior in the housing market, city governments in China impose higher down-payment requirements for purchasing additional housing units.

[20] A single bedroom apartment typically has a minimum size of 30 square meters, and a studio apartment typically has a minimum size of 22 square meters. In recent years, the government of China has started to implement policies that aim to encourage land developers to build and sell smaller apartments.

Next, we would like to see if the effect of a change in expected capital gains on housing demand gets larger as wealth level increases. In column 2 of Table 4, we add to our baseline regression model an interaction term between the expected capital gains and the log of wealth. The interaction term has a positive sign that is significant, suggesting that as the wealth level increases, a household becomes more responsive to changes in the expected capital gains.

We then divide the sample of *own1* households by their *predicted wealth level.* Specifically, we examine the group whose predicted wealth level is above the median for all households. We run the baseline regression for this group separately. In doing so, we allow for the flexibility of different coefficients of the control variables across different groups. The results are presented in column 4 of Table 4. The effect of changing expected capital gains on housing demand for this group is much greater than that for all *own1* households. A one-standard-deviation increase in expected capital gains would increase the household's demand for primary residence by 15.93%, much higher than the 11.51% we find for the full sample of the *own1* group. As households get richer, their housing investment need increases and thus they become more sensitive to expected housing price appreciation.

Meanwhile, as in the full sample *own1* case, the hedonic housing price level in the purchase year has a negative but insignificant effect on the housing demand. Both household income and household wealth have a significant and positive impact on housing demand. Unlike the full sample *own1* case, urban Hukou has an insignificant effect. This suggests that as households get richer, urban Hukou becomes a less difficult hurdle for rural migrants who want to settle down in cities.

It is also interesting to note that among the rich group, households that include either old people or young children tend to have smaller primary housing (after controlling for family size). Perhaps for these households, investing in human capital is a

substitution for investing in housing. In addition, government employees tend to have smaller primary housing. This might be because even though government employees have privileges in buying subsidized housing, the size and quality of such subsidized housing is limited compared to the primary housing of other households in the same wealth group. The age effect of household head on the demand for primary housing is concave.

4.3 Demand for primary housing among homeowners who own multiple houses

In this subsection, we turn to the group of homeowners who own more housing units than just their primary residence, referred to as *own2* households in this paper. Because *own2* households can afford to own additional housing, they do not face the same constraints as *own1* households do. As our theory demonstrates, their demand for primary housing reflects mainly their consumption demand. This will not increase with the expected capital gains of housing investment. When the expected capital gains increase, an *own2* household would increase her housing investment, mainly through increasing her demand for housing other than her primary residence.

In our empirical analysis, for the sample of all *own2* households, we run Heckman regressions of their demand for a primary residence (consumption demand) using the same specification as the baseline model in subsection 4.2 except for the changes in dependent variables. The results are shown in column 6 of Table 4. As the expected capital gains increase, the demand for a primary residence changes little. To check whether the primary residence demand of richer *own2* households is more sensitive to changes in expected capital gains, we then add the interaction between expected capital gains and the log of wealth to the baseline regression and the results appear in column 7 of Table 4. The estimated coefficient of the interaction term is small and insignificant, as is the estimated coefficient of the expected capital gains. We also run a separate regression on the sub-group of households with above-median wealth level, shown in column 9 of Table 4. Changes in expected capital gains still have little effect. In sum, our results suggest that the primary residence demand of households that own

multiple houses mainly reflects their consumption need and thus is insensitive to changes in expected capital gains. This is consistent with our theory.

Based on column 6, for the full sample of households who own multiple houses, the hedonic price level in the purchase year of the primary residence has a negative but insignificant impact on the demand for a primary residence. Household income has a significant impact on the demand for a primary residence. As for other household characteristics, larger families and families with better educated heads demand larger primary residences. Households with young children demand larger primary residences but the effect appears to be opposite for households that include older people. As the head of a household gets older, the household demands a larger primary residence, although at a decelerating rate. Finally, households with urban Hukou live in larger primary residences.

4.4 Whether to own multiple houses and how many to own

In this subsection, we investigate another channel of housing investment which is through owning multiple houses. When a household's need for housing investment increases, she may choose to buy a second housing unit if she is financially capable of doing so. In this case, her tenure status would change to *own2*. To explore this alternative channel for increasing housing investment, we run a probit regression on *own2* status. The dependent variable is a binary variable indicating whether a household owns multiple housing units or not. Since our regression is based only on the sample of homeowners, we adopt a Heckman selection model to deal with the possible endogenous sample selection problem as we did previously.

As for the key explanatory variable, the expected capital returns of those multiple-house owners, unfortunately, we do not have information on the year in which a household purchased its second house. Thus we cannot construct a measure of expected capital returns for the second house in the same way we did for the primary residence. However, we notice that some households in urban China

purchased their first houses from work units (these are usually not very good houses) and later purchased additional (and better) ones for primary living purposes. So for them, the expectation of capital gains in the purchase year of their primary residence is actually the expectation of purchasing a second house.

Also, notice that the median purchase year of primary residence is 2005 (which is understandable since the privatization of the housing market occurred in 1998). And the survey year is 2010 or 2011. This implies that the time span between the purchase year of the primary residence and that of a second house (if it is later than the former) should not be long. So the expectation of capital gains in the purchase year of the primary residence may have a persistent impact on the expectation of when households purchase a second house. As supporting evidence, for a subsample from the Chinese Household Finance survey, we have information on each household's subjective view on future housing markets as of the survey year (2011). The views are ranked intofive categories: very poor, poor, normal, good, and very good. Correspondingly, we group households by their view category, and for each group, we calculate the average (and median) of their expected capital gains based on the housing price growth rate around the purchase year of the primary residence. We then rank the calculated average (and median) expected capital gains. We find that this ranking exactly coincides with the ranking based on their subjective views. See Table A1 in the Appendix for details.

Therefore, we use the expected capital gains in the purchase year of the primary residence to approximate the expected gains in the purchase year of a second house. Other explanatory variables in the Heckman probit regression are the same as those in the baseline model in section 4.2. The results are presented in Table 5-a.

In Table 5-a, column 1 presents the Heckman probit regression results based on the full sample of homeowners. From column 1, we can see that increased housing price appreciation encourages a household to own more than just primary housing. This

effect is significant at P<0.01 level. An increase of one standard deviation in the expected capital gain (8.85 percentage points) would increase the chance of owning multiple houses by 3.54%. Household income has a positive and significant impact on the possibility of owning a second house. The unit price level of primary houses has a negative impact on the possibility of owning additional housing because of increased financial burdens. In addition, larger households are more likely to own multiple houses. The age effect of the household head on the chance of owning multiple houses is concave.

We then turn to the sub-sample of homeowners who are relatively rich in the sense that their net wealth level is above the median of all households. The results are reported in column 3. Because the Heckman probit regression based on this sub-sample does not converge, we can only report the probit regression results. From the first stage of the Heckman probit regression based on the full sample shown in column 2, we can see that *rho* is insignificant and small, which suggests that the sample selection problem is not severe. The effect of changes in expected capital gains becomes much larger. This is not surprising, because given the down-payment and minimum housing size constraints, only households that are financially capable would consider buying a second housing unit when facing an increase in expected capital gains. Simple calculations based on column 3 estimates show that a one-standard-deviation increase in the expected capital gains would raise the odds of owning multiple houses by 7.97%.

Since probit regressions deal only with discrete choices, in order to understand how housing assets other than primary residence change with expected capital gains, we run Tobit regressions. There is an issue of data availability here. Because we do not know the exact location city of a household's additional (non-primary) housing asset, we cannot apply the corresponding city level hedonic price to obtain the continuous demand for other housing as we do for the primary residence. However, we do know the total asset value of all other housing. Therefore, we use a household's total

housing asset value excluding primary residence as the dependent variable in the regression. The explanatory variables are the same as those in the baseline model in section 4.2. The results are presented in columns 4 and 5of Table 5-afor the full sample and for the sub-sample of above-median wealth households, respectively. The expected-capital-gain effect is significant and positive and it gets much greater in magnitude for the sub-sample of households whose wealth level is above the median. The coefficients of the other variables are qualitatively similar to those in the probit regressions.

4.5 Robustness Checks

4.5.1 Alternative measures of expected capital gains

As a robustness check, we try a different measure of expected capital gains and re-run all the regressions in Table 5-a. Specifically, following Dusanski and Koc (2007), we use the house price in the survey year as a proxy for the expected returns while controlling for rent. Because hedonic housing price at the urban district level (a sub-city administrative unit corresponding to the county level in the U.S.) is not available, we use the hedonic price at the city level instead. Thus we have to drop the city fixed effect from the regression. Instead we add city amenity controls including climate and geographic conditions. Other explanatory variables are the same as those in the baseline model in section 4.2.

We run both Heckman probit and tobit regressions. Since only the 2010 survey data from CFPS has information on rent, our regressions must be based on the sub-sample of the 2010 survey data only. The results concerning the effect of the survey year price on households' demand for extra housing units are shown in Table 5-b.The results exhibit a qualitatively similar pattern to those in Table 5-a. The expected-capital-gain effect on owning multiple houses is still positive and significant. This effect is stronger for households whose wealth is above the median level.

In addition, we also check the effect of the expected capital gain on the households' tenure choices as well as their demand for primary residence with the forward-looking measurement (i.e., using the survey year price as a proxy of the expected capital gain). According to Table A10in the Appendix, the forward-looking measurement can significantly increase the household's housing tenure status. Also, using the new measurement, Table A11 shows that the expected capital gain also has a positive impact on own1-type (i.e., owning only one housing unit) households' demand for primary residence, while it has a negative impact on own2-type (i.e., owning multiple housing units) households' demand for primary residence. These results are all consistent with our main regression findings.

For the subjective measurement, we do have information on each household's subjective view on future housing markets in the 2011 survey data. The views are ranked into five categories: very poor, poor, normal, good, and very good. Correspondingly, we group households by their view category, and for each group, we calculate the average (and median) of their expected capital gains based on the housing price growth rate around the purchase year of the primary residence. We then rank the calculated average (and median) expected capital gains. We find that this ranking exactly coincides with the ranking based on their subjective views (see Table A1 in the Appendix). This suggests that our original measurement is consistent with such a subjective measurement. The main reason that we did not use such a subjective measurement in our regressions is that the coarse value of such discrete measurement drops much useful information.

4.5.2Subsidized Housing (Fang-gai-fang in Chinese)

In China, before 1998, most residential housing was allocated by "work units" (employers) to which households belonged through a planning system. The households only paid a very small amount of rent to live in such housing units. A comprehensive housing privatization reform was initiated in 1998. People who

worked in SOEs, government branches or government-related institutions were allowed to “purchase” the property rights of the housing units originally allocated to them at subsidized prices (Xie, Wu, Zheng and Li 2012). We refer to those housing units purchased during the privatization reformat subsidized prices as “subsidized housing” or “fang-gai-fang” in Chinese. Our data includes information on whether a household owns a subsidized housing unit.

To check whether the existence of subsidized housing affects our main results in TablesA3, A4, and A5, we try in the following two ways to re-do the empirical analysis, considering the potential impact of Fang-gai-fang: (1) we drop those households whose primary residences are subsidized housing units; (2) we add intothe regressions a dummy indicating whether the primary residence is a subsidized housing unit. In either case, our main results remain fairly robust. In addition, from Table A4,we can see that the demand for primary residence is relatively smaller if the primary residence is a subsidized housing unit. This is because subsidized housing units are typically smaller than non-subsidized ones. Also, according to Table A5, households are more likely to invest in additional houses if their primary residence is a subsidized housing unit. The reason is that their primary residence costs are lower and they are thus more financially capable of investing in a second house. For more detailed results, please check Tables A3, A4 and A5 in the Appendix.

4.5.3 Renting while owning housing unit(s)

There are 326 households that rent a housing unit for residence while owning housing units as an investment (*rent_own* type), constituting 10.26% of the 3,177 total observations in our sample. These *rent_own* types are mainly concentrated in Shanghai, Beijing, Hangzhou, and Shenzhen. People who work in those large cities may find the residence housing near their workplaces too expensive to afford. Therefore they choose to own housing units outside the central districts while renting units near their workplaces, which reduces their weekday commuting cost. In Table A6 of the Appendix, we show the distribution of households who own one or more

housing units while renting another unit for residence across cities.

As a robustness check, we consider the *rent_own*-type household, which rents a housing unit while owning house(s) in other places. Table A6 of the Appendix shows the distribution of such households that own housing unit(s) while renting another unit for residence by city. In our benchmark analysis, we deleted those 326 households (10.26% of the 3177 total observations). As a robustness check, we re-run the ordered-probit tenure choice regression by adding one more tenure status: *rent_own*. It is placed above status *rent* but below status *own1*. As an alternative, we also run another ordered-probit regression that treats those *rent_own*-type households as either own1 if she owns just one housing unit or own2 if she owns more than one. Table A7 in the Appendix shows that, in either case, the expected-payoff-gain effect is positive in determining the tenure choice. When we focus on the subsample of the four main cities (Shanghai, Beijing, Hangzhou and Shenzhen) where the *rent_own* type is concentrated, the effect is significant.

We also re-run the other benchmark regressions on continuous housing demand by coding *rent_own* type households as own1 (or own2) if she owns only one housing unit (or more than one) if a *rent_own* household reports one housing unit she owns as primary residence. We find qualitatively similar results as in the benchmark analysis. Specifically, Table A8 shows that the expected capital gain still has a significant positive impact on *own1*'s primary residence demand, while *own2*'s primary residence demand is not significantly increased by the expected capital gain. Table A9 shows that the expected capital gain significantly raises the pure investment demand of *own2* (i.e., those households who own multiple housing units). These results are all consistent with the prediction of our theory.

4.5.4 Heterogeneity of the expected-capital-gain effect

We investigate the heterogeneity of the expected-capital-gain effect for two dimensions. First of all, it is widely argued that housing demand in China is linked to households' investment in their unmarried boys so as to increase their competitiveness in the marriage market. To make our analysis speak to this substantive argument, we follow a similar analysis to that of Xie, Wu, Li and Zheng (2012), and check if such

expected-capital-gain effect is higher for households with an unmarried boy than for those without an unmarried boy). Specifically, in our baseline regressions, we add a dummy variable indicating whether the household has an unmarried boy who is 18 years or older, and an interaction of this dummy variable with the expected capital gain. We summarize the results in TablesA14 and A15 in the Appendix.

In general, we find that the expected-capital-gain effect is less sensitive for those households with unmarried boys, because they have more rigid demand for extra housing units which are prepared to increase the competitiveness of their kids in the marriage market. In other words, the status of having unmarried boys makes the demand for multiple housing units more rigid so the extent to which the demand can be influenced by the expected housing price is reduced. Specifically, Table 14 shows that the expected-capital-gain effect on the housing tenure choice is less sensitive for those households with unmarried boys. In addition, Table A15 further shows that the expected-capital-gain effect on the investment in extra housing is smaller for those households with unmarried boys.

Consistent with the above findings, Table A14 also shows that the effect of unmarried boys on tenure choice is significant in the ordered-probit regression. Table A15 shows that households with unmarried boys tend to invest more in extra housing units.

Another dimension of the heterogeneity concerns the housing supply elasticity, which plays an important role in determining market outcomes (Glaeser, Gyourko and Saks, 2005, Saiz, 2010 and Gao, Sockin and Xiong, 2015). Although the focus of the paper is on the demand side of the housing market, to lay out a helpful basis for future equilibrium analysis, we also document how the effects of expected capital gains vary by city's elasticity of housing supply. Like Zheng, Sun and Kahn (2015), we borrow the measurement for price elasticity of the housing supply directly from Wang, Chan and Xu (2012). Based on panel data from 1998 to 2009, Wang, Chan and Xu (2012) estimate the price elasticity of the housing supply at the city level.

In general, Table A12-a, Table A12-b and Table A13 in the Appendix show that housing supply elasticity weakens the magnitude of the expected capital gain. Specifically, Table A12-a shows that housing supply elasticity reduces the effect of expected capital gain on the tenure choice. Table A12-b in the Appendix shows that the effect of the expected capital gain on the primary residence demand of *own1*-type households is smaller when the housing supply has a larger elasticity. In addition, the housing supply elasticity, per se, has a significant negative impact on the investment in extra housing units.

4.5.5 Purchasing restriction policy

In China, different municipalities are allowed to implement their own "purchasing restrictions" to deal with the high speed of growth in the housing market. Those "restriction" policies typically increase the difficulty of buying housing units (especially extra ones). We collect the information on which year (if any) a restriction policy (or encouragement policy) on housing purchases was implemented in each city. Since it is generally difficult to quantitatively compare the degree of restriction in those restriction policies, we utilize a binary measurement. If some restriction policy was implemented and had neither been lifted nor neutralized by new "encouragement" policies in the survey year or in a prior year, we code it as 1; otherwise we code is as 0.

Table A16 in the Appendix summarizes the tenure choice results when we take the restriction policy into account. A restriction policy significantly reduces the status in the tenure choice ladder, whereas the expected capital gain still plays a significant role. Table A17 in the Appendix summarizes the primary residence demand results when we take the restriction into account. The effect of the expected capital gain on the primary residence demand for those relatively wealthier *own1* households remains significant. Table A18 in the Appendix summarizes the investment demand results for extra housing units when we take the restriction policy into account. As we expected, the restriction policy reduces the investment demand for extra housing units. However, the effect of the expected capital gain is still significant.

4.5.6 Other Considerations

Some of the other robustness checks are not presented in this paper, but are available upon request. For example, the results remain unchanged when we exclude the households either with the top 1% wealth or with the bottom 1% wealth. The results are also robust after we control for the dummy indicating whether the household has a local Hukou or not.

5. Conclusions

Using recent urban household survey data that covers 19 major cities across China, we study how expected capital gains influence housing demand, aiming to understand both the channels of housing investment and the driving force behind it. We find strong evidence for the two housing investment channels. Specifically, an increase in the expected capital gains enhances homeowners' probability of owning multiple housing units. A one-standard-deviation increase in the expected capital gains raises the probability of owning multiple housing units by 3.54%. For the sub-sample of homeowners who are relatively rich in the sense that their predicted wealth level is above the median of all homeowners, a one-standard-deviation increase in the expected capital gains raises the probability of owning multiple housing units by 7.97%.

Moreover, we find that households increase their housing investment not only through owning multiple housing units but also through owning larger primary residences if they are constrained from owning multiple housing units. An increase of one standard deviation in the expected capital gains raises the primary housing demand by 11.51%. For the sub-sample of homeowners who are relatively rich in the sense that their predicted wealth level is above the median of all households, an increase of one standard deviation in the expected capital gains raises the primary housing demand by 15.9%.

The housing market in China, being one of the most important aspects of the Chinese economy, has been under intense discussion. Since early 2011, in order to cool down the overly hot residential housing markets, most provincial-level or provincial capital cities in China have imposed very tight borrowing constraints on households when they buy a second house, in order to curb speculative investment demand. For example, the down-payment requirement is higher for households who buy a second housing unit, as is the mortgage rate. Our findings suggest that this policy, together with the minimum size requirement, may lead people to divert their housing investment need to a larger consumption for residence than in the counterfactual case when the financial friction or the minimum size requirement is smaller. The minimum size requirement, per se, may also lead to misallocation of resources in real estate development as developers may build larger houses than is socially efficient.

Lastly, we find that wealthier households are more sensitive to changes in expected capital gains and have greater desire to invest in housing. This implies that income inequality and a lack of other asset investment channels may be among the main reasons for the rising housing demand and sky rocketing housing prices in urban China. This is also consistent with Wang and Zhang (2014)’s finding that in richer coastal cities, the housing price appreciation rate is higher and deviates more than can be explained by the fundamentals of the economy.

References:

Corradin, Stefano, José L. Fillat, and Carles Vergara-Alert. “Optimal portfolio choice with predictability in house prices and transaction costs.” *Review of Financial Studies* 27.3 (2014): 823-880.

Coulson, N. Edward, and Mingzhe Tang. “Institutional and demographic influences on the presence, scale and geographic scope of individual Chinese real estate investment.” *Regional Science and Urban Economics*43.2 (2013): 187-196.

Deutsch, Edwin, Piyush Tiwari, and Yoko Moriizumi. “The slowdown in the timing of housing purchases in Japan in the 1990s.” *Journal of Housing Economics* 15.3 (2006): 230-256.

Dusansky, Richard, and Çağatay Koç. “The capital gains effect in the demand for housing.” *Journal of Urban Economics* 61.2 (2007): 287-298.

Fang, Hanming, Quanlin Gu,and Li-an Zhou. “The Gradients of Power: Evidence from the Chinese Housing Market.”*NBER Working Paper* #20317.

Fischer, Marcel, and Michael Z. Stamos. “Optimal life cycle portfolio choice with housing market cycles.” *Review of Financial Studies* 26.9 (2013): 2311-2352.

Flavin, Marjorie, and Takashi Yamashita. “Owner-occupied housing and the composition of the household portfolio.” *The American Economic Review*92.1 (2002): 345-362.

Gan, Li. “Urbanization and the housing market in China.” (2014):*Working Paper*, Department of Economics, Texas A&M University.

Gao, Zhenyu, Michael Sockin, and Wei Xiong. “Learning about the Neighborhood: Supply Elasticity and Housing Cycles.” (2015): *Working Paper*, Department of Economics, Princeton University

Gervais, Martin. “Housing taxation and capital accumulation.” *Journal of Monetary Economics* 49.7 (2002): 1461-1489.

Glaeser, Edward L., and Joseph Gyourko. “Why Have Housing Prices Gone Up?” *The American Economic Review* 95.2 (2005): 329-333.

Guiso, Luigi, and Tullio Jappelli. “Private transfers, borrowing constraints and the timing of homeownership.” *Journal of Money, Credit and Banking* (2002): 315-339.

Henderson, J. Vernon, and Yannis M. Ioannides. “A model of housing tenure choice.” *The American Economic Review* 73.1 (1983): 98-113.

Henderson, J. Vernon, and Yannis M. Ioannides. “Tenure choice and the demand for housing.” *Economica* (1986): 231-246.

Henderson, J. Vernon, and Yannis M. Ioannides. “Owner occupancy: investment vs consumption demand.” *Journal of Urban Economics* 21.2 (1987): 228-241.

Iacoviello, Matteo, and Marina Pavan. “Housing and debt over the life cycle and over the business cycle.” *Journal of Monetary Economics* 60.2 (2013): 221-238.

Ioannides, Yannis M., and Stuart S. Rosenthal. “Estimating the consumption and investment demands for housing and their effect on housing tenure status.” *The Review of Economics and Statistics* (1994): 127-141.

Kiyotaki, Nobuhiro, Alexander Michaelides, and Kalin Nikolov. “Winners and losers in housing markets.” *Journal of Money, Credit and Banking* 43.2‐3 (2011): 255-296.

Moriizumi, Yoko, and Michio Naoi. “Unemployment risk and the timing of homeownership in Japan.” *Regional Science and Urban Economics* 41.3 (2011): 227-235.

Saiz, Albert. “The Geographic Determinants of Housing Supply.” *The Quarterly Journal of Economics* 125.3 (2010): 1253-1296.

Sommer, Kamila, Paul Sullivan, and Randal Verbrugge. “The equilibrium effect of fundamentals on house prices and rents.” *Journal of Monetary Economics* 60.7 (2013): 854-870.

Tiwari, Piyush, Edwin Deutsch, and Yoko Moriizumi. “Housing finance arrangements, wealth positioning and housing consumption in Japan: an analysis of built-for-sale homeowners.” *The Journal of Real Estate Finance and Economics* 34.3 (2007): 347-367.

Wang, Songtao, Su Han Chan, and Bohua Xu. “The estimation and determinants of the price elasticity of housing supply: Evidence from China.” *Journal of Real Estate Research* (2012).

Wang, Zhi, and Qinghua Zhang. “Fundamental factors in the housing markets of China.” *Journal of Housing Economics* 25 (2014): 53-61.

Wu, Jing, Joseph Gyourko, and Yongheng Deng. “Evaluating conditions in major Chinese housing markets.” *Regional Science and Urban Economics* 42.3 (2012): 531-543.

Xie, Jieyu, Binzhen Wu, Hongbin Li, and Siqi Zheng. “Chinese urban real estateprice and resident consumption.” *Financial Research (Chinese),* 6 (2012) 13-27.

Zheng, Siqi, Weizeng Sun, and Matthew E. Kahn. “Investor Confidence as a Determinant of China's Urban Housing Market Dynamics.” *Real Estate Economics* (2015).

Table 1-a: Detailed description of some explanatory variables used in regression equations

Variable	Description
City-level variables	
Past growth rate_3	Weighted growth rate of hedonic housing price in the three years immediately preceding the primary residence purchase
Price in purchase year	Hedonic price of housing in the primary residence purchase year
Price in survey year	Hedonic price of housing in the survey year
GDP_pc	GDP per capita in the primary residence purchase year
Population growth rate	Population growth rate in the primary residence purchase year
Household-level variables	
Family income	Family income(Yuan)in the survey year
Family Wealth	Family wealth (Yuan)in the survey year
Other house value	Value of houses other than primary house in the survey year
Normalized primary housing demand	Normalized primary housing demand in the purchase year
Family size	The number of family membersin the survey year
Male	1 if the household head is male; 0 if the household head is female
Age	Age of household head
Education	Years of education that the household has starting from the first year in elementary school
Old	1 if there is a family member aged above 60; 0 otherwise
Child	1 if there is a child aged below 6 in the family; 0 otherwise
Hukou_urban	1 if household head holds urban Hukou; 0 otherwise
Job_gov	1 if household head is working for the government or government-related institutions; 0 otherwise
_Imarry_1	1 if married or cohabiting, 0 otherwise
_Imarry_2	1 if divorced or widowed, 0 otherwise

Table 1-b: Sample distribution by city

City Code	City Name	Number of Observations	Observations in 2010 Survey	Observations in 2011 Survey	Percentage	Cumulative Percentage
110000	Beijing	277	61	216	9.72	9.72
120000	Tianjin	174	48	126	6.10	15.82
130100	Shijiazhuang	10	10	0	0.35	16.17
140100	Taiyuan	46	46	0	1.61	17.78
210100	Shenyang	115	115	0	4.03	21.82
210200	Dalian	95	95	0	3.33	25.15
230100	Harbin	113	60	53	3.96	29.11
310000	Shanghai	1015	811	204	35.60	64.71
330100	Hangzhou	102	14	88	3.58	68.29
330200	Ningbo	63	63	0	2.21	70.50
340100	Hefei	47	47	0	1.65	72.15
370100	Jinan	34	34	0	1.19	73.34
370200	Qingdao	56	0	56	1.96	75.31
410100	Zhengzhou	59	59	0	2.07	77.38
420100	Wuhan	84	52	32	2.95	80.32
430100	Changsha	50	50	0	1.75	82.08
440100	Guangzhou	134	121	13	4.70	86.78
440300	Shenzhen	102	0	102	3.58	90.35
500000	Chongqing	79	60	19	2.77	93.13
510100	Chengdu	80	80	0	2.81	95.93
610100	Xi’an	72	72	0	2.53	98.46
620100	Lanzhou	44	44	0	1.54	100
Total		2851	1942	909		

Table 1-c Sample distribution by tenure status

Tenure status	Number of Observations
Renter (owning no houses)	507
Own1 (owning 1 housing unit)	1907
Own2(owning more than1 housing unit)	437
Total	2851

Table 2-a: Summary of Statistics: sample of renters

Variable	Number of Observations	Mean	Standard Deviation	Min	Max
Family income	412	51410.67	78053.85	5	1000000
Family wealth (10,000 Yuan)	507	254.08	3584.57	-5.00	70066
Family size	507	2.23	1.12	1	8
Male	507	0.46	0.50	0	1
Age	498	44.35	17.41	16	97
Education	497	11.03	4.40	0	22
Old	507	0.26	0.44	0	1
Child	507	0.13	0.33	0	1
Hukou_urban	497	0.70	0.46	0	1
Job_gov	507	0.03	0.17	0	1
_Imarry_1	497	0.66	0.47	0	1
_Imarry_2	497	0.14	0.35	0	1

Table 2-b: Summary of Statistics: sample of homeowners (own1+own2)

Variable	Number of Observations	Mean	Standard Deviation	Min	Max
Normalized primary housing demand	1857	68.33	63.53	0.35	814.71
Other house value(10,000 Yuan)	2297	17.94	91.38	0	3000
Family income	1991	57981.94	94111.34	1	2086000
Family wealth (10,000 Yuan)	2344	267.81	3829.63	-19044.99	144401
Purchasingyear	2322	2005.47	4.49	1997	2011
Family size	2344	2.80	1.01	1	9
Male	2344	0.62	0.48	0	1
Age	2126	51.30	13.72	16	90
Education	2116	9.85	4.75	0	22
Old	2344	0.38	0.49	0	1
Child	2344	0.10	0.30	0	1
Hukou_urban	2124	0.70	0.46	0	1
Job_gov	2344	0.07	0.26	0	1
_Imarry_1	2120	0.87	0.34	0	1
_Imarry_2	2120	0.10	0.30	0	1
GDP_pc	2344	47622.69	26669.99	109.46	152099
Population growth rate	2261	1.09	3.56	-11.39	31.65
Price in purchase year	2344	7895.30	5659.78	1728.20	27262.10
Price in Survey year	2344	13666.5	7394.306	3078.87	27262.1
Past growth rate_3	2051	11.52	8.85	-3.56	27.25

Table 2-c: Summary of Statistics: sample of homeowners who own just one house

Variable	Number of Observations	Mean	Standard Deviation	Min	Max
Normalized primary house demand	1480	65.80	65.15	0.35	814.71
Other house value (10,000 Yuan)	1907	0	0	0	0
Family income	1617	50860.63	90287.12	1	2086000
Family wealth (10,000 Yuan)	1908	185.16	3505.34	-38.35	144401
Purchaseyear	1897	2005.64	4.52	1997	2011
Family size	1907	2.76	1.01	1	9
Male	1907	0.63	0.48	0	1
Age	1722	52.00	13.78	16	90
Education	1716	9.57	4.75	0	22
Old	1907	0.39	0.49	0	1
Child	1907	0.09	0.29	0	1
Hukou_urban	1720	0.69	0.46	0	1
Job_gov	1907	0.06	0.24	0	1
_Imarry_1	1720	0.86	0.34	0	1
_Imarry_2	1720	0.11	0.31	0	1

Table 2-d: Summary of Statistics: sample of homeowners who own multiple houses

Variable	Number of Observations	Mean	Std. Dev.	Min	Max
Normalized primary house demand	377	78.24	55.71	0.58	366.05
Other house value (10,000 Yuan)	390	105.69	199.97	0	3000
Family income	374	88771.13	103756.8	100	1010000
Family wealth (10,000 Yuan)	437	628.37	4990.95	-19044.99	80159.5
Purchasingyear	436	2004.71	4.28	1997	2011
Family size	437	2.98	0.97	1	6
Male	437	0.60	0.49	0	1
Age	404	48.32	13.04	17	85
Education	401	11.07	4.53	0	22
Old	437	0.34	0.47	0	1
Child	437	0.12	0.33	0	1
Hukou_urban	404	0.76	0.43	0	1
Job_gov	437	0.11	0.31	0	1
_Imarry_1	401	0.90	0.30	0	1
_Imarry_2	401	0.04	0.20	0	1

Table3: Housing tenure choice

	Ordered probit	Probit-own
Past growth rate_3	0.069*	-0.22
	(0.04)	(0.2)
ln(Price in purchase year)	-2.84***	-9.20**
	(0.8)	(4.3)
ln(Family income)	0.13***	0.079**
	(0.03)	(0.04)
ln(Family wealth)	0.0012	-0.0026
	(0.003)	(0.02)
Family size	0.15***	0.33***
	(0.04)	(0.09)
Male	0.14**	0.35***
	(0.06)	(0.1)
Age	0.084***	0.12***
	(0.009)	(0.02)
Age^2	-0.00072***	-0.00100***
	(0.00008)	(0.0002)
Education	-0.023	-0.054*
	(0.02)	(0.03)
Old	0.13*	0.068
	(0.07)	(0.07)
Child	-0.11	-0.19
	(0.1)	(0.2)
Hukou_urban	-0.25**	-0.47***
	(0.1)	(0.1)
Job_gov	0.36***	0.38***
	(0.08)	(0.1)
_Imarry_1	-0.030	-0.42**
	(0.08)	(0.2)
_Imarry_2	-0.18	-0.43***
	(0.2)	(0.2)
ln(GDP_pc)	0.35	-5.33
	(0.2)	(4.1)
Population growth rate	0.0072	-0.000073
	(0.008)	(0.2)
City Fixed Effect	Y	Y
Constant1	-19.2***	154***
	(7.1)	(35)
Constant2	-16.7**	
	(7.0)	
Observations	1931	1859
R2	0.23	0.57

Table 4 Demand for primary residence by tenure status

	Primary residence demand of own1					Primary residence demand of own2				
	Heckman	Heckman	1st stage of Heckman	Heckman (50pc)	1st stage of Heckman (50pc)	Heckman	Heckman	1 stage of Heckman	Heckman (50pc)	1 stage of Heckman (50pc)
Past growth rate_3	0.013*	-0.0053	0.032	0.018***	0.026	0.0045	0.0079	0.038**	-0.016	0.039***
	(0.007)	(0.010)	(0.03)	(0.005)	(0.03)	(0.01)	(0.01)	(0.02)	(0.1)	(0.007)
Past growth rate_3* Family wealth		0.0016***					-0.00033			
		(0.0004)					(0.0004)			
ln(Price in purchasing year)	-0.16	-0.27	-1.34**	-0.093	-0.89	-0.17	-0.15	-1.62***	-0.060	-1.55***
	(0.2)	(0.2)	(0.6)	(0.1)	(0.8)	(0.3)	(0.3)	(0.3)	(0.4)	(0.2)
ln(Family income)	0.075***	0.075***	-0.039*	0.11***	-0.068***	0.053*	0.053*	0.16***	0.14*	0.20***
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.07)	(0.07)
ln(Family wealth)	0.011***	-0.0025	0.0055	0.085**	0.083**	-0.0046	-0.0019	0.00012	0.13**	0.17
	(0.004)	(0.005)	(0.004)	(0.04)	(0.04)	(0.004)	(0.006)	(0.005)	(0.07)	(0.1)
Family size	0.088*	0.071	0.048	0.048***	0.033	0.11***	0.12***	0.089*	0.11	0.0083
	(0.05)	(0.05)	(0.03)	(0.02)	(0.05)	(0.04)	(0.04)	(0.05)	(0.07)	(0.02)
Male	-0.069	-0.075*	0.14***	-0.021	0.079	0.034	0.028	0.015	0.11***	0.028
	(0.04)	(0.04)	(0.06)	(0.02)	(0.09)	(0.04)	(0.05)	(0.06)	(0.02)	(0.1)
Age	0.0094	0.0089	0.019	0.015	-0.025	0.042**	0.042**	0.054**	0.061	0.084***
	(0.009)	(0.009)	(0.02)	(0.009)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
Age^2	-0.000072	-0.000072	-0.00019	-0.000079	0.00019	-0.00030*	-0.00031*	-0.00048***	-0.00049	-0.00077***

	(0.00008)	(0.00009)	(0.0002)	(0.00009)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0002)
Education	0.025**	0.027**	-0.031***	0.029***	-0.041***	0.020*	0.020	0.016	0.015	-0.016
	(0.01)	(0.01)	(0.009)	(0.005)	(0.008)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
Old	-0.054	-0.057	0.083	-0.12***	0.092	-0.14*	-0.14*	0.10	-0.045	0.15*
	(0.05)	(0.04)	(0.08)	(0.05)	(0.09)	(0.08)	(0.08)	(0.1)	(0.1)	(0.08)
Child	0.013	0.026	-0.054	-0.13**	0.035	0.22*	0.24*	-0.14	0.20	-0.21
	(0.08)	(0.09)	(0.09)	(0.06)	(0.09)	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)
Hukou_urban	0.39***	0.35***	-0.094	-0.087**	0.25	0.30*	0.30*	-0.13	0.30	-0.20
	(0.10)	(0.10)	(0.1)	(0.04)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Job_gov	0.055	0.030	0.12	-0.069**	0.21	-0.13	-0.12	0.27**	0.028	0.17
	(0.1)	(0.1)	(0.1)	(0.03)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
_Imarry_1	-0.052	-0.041	0.41***	0.11*	0.75***	0.20	0.19	-0.14	0.16	-0.32
	(0.1)	(0.1)	(0.1)	(0.06)	(0.2)	(0.3)	(0.3)	(0.1)	(0.2)	(0.2)
_Imarry_2	-0.055	-0.042	0.46***	-0.026	0.64***	0.47**	0.47**	-0.55**	0.38	-0.63***
	(0.1)	(0.1)	(0.1)	(0.05)	(0.1)	(0.2)	(0.2)	(0.2)	(0.3)	(0.2)
ln(GDP_pc)	-0.24*	-0.17	-0.35*	-0.046	-0.63**	-0.33	-0.35	0.51***	-0.40***	0.57
	(0.1)	(0.1)	(0.2)	(0.2)	(0.3)	(0.2)	(0.2)	(0.2)	(0.1)	(0.3)
Population growth rate	0.020*	0.023**	-0.028**	0.019***	-0.019	0.0072	0.0072	0.0020	0.089**	0.051
	(0.01)	(0.01)	(0.01)	(0.005)	(0.03)	(0.02)	(0.02)	(0.007)	(0.04)	(0.04)
City Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Constant	6.01***	6.36***	15.5***	1.93***	14.3*	6.20***	6.20***	4.66*	2.56*	0.28
	(1.7)	(1.6)	(5.9)	(0.7)	(7.4)	(2.0)	(2.0)	(2.5)	(1.5)	(1.7)
Rho	0.11	0.088		-0.026		0.22	0.22		0.41	
	(0.1)	(0.1)		(0.07)		(0.2)	(0.2)		(1.1)	

Observations	1638	1638	1638	828	828	1886	1886	1886	884	884

Note:“50pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level.

Table 5-a Whether to own multiple housing units and how many to own

	Heckman probit(own2)		Probit based on own	Tobit (Other house value)	
	Own2	1st stage	Own2 (50 pc)	Own2	Own2 (50 pc)
Past growth rate_3	0.016**	-0.23	0.029***	0.099**	0.17***
	(0.008)	(0.2)	(0.008)	(0.04)	(0.03)
Ln(Price in purchase year)	-0.64***	-8.90**	-1.06***	-3.99***	-5.20***
	(0.2)	(4.0)	(0.1)	(0.8)	(0.6)
ln(Family income)	0.15***	0.077**	0.18***	0.93***	1.16**
	(0.03)	(0.04)	(0.07)	(0.2)	(0.5)
ln(Family wealth)	-0.00060	-0.0022	0.065	-0.011	0.70
	(0.004)	(0.02)	(0.1)	(0.03)	(0.5)
Family size	0.099**	0.33***	-0.0018	0.35	-0.32
	(0.04)	(0.09)	(0.04)	(0.3)	(0.2)
Male	-0.076	0.35***	-0.047	-0.37	-0.12
	(0.06)	(0.1)	(0.09)	(0.3)	(0.4)
Age	0.042**	0.12***	0.057***	0.19*	0.28***
	(0.02)	(0.03)	(0.02)	(0.1)	(0.10)
Age2	-0.00035**	-0.00099***	-0.00050***	-0.0016*	-0.0024***
	(0.0002)	(0.0003)	(0.0002)	(0.0008)	(0.0008)
Education	0.014	-0.055*	-0.0084	0.079	-0.059
	(0.02)	(0.03)	(0.02)	(0.09)	(0.1)
Old	0.0040	0.068	0.065	0.24	0.42
	(0.08)	(0.08)	(0.08)	(0.5)	(0.4)
Child	-0.071	-0.20	-0.12	-0.55	-0.83
	(0.1)	(0.2)	(0.1)	(0.6)	(0.8)
Hukou_urban	-0.077	-0.47***	-0.27	0.089	-0.76
	(0.2)	(0.1)	(0.2)	(0.8)	(0.6)
Job_gov	0.16	0.40***	0.096	0.70	0.42
	(0.1)	(0.1)	(0.1)	(0.6)	(0.5)
_Imarry_1	-0.53***	-0.43**	-0.63***	-2.26***	-2.58***
	(0.2)	(0.2)	(0.2)	(0.8)	(1.0)
_Imarry_2	-0.86***	-0.45***	-0.91***	-4.22***	-3.95***
	(0.2)	(0.2)	(0.2)	(1.4)	(1.5)
ln(GDP_pc)	0.34***	-5.50	0.59***	1.61**	2.27***
	(0.1)	(3.9)	(0.1)	(0.7)	(0.8)
Population growth rate	0.013*	-0.0032	-0.0023	0.015	-0.046
	(0.008)	(0.2)	(0.02)	(0.03)	(0.09)
City Fixed Effect	Y	Y	Y	Y	Y
Constant	-1.22	153***	-1.27	9.49	0.23

Rho	(1.4)	(35) -0.17 (0.2)	(2.7)	(8.3)	(14)
Sigma				5.44*** (0.3)	5.45*** (0.3)
Observations	1931	1931	684	1491	684

Note: “50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2* whose wealth is above the 50th percentile, we report the results of the probit regression instead.

Table 5-b Whether to own multiple housing units and how many to own
(Using the hedonic housing price in the survey year as proxy for the expected capital gains)

	Heckman probit (own2)		Probit conditional on own	Tobit (Other house value)	
	Own2	1st stage of Heckman	Own2-50pc	Own2	Own2-50pc
ln(Price insurvey year)	4.27*	-3.29***	5.28	16.8***	20.5***
	(2.5)	(1.1)	(7.0)	(0.0007)	(0.001)
Ln(Rent)	0.037	-0.40***	-0.025	0.038***	-0.28***
	(0.06)	(0.08)	(0.03)	(0.004)	(0.003)
ln(Family income)	0.33***	0.22***	0.51***	2.03***	2.46***
	(0.06)	(0.06)	(0.07)	(0.0006)	(0.001)
ln(Family wealth)	0.047*	-0.0017	-0.037	0.26***	0.35***
	(0.03)	(0.02)	(0.08)	(0.0005)	(0.0009)
Family size	0.066	0.24*	-0.050	0.23***	-0.28***
	(0.07)	(0.1)	(0.04)	(0.004)	(0.007)
Male	-0.11	0.38***	-0.066	-0.22***	-0.15***
	(0.08)	(0.1)	(0.1)	(0.01)	(0.02)
Age	0.030	0.098***	0.029	0.12***	0.16***
	(0.02)	(0.02)	(0.02)	(0.0004)	(0.0003)
Age^2	-0.00018	-0.00075***	-0.00023	-0.00068***	-0.0012***
	(0.0002)	(0.0002)	(0.0002)	(0.000009)	(0.000005)
Education	-0.0034	-0.049*	-0.023**	-0.045***	-0.13***
	(0.01)	(0.03)	(0.009)	(0.002)	(0.0010)
Old	-0.18*	0.17**	-0.039	-0.94***	-0.36***
	(0.09)	(0.09)	(0.07)	(0.04)	(0.03)
Child	-0.059	-0.13	-0.20	-1.01***	-1.19***
	(0.2)	(0.3)	(0.2)	(0.04)	(0.04)
Hukou_urban	-0.27*	-0.25*	-0.28*	-0.62***	-1.14***
	(0.2)	(0.2)	(0.2)	(0.02)	(0.007)
Job_gov	0.13	0.15	0.14	0.56***	0.57***
	(0.2)	(0.1)	(0.1)	(0.03)	(0.02)
_Imarry_1	-0.59	-0.28	-0.58*	-2.33***	-2.51***
	(0.4)	(0.2)	(0.3)	(0.03)	(0.04)
_Imarry_2	-1.13**	-0.40*	-1.12**	-4.49***	-5.12***
	(0.5)	(0.2)	(0.4)	(0.07)	(0.05)
ln(GDP_pc)	-0.15	-15.0***	-0.098	-0.67***	-0.65***
	(0.2)	(3.4)	(0.1)	(0.0006)	(0.001)
Population growth rate	0.054***	-0.072***	0.070*	0.20***	0.38***

	(0.02)	(0.01)	(0.04)	(0.0006)	(0.004)
City amenities	Y	Y	Y	Y	Y
Constant	-160*	346***	60.4	-716***	-213***
	(84)	(54)	(95)	(0.006)	(0.01)
Rho		-0.13			
		(0.3)			
Sigma				5.02***	5.35***
				(0.006)	(0.007)
Observations	1347	1347	456	973	449

Note: "50 pc" refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2*whose wealth is above the 50th percentile, we report the probit regression results instead.

Appendix: Model solution and simulations

Proof of Proposition 1

(1) We first show that whenever $E(p_1) < (1+r)(p_0 - s)$, the household chooses to be a renter. Suppose that $\{h_I^*, h_c^*, x^*, q_0^*\}$ is an optimal choice if she chooses to make an investment in the housing market. Now construct a renting choice as follows:

$x^{**} \triangleq x^*$, $h_c^{**} \triangleq h_c^*$ and $q_0^{**} \triangleq q_0^* + (p_0 - s)h_I^*$.

We have $x^{**} + sh_c^{**} + q_0^{**} = x^* + sh_c^* + q_0^* + (p_0 - s)h_I^* \le w$, so the constructed allocation is feasible for a renter. Furthermore, we also have

$$\begin{aligned} & u(x^{**}, h_c^{**}) + (1+r)q_0^{**} \\ &= u(x^*, h_c^*) + (1+r)q_0^* + (1+r)(p_0 - s)h_I^* \\ &> u(x^*, h_c^*) + (1+r)q_0^* + E(p_1)h_I^*. \end{aligned}$$

Thus renting is strictly preferred.

(2) In the second step, we show that whenever $E(p_1) > (1+r)(p_0 - s)$, the owner's optimization problem is equivalent to the following optimization:

$$\begin{aligned} & \max_{h_c, h_I} \phi_1(w - (\delta p_0 - s)(h_I - h_c) - \delta p_0 h_c) + \phi_2(h_c) + [E(p_1) - (1+r)(1-\delta)p_0]h_I \\ & s.t.\ \ h_c \in [\underline{h}, +\infty), \\ & \qquad (h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty). \end{aligned}$$

Notice that in the original optimization, the budget constraint $p_0 h_I + x \le w + s(h_I - h_c) - q_0$ must be binding, otherwise the household can always strictly improve her welfare by increasing her non-housing consumption.

By using the binding budget constraint, we can rewrite the objective function as

$$u(\mathrm{x}, h_c) + (1+r)w - (1+r)x + [E(p_1) - (1+r)(p_0 - s)](h_I - h_c) + [E(p_1) - (1+r)p_0]h_c + y.$$

The credit constraint can also be rewritten as $w \ge (\delta p_0 - s)h_I + x + sh_c$. Hence, the optimization problem is equivalent to

$$\begin{aligned} & \max_{h_c, h_I - h_c, x} u(\mathrm{x}, h_c) - (1+r)x + [E(p_1) - (1+r)(p_0 - s)](h_I - h_c) + [E(p_1) - (1+r)p_0]h_c \\ & s.t.\ \ w \ge (\delta p_0 - s)(h_I - h_c) + x + \delta p_0 h_c, \\ & \qquad h_c \in [\underline{h}, +\infty), \\ & \qquad (h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty). \end{aligned}$$

Suppose that the credit constraint is not binding at the optimum, then the optimal

solution to the above program is equivalent to the solutions in the program without such constraint, that is

$$\max_{h_c, h_I - h_c, x} u(\mathrm{x}, h_c) - (1+r)x + [E(p_1) - (1+r)(p_0 - s)](h_I - h_c) + [E(p_1) - (1+r)p_0]h_c$$

$$s.t. \quad h_c \in [\underline{h}, +\infty),$$

$$(h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty).$$

However, in the above program, it is easy to verify that at the optimum, $h_I^* - h_c^* = +\infty$ and none of x^* and h_c^* can be negative infinite, provided that $E(p_1) > (1+r)(p_0 - s)$. As a result, the credit constraint cannot be satisfied, which is a contradiction. Therefore, at the optimum, the credit constraint is binding so that the optimization program can be simplified as

$$\max_{h_c, h_I - h_c} u(w - (\delta p_0 - s)(h_I - h_c) - \delta p_0 h_c, h_c) + [E(p_1) - (1+r)(1-\delta)p_0][(h_I - h_c) + h_c]$$

$$s.t. \quad h_c \in [\underline{h}, +\infty),$$

$$(h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty).$$

(3) According to Lemma 1, conditional on the household owning at least one housing unit, we have: $h_I^* - h_c^* \geq \underline{h}$ if and only if $A\underline{h} + G(\underline{h}) - G(0) > 0$, where

$G(x) = \underset{y \geq \underline{h}}{Max} \phi_1(w - (\delta p_0 - s)x - \delta p_0 y) + \phi_2(y) + Ay$ and $A = E(p_1) - (1+r)(1-\delta)p_0$.

Since $A\underline{h} + G(\underline{h}) - G(0)$ is strictly increasing in A, the house owner owns more than one housing units if and only if A is sufficiently high, namely, $E(p_1)$ is sufficiently high.

(4) It is easy to verify that house owner's optimal expected utility is strictly increasing in $E(p_1)$, whereas the renter's payoff is independent of $E(p_1)$. As a result, the household is a renter if and only if her expected capital gain is sufficiently low. Q.E.D.

Proof of Corollary 1

Given that $\underline{h} < \min\{h_c^*, \frac{q_0^*}{\delta p_0 - s} - h_c^*\}$, where $\{h_c^*, q_0^*\}$ is a solution of the renter's problem, suppose for any $E(p_1) > (1+r)(p_0 - s)$, renting is a strictly dominant strategy. Let's construct a choice of owning multiple housing units as follows.

$\{h_c^{**} \triangleq h_c^*, h_I^{**} \triangleq \frac{q_0^*}{\delta p_0 - s}\}$ is feasible for a house owner. Then we have

$$u(w-(\delta p_0 - s)(h_I^{**} - h_c^{**}) - \delta p_0 h_c^{**}, h_c^{**}) + [E(p_1) - (1+r)(1-\delta)p_0]h_I^{**}$$
$$= u(w - q_0^* - sh_c^*, h_c^*) + [E(p_1) - (1+r)(1-\delta)p_0]\frac{q_0^*}{\delta p_0 - s}$$
$$= u(w - q_0^* - sh_c^*, h_c^*) + \frac{[E(p_1) - (1+r)(1-\delta)p_0]}{\delta p_0 - s} q_0^*$$
$$> u(w - q_0^* - sh_c^*, h_c^*) + (1+r)q_0^*$$

Therefore renting is always strictly dominated. Thus the lower cut-point reaches its minimum value, i.e., $k_0^* = (1+r)(p_0 - s)$.

When $E(p_1)$ becomes sufficiently close to $(1+r)(p_0 - s)$, $E(p_1) - (1+r)(1-\delta)p_0$ becomes sufficiently close to $\delta p_0 - s$. With such $E(p_1)$, as long as $(\delta p_0 - s)\underline{h} + G(\underline{h}; \delta p_0 - s) < G(0; \delta p_0 - s)$, the sufficient condition that leads to the choice of owning one unit is satisfied and the household will choose to own only one housing unit. As a result, we have $k_1^* > (1+r)(p_0 - s)$. Q.E.D.

Proof of Corollary2

According to the third part of Lemma 1, $A\underline{h} + G(\underline{h}) - G(0)$ is strictly increasing in A and w, and is decreasing in δ. We have $[k_1^* - (1+r)(1-\delta)p_0]\underline{h} + G(\underline{h}; k_1^*) - G(0; k_1^*) = 0$. As we increase δ, if k_1^* decreases, then the inequality will not hold. As a result, k_1^* is increasing in the down-payment ratio whenever $k_1^* > k_0^*$.Using the same method, we can also show that k_1^* is strictly decreasing in initial wealth w whenever $k_1^* > k_0^*$.

Notice that the owner's optimal expected payoff is weakly decreasing in the down-payment ratio δ, whereas the renter's expected payoff is independent of it. So a higher down-payment ratio makes owning houses less profitable. Hence, k_0^* is

weakly increasing in the down-payment ratio δ.

In the following, we only need to show that k_0^* is strictly decreasing in initial wealth w. Following the method above, we only need to show that the difference between the owner's expected payoff $V^O(w)$ and the renter's expected payoff $V^R(w)$ is strictly increasing in initial wealth w. Notice that owner's optimization problem is equivalent to

$$\max_{h_c, h_I - h_c} u(x, \frac{w - x - (\delta p_0 - s)(h_I - h_c)}{\delta p_0}) - (1+r)x + [E(p_1) - (1+r)(p_0 - s)](h_I - h_c)$$
$$+ [E(p_1) - (1+r)p_0] \frac{w - x - (\delta p_0 - s)(h_I - h_c)}{\delta p_0}$$
$$s.t. \quad \frac{w - x - (\delta p_0 - s)(h_I - h_c)}{\delta p_0} \in [\underline{h}, +\infty),$$
$$(h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty).$$

By the Envelope Theorem, we have $\frac{dV^O(w)}{dw} > \frac{E(p_1) - (1+r)p_0}{\delta p_0}$.

By applying the Envelope Theorem to the renter's problem, we have $\frac{dV^R(w)}{dw} = 1 + r < \frac{dV^O(w)}{dw}$. Thus, the difference between the owner's expected payoff $V^O(w)$ and the renter's expected payoff $V^R(w)$ is strictly increasing in initial wealth w. Q.E.D.

Lemma 1 Consider the following optimization problem

$$\max_{x,y} \phi_1(w - \alpha x - \beta y) + \phi_2(y) + A(x + y)$$
$$s.t. \ x \in \{0\} \bigcup [\underline{h}, +\infty), y \in [\underline{h}, +\infty)$$

with the assumption that $0 < \alpha < \beta$, that A, $\underline{h} > 0$, and that $\phi_1(\bullet)$ and $\phi_2(\bullet)$ are continuously differentiable, strictly increasing and strictly concave. Then we have:

(1) if $A\underline{h} + G(\underline{h}) - G(0) > 0$, we have $x^* \geq \underline{h}$; if $A\underline{h} + G(\underline{h}) - G(0) < 0$, we have $x^* = 0$, where $G(x) = \underset{y \geq \underline{h}}{Max} \phi_1(w - \alpha x - \beta y) + \phi_2(y) + Ay$;[21]

(2) $G(x)$ is strictly decreasing and strictly concave in x.

[21]Notice that when $A\underline{h} + G(\underline{h}) - G(0) = 0$, the optimal choices are $x^* = 0$ or $x^* = \underline{h}$, and the decision maker is indifferent between these two.

(3) $A\underline{h}+G(\underline{h})-G(0)$ is strictly increasing in A and w.

(4) $A\underline{h}+G(\underline{h})-G(0)$ is strictly decreasing in δp_0 if $\alpha=\delta p_0-s, \beta=\delta p_0, A=\delta p_0+A_0$.

Proof of Lemma 1

The original optimization can be decomposed into two steps. First, we take x as given and calculate the following:

$G(x)=\underset{y\geq \underline{h}}{Max}\,\phi_1(w-\alpha x-\beta y)+\phi_2(y)+Ay$.

In the second step, we then operate the following optimization: $\max_{x\in\{0\}\cup[\underline{h},+\infty)} G(x)+Ax$.

The derivative of the objective function in the first optimization with respect to y $-\beta\phi_1'(w-\alpha x-\beta y)+\phi_2'(y)+A$ is strictly decreasing in y. So the optimal solution y^* can be characterized as follows:

whenever $-\beta\phi_1'(w-\alpha x-\beta\underline{h})+\phi_2'(\underline{h})+A\leq 0$, we get $y^*=\underline{h}$;

whenever $-\beta\phi_1'(w-\alpha x-\beta\underline{h})+\phi_2'(\underline{h})+A>0$, we get $y^*>\underline{h}$ and is uniquely pinned down by $-\beta\phi_1'(w-\alpha x-\beta y^*)+\phi_2'(y^*)+A=0$.

(a) We now show that y^* is weakly increasing in A and w, and weakly decreasing in x, α and β, and $w-\alpha x-\beta y^*$ is strictly increasing in w, strictly decreasing in x, α and β, and weakly decreasing in A. When y^* is an interior solution, the increasing or decreasing patterns are strict.

First of all, when A is sufficiently small, i.e., $-\beta\phi_1'(w-\alpha x-\beta\underline{h})+\phi_2'(\underline{h})+A\leq 0$, we get $y^*=\underline{h}$. When A becomes larger we have $-\beta\phi_1'(w-\alpha x-\beta y^*)+\phi_2'(y^*)+A=0$.

Suppose now that $A_1>A_2$. Then for the induced solutions, we must have $y_1^*>y_2^*$, otherwise we get

$-\beta\phi_1'(w-\alpha x-\beta y_1^*)+\phi_2'(y_1^*)+A_1>-\beta\phi_1'(w-\alpha x-\beta y_2^*)+\phi_2'(y_2^*)+A_2$,

which contradicts the first order conditions. As a result, $y_1^*>y_2^*$.

Now we show that $w-\alpha x-\beta y^*$ is decreasing in A. Define $z^*\triangleq w-\alpha x-\beta y^*$. So we have: whenever $-\beta\phi_1'(w-\alpha x-\beta\underline{h})+\phi_2'(\underline{h})+A\leq 0$, we get $z^*=w-\alpha x-\beta\underline{h}$;

whenever $-\beta\phi_1'(w-\alpha x-\beta\underline{h})+\phi_2'(\underline{h})+A>0$, we get $z^*<w-\alpha x-\beta\underline{h}$ and is uniquely pinned down by $-\beta\phi_1'(z^*)+\phi_2'(\frac{w-\alpha x-z^*}{\beta})+A=0$. By similar methods to those above, we can show that z^* is decreasing in A. Similarly we can also show all the other comparative statics.

(b) Now we show that $G(x)$ is strictly decreasing and concave.

By the Envelope Theorem, we have $G'(x)=-\alpha\phi_1'(w-\alpha x-\beta y^*)<0$ so that $G(x)$ is strictly decreasing in x. According to part (a), $w-\alpha x-\beta y^*$ is strictly decreasing in x, $G'(x)$ is also strictly decreasing in x.

(c) Since $G(x)$ is strictly concave, $G(x)+Ax$ is also strictly concave. Therefore, by the property of a concave objective function, we know that $x^*\geq\underline{h}$ if and only if $G(\underline{h})+A\bullet\underline{h}\geq G(0)+A\bullet 0$ i.e, $A\underline{h}+G(\underline{h})-G(0)\geq 0$.

(d) Now we show that $A\underline{h}+G(\underline{h})-G(0)$ is strictly increasing in A.
By the Envelope Theorem, the derivative of $A\underline{h}+G(\underline{h})-G(0)$ with respect to A is $\underline{h}+y^*(\underline{h})-y^*(0)$.

By the Intermediate Value Theorem, it equals to $\underline{h}(1+\frac{\partial y^*(x)}{\partial x}|_{x=\xi})$ for some ξ. So we only need to show that $\frac{\partial y^*(x)}{\partial x}>-1$ for any x.

Because $-\beta\phi_1'(w-\alpha x-\beta y^*)+\phi_2'(y^*)+A=0$, using the Implicit Function Theorem, we know that $\beta(\alpha+\beta\frac{\partial y^*(x)}{\partial x})\phi_1''(w-\alpha x-\beta y^*)+\frac{\partial y^*(x)}{\partial x}\phi_2''(y^*)=0$ so that

$$\frac{\partial y^*(x)}{\partial x}=-\frac{-\beta\alpha\phi_1''(w-\alpha x-\beta y^*)}{-\beta^2\phi_1''(w-\alpha x-\beta y^*)-\phi_2''(y^*)}>-1.$$

(e) The derivative of $G(\underline{h})-G(0)$ with respect to w is
$\phi_1'(w-\alpha x-\beta y^*(x))|_{x=\underline{h}}-\phi_1'(w-\alpha x-\beta y^*(x))|_{x=0}$. Since we already show that $w-(\delta p_0-s)x-\delta p_0 y^*(x)$ is strictly decreasing in x,
$\phi_1'(w-\alpha x-\beta y^*(x))|_{x=\underline{h}}-\phi_1'(w-\alpha x-\beta y^*(x))|_{x=0}>0$.
Suppose $\alpha=\delta p_0-s, \beta=\delta p_0, A=\delta p_0+A_0$.
The derivative of $G(\underline{h})-G(0)$ with respect to δp_0 is
$-(x+y^*(x))\phi_1'(\bullet)+y^*(x)|_{x=\underline{h}}-[-(x+y^*(x))\phi_1'(\bullet)+y^*(x)]|_{x=0}<0$.
So $G(\underline{h})-G(0)$ is strictly increasing in w, and strictly decreasing in δp_0 if $\alpha=\delta p_0-s, \beta=\delta p_0, A=\delta p_0+A_0$. Q.E.D.

Proof of Proposition 2

Suppose a household in equilibrium is the type that buys a house for residence without making any additional investment. According to our proof for Proposition 1, her optimal choice $h_I^*=h_c^*\geq\underline{h}$ can be pinned down by solving the following:

$$\max_{h_I} u(w-\delta p_0 h_I, h_I)+[E(p_1)-(1+r)(1-\delta)p_0]h_I$$
$$s.t.\quad h_I\in[\underline{h},+\infty).$$

The derivative of the objective function

$$-\delta p_0\phi_1'(w-\delta p_0 h_I)+\phi_2'(h_I)+[E(p_1)-(1+r)(1-\delta)p_0]$$

is a strictly decreasing function in h_I. Define this function as $D(h_I;E(p_1),w)$. We can then easily verify that when $D(\underline{h};E(p_1),w)\leq 0$, $h_I^*=\underline{h}$; otherwise, h_I^* is uniquely and well characterized by the first-order condition $D(h_I;E(p_1),w)=0$.
Because $D(h_I;E(p_1),w)$ is strictly increasing in $E(p_1)$ and w, we know that h_I^* is weakly increasing in $E(p_1)$ and w.

Now we show that $\frac{\partial h_I^*}{\partial E(p_1)}$ is increasing in w. Notice that $D(h_I; E(p_1), w)$ is strictly increasing in w so we only need to show that $\frac{\partial h_I^*}{\partial E(p_1)}$ is increasing in w for interior solutions. By using the Implicit Function Theorem, we have

$$\frac{\partial h_I^*}{\partial w} = \frac{\delta p_0 \phi_1^{"}(w-\delta p_0 h_I^*)}{(\delta p_0)^2 \phi_1^{"}(w-\delta p_0 h_I^*) + \phi_2^{"}(h_I^*)} > 0,$$

$$\frac{\partial (w-\delta p_0 h_I^*)}{\partial w} = \frac{\phi_2^{"}(h_I^*)}{(\delta p_0)^2 \phi_1^{"}(w-\delta p_0 h_I^*) + \phi_2^{"}(h_I^*)} > 0,$$

Then, $\frac{\partial h_I^*}{\partial E(p_1)} = -\frac{1}{(\delta p_0)^2 \phi_1^{"}(w-\delta p_0 h_I^*) + \phi_2^{"}(h_I^*)}$ is strictly increasing in w. Q.E.D.

Proof of Proposition 3

According to the proof in Proposition 1, we focus on the following optimization problem:

$$\max_{h_c \geq \underline{h}, h_I - h_c \geq \underline{h}} u(w-(\delta p_0 - s)h_I - sh_c, h_c) + E[(p_1 - (1+r)(1-\delta)p_0)h_I].$$

Define $O(h_I, z, E(p_1)) = \phi_1(w-\delta p_0 h_I + sz) + \phi_2(h_I - z) + [E(p_1) - (1+r)(1-\delta)p_0)]h_I$.

Then the objective function is $O(h_I, h_I - h_c, E(p_1))$ .We can then verify that $\frac{\partial^2 O}{\partial h_I \partial (h_I - h_c)} > 0$, $\frac{\partial^2 O}{\partial h_I \partial E(p_1)} > 0$ and $\frac{\partial^2 O}{\partial (h_I - h_c) \partial E(p_1)} \geq 0$. By directly using the theorem of Monotone Comparative Statics, we know that h_I^* and $h_I^* - h_c^*$ are weakly increasing in $E(p_1)$.

Similarly, we can also show that h_I^* and $-h_c^*$ are weakly increasing in $E(p_1)$. Hence, h_c^* is weakly decreasing in $E(p_1)$. Q.E.D.

The following proposition demonstrates that the minimum size requirement pulls a household's status down along the tenure-choice ladder.

Proposition 4 (Minimum Size and Tenure Choice)

(1) As the minimum size requirement increases, a household is more likely to be a renter than a house owner, i.e., k_0^* is weakly increasing in $\underline{h}$.

(2) When $\underline{h} \geq \frac{w}{2\delta p_0 - s}$,[22] a house-owner never owns multiple housing units, i.e., $k_1^* = +\infty$;when $\underline{h} < min\{h_c^{**}, h_I^{**} - h_c^{**}\}$, a houseowner owns multiple housing units, i.e., $k_1^* = k_0^*$, where $\{h_c^{**}, h_I^{**}\}$ is the householder's choice with 0 minimum size constraint, i.e., the solution to the following optimization

$$\max_{h_c \geq 0, h_I - h_c \geq 0} u(w - (\delta p_0 - s)(h_I - h_c) - \delta p_0 h_c, h_c) + [E(p_1) - (1+r)(1-\delta)p_0][(h_I - h_c) + h_c].$$

The intuition for the first part is obvious. As the household becomes more constrained in owning housing units, she has less incentive to own houses. For house owners, as the minimum requirement becomes sufficiently large, owning multiple housing units is not feasible, therefore she owns only one unit. As the constraint becomes looser, such incentive distortion disappears and she owns at least two units.

Proof of Proposition 4

Notice that the household's optimization problem is the following:

$$\max_{h_c, h_I - h_c} u(w - (\delta p_0 - s)(h_I - h_c) - \delta p_0 h_c, h_c) + [E(p_1) - (1+r)(1-\delta)p_0][(h_I - h_c) + h_c]$$

$$s.t. \quad h_c \in [\underline{h}, +\infty),$$
$$(h_I - h_c) \in \{0\} \bigcup [\underline{h}, +\infty).$$

(1) The result is obvious if we observe that a house owner's expected utility is weakly decreasing in the minimum size, whereas the rent's expected payoff is independent of the minimum size.

---

[22] In fact, for a solution to exist, we need to assume that $\underline{h} < \frac{w}{\delta p_0}$ so that buying one unit is feasible. If $\underline{h} \geq \frac{w}{\delta p_0}$, buying houses is not feasible and the household can only be a renter.

(2) When $\underline{h} \geq \frac{w}{2\delta p_0 - s}$, the non-housing consumption $w-(\delta p_0 - s)(h_I - h_c) - \delta p_0 h_c$ is at most $w-(\delta p_0 - s)\underline{h} - \delta p_0 \underline{h} < 0$ provided that a household buys multiple units. Thus buying multiple housing units is not feasible and house-owners always own only one housing unit.

Whenever $\underline{h} < min\{h_c^{**}, h_I^{**} - h_c^{**}\}$, the constrained optimization problem is equivalent to the unconstrained one. Therefore, in equilibrium, $h_I^* - h_c^* \geq \underline{h}$ and the household owns multiple housing units.

Simulations

We carried out simulations of our model in order to demonstrate the properties of housing demand numerically. In choosing the parameter values, we took some from literature and we calculated some from China's statistical data.

The rate r is the interest rate, which is fixed at the nominal annual rate of 4%. When borrowing funds to buy a home, the mortgage rate that households pay is also r, which is consistent with the reality in China. Down-payment fraction δ is equal to 30%.

Housing price p and rental price s are chosen according to the price-to-rent ratio in China. For most cities in China, the price-to-rent ratio is between 20 and 40. So we take it as 20 in our baseline model. Specifically, we present numerical results when $s = 0.5$ and $p_0 = 10$.

For simplicity, we set $\underline{h} = 1$. We also set $y = 20$.[23] We let the future price p_1 take binary values ($p_H = 15$ and $p_L = 11$) with equal probability. In the simulation, we use the following CRRA utility functions: $\phi_1(x) = \frac{x^{1-\sigma_1} - 1}{1-\sigma_1}$, $\phi_2(h_c) = \frac{h_c^{1-\sigma_2} - 1}{1-\sigma_2}$, and

[23] The component y in the model can be interpreted as the sum of income in the next few years. When the second-period utility is close to a linear function, the results are not sensitive to the value of y.

$V(x) = \frac{x^{1-\sigma_V} - 1}{1-\sigma_V}$, with $\sigma_1 = 4$, $\sigma_2 = 4$, and $\sigma_V = 0.5$.

Our simulation results are shown in FiguresA1-A3. Figure A1 shows the housing investment demand (h_I) versus the current wealth level (w) in a solid curve. We can see clearly that housing investment increases with wealth. Initially, the housing investment is zero. When the wealth reaches a certain level *o1*, the housing investment jumps up, becoming positive, and the household's tenure status changes from *renter* to *own1*. From *o1* on, the investment increases with wealth smoothly until it reaches the wealth level of *o2*. At this point, the investment jumps up again because the household changes tenure status from owning just one primary housing unit*(own1*) to owning multiple housing units(*own2*). After *o2*, the housing investment increases with wealth smoothly and there are no more jumps. The jumpsare caused by the minimum housing size constraint and the down-payment constraint. We also draw the housing consumption demand (h_C, i.e., primary residence demand) in a dotted curve. Note that at *own1* status, housing investment demand is equal to housing consumption demand.

Figure A2 compares the housing investment demand schedule under two expected future housing prices. The solid curve is the housing investment demand corresponding to a lower expected future price (i.e., $p_H = 11$), the dotted curve corresponds to a higher expected future price (i.e., $p_H = 15$). At any wealth level and any tenure status, the housing investment demand is weakly higher when the expected capital gain is higher. Moreover, the range of *own2* expands when the expected future price is higher, indicating a higher probability of owning a second house.

Figure A3 compares the housing consumption demand (i.e., the demand for a primary residence) schedule under two expected future housing prices. The solid curve is the housing consumption demand that corresponds to a lower expected future price; the dotted curve corresponds to a higher expected future price. We can see that in the range of *own1*, housing consumption demand increases with expected future price because now the total investment demand is equal to the consumption demand. However, in the range of *own2*, housing consumption demand decreases a bit when the expected capital gain is higher. Note that there is a downward jump in consumption where households change tenure status from *own1* to *own2*, which reflects the fact that some *own1* households have to divert their investment demand toward having a larger primary residence due to the distortion caused by financial

frictions.

In our empirical analysis, we will examine how the expected capital gains influence households' housing tenure choices and how housing investment demand changes in response to changes in expected capital gains by tenure status. We will also examine whether wealthier households are more responsive to changes in expected capital gains.

Figure A1. Housing investment demand and housing consumption demand

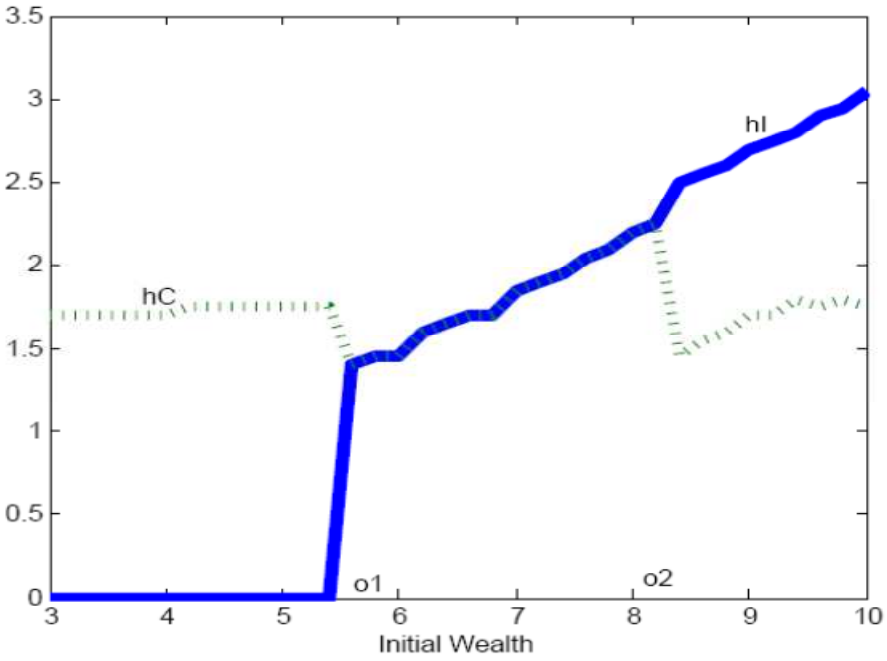


Figure A2. Housing investment demand and expected capital gains

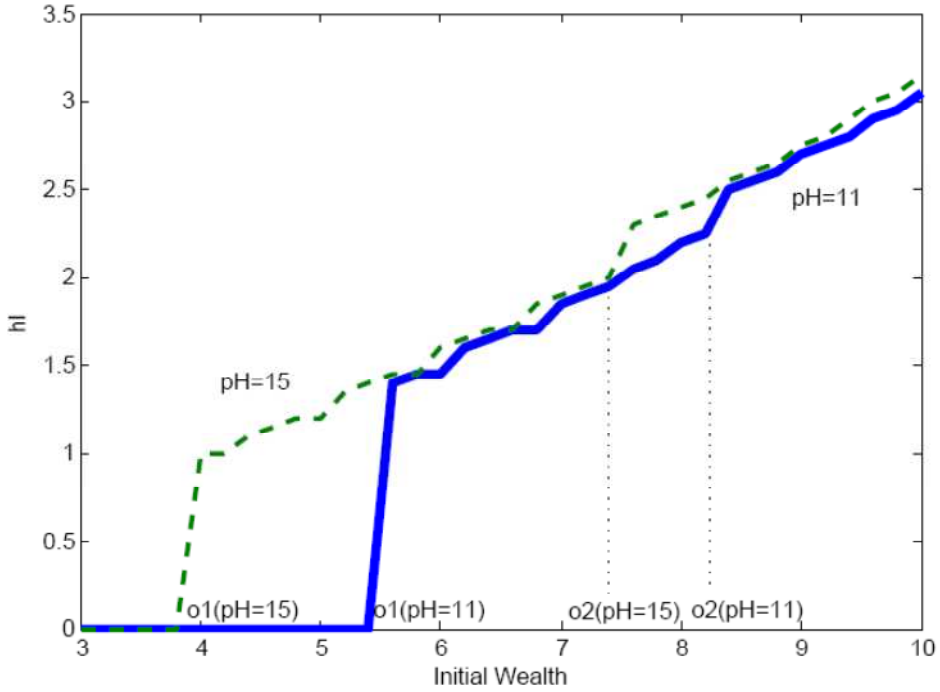
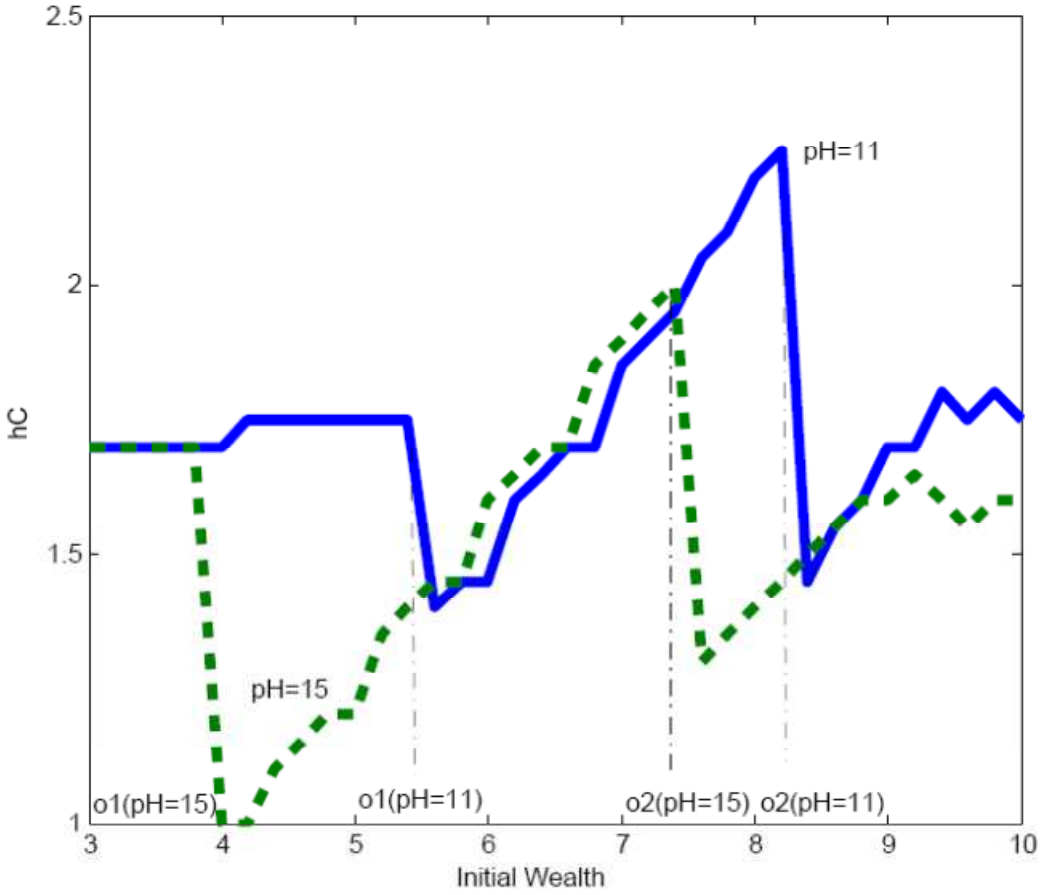


Figure A3. Housing consumption demand



Appendix: Tables

Table A1.Mean (and median) of households' expected capital returns based on hedonic price growth rate around the purchase year of the primary residence by subjective view groups

Group	Number of Observations	Mean of Past growth rate_3	Median of Past growth rate_3
1	18	4.41%	6.19%
2	174	4.67%	6.46%
3	284	6.00%	6.51%
4	116	6.05%	7.33%
5	7	11.22%	9.66%

Note: Groups 1,2,3,4 and 5 represent different subjective views about housing markets (very poor, poor, normal, good, and very good, respectively).Calculations are based on the sample of all homeowners in the CHFS 2011 survey.

Table A2. Distribution of Purchase Year

Purchase Year	Total Number of Observations	Number of Observations of Subsidized Housing Units (Fang-gai-fang)
1997	83	32
1998	124	47
1999	86	23
2000	182	42
2001	125	18
2002	117	15
2003	123	11
2004	138	18
2005	121	10
2006	101	7
2007	91	6
2008	66	10
2009	85	7
2010	882	24
2011	8	0
Total	2332	270

TableA3. Housing tenure choice
(Robustness check with respect to subsidized housing (*Fang-gai-fang* in Chinese))

	With Fang-gai-fang dummy		Drop Fang-gai-fang=1 observations	
Variable	(1)	(2)	(3)	(4)
	Orderedprobit	Linear probit regression-own	Ordered probit	probit-own
Past growth rate_3	0.069*	0.018*	0.067	-0.22
	(0.039)	(0.010)	(0.041)	(0.19)
Ln (Price in purchase year)	-2.85***	-0.75***	-2.85***	-9.33**
	(0.84)	(0.20)	(0.88)	(4.51)
Fang-gai-fang dummy	0.23**	0.11**		
	(0.12)	(0.042)		
Observations	1,931	1,931	1,811	1,739
R2	0.23	0.42	0.23	0.57

Note: *Fang-gai-fang* dummy=1 if primary residence is subsidized housing. Column (2) presents the results from a linear probit regression. We use a linear probit regression because the probit regression does not converge. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A4 Demand for primary residence by tenure status

(Robustness check with respect to subsidized housing (*Fang-gai-fang* in Chinese))

	With Fang-gai-fang dummy				Drop Fang-gai-fang=1 observations			
	Primary housing demand of own1		primary housing demand of own2		primary housing demand of own1		primary housing demand of own2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Heckman	Heckman-50pc	Heckman	Heckman-50pc	Heckman	OLS-50pc	Heckman	Heckman-50pc
Past growth rate_3	0.013*	0.017***	0.0031	0.0083	0.016**	0.012	-0.00095	0.0075
	(0.0068)	(0.0042)	(0.011)	(0.020)	(0.0063)	(0.0083)	(0.010)	(0.020)
Ln (Price in purchase year)	-0.16	-0.084	-0.15	-0.13	-0.21	-0.15	-0.13	-0.12
	(0.17)	(0.14)	(0.28)	(0.61)	(0.21)	(0.22)	(0.22)	(0.63)
Fang-gai-fang dummy	-0.14	-0.27**	-0.27**	-0.076				
	(0.093)	(0.11)	(0.11)	(0.17)				
Rho	0.12	-0.013	0.23	0.73	0.096		0.38	0.75
	(0.12)	(0.068)	(0.20)	(1.24)	(0.12)		(0.35)	(1.30)
Observations	1638	828	1886	884	1536	690	1768	837

Note: *Fang-gai-fang* dummy=1 if primary residence is subsidized housing. “50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. In column (9), we use OLS regression because the Heckman regression does not converge. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A5Whether to own multiple housing units and how many to own
(Robustness check with respect to subsidized housing (*Fang-gai-fang* in Chinese))

	With Fang-gai-fang dummy				Drop Fang-gai-fang=1 observations			
	Probit of own2		Tobit of other house value		Probit of own2		Tobit of other house value	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Heckprob-own2	own2-50pc (based on own)	own2	own2-50pc	Heckprob-own2	own2-50pc (based on own)	own2	own2-50pc
Past growth rate_3	0.017**	0.029***	0.098**	0.17***	0.020*	0.029***	0.12*	0.17***
	(0.0078)	(0.0080)	(0.043)	(0.034)	(0.012)	(0.010)	(0.069)	(0.043)
Ln (Price in purchase year)	-0.70***	-1.06***	-3.98***	-5.18***	-0.72***	-1.04***	-4.30***	-4.99***
	(0.21)	(0.12)	(0.86)	(0.66)	(0.23)	(0.16)	(1.21)	(0.80)
Fang-gai-fang dummy	0.15***	0.18***	0.93***	1.16**				
	(0.035)	(0.068)	(0.18)	(0.46)				
Rho	-0.09				-0.17			
	(0.22)				(0.23)			
Sigma			5.43***	5.45***			5.42***	5.44***
			(0.33)	(0.31)			(0.40)	(0.34)
Observations	1931	684	1491	684	1811	640	1,372	636

Note: *Fang-gai-fang* dummy=1 if primary residence is subsidized housing. “50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2*whose wealth is above the 50th percentile level, we report probit regression results instead in columns (2) and (6).Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A6

Distribution of households who own a housing unit while renting another unit for residence

City name	City code	Number of Observations	Percent(%)
Beijing	110100	75	23.01
Tianjin	120100	5	1.53
Shijiazhuang	130100	1	0.31
Taiyuan	140100	2	0.61
Shenyang	210100	3	0.92
Dalian	210200	5	1.53
Haerbin	230100	6	1.84
Shanghai	310100	106	32.52
Hangzhou	330100	58	17.79
Ningbo	330200	1	0.31
Qingdao	370200	4	1.23
Zhengzhou	410100	5	1.53
Wuhan	420100	15	4.60
Changsha	430100	3	0.92
Guangzhou	440100	14	4.29
Shenzhen	440300	18	5.52
Chongqing	500100	1	0.31
Xian	610100	2	0.61
Lanzhou	620100	2	0.61
All		326	

Table A7. Housing tenure choice

(Robustness check with respect to rent_own)

Variable	Orderedprobit (1)	Orderedprobit (2)	Orderedprobit (sub-sample)
Past growth rate_3	0.044	0.027	0.044**
	(0.03)	(0.02)	(0.020)
Ln (Price in purchase year)	-2.29***	-1.61***	-1.15
	(0.5)	(0.4)	(0.83)
Observations	2,184	2,184	1,216
R2	0.19	0.15	0.18

Note: As a robustness check, we re-run the ordered-probit tenure choice regression by adding one more tenure status: *rent_own*. It is placed above status *rent* but below status *own1*. The results are presented in the first column. Furthermore, we also treat *rent_own* as either *own1* or *own2* in according to the total number of houses the household owns. The second column represents the results of the ordered-probit regression on the whole sample. Since most of the observations of *rent_own* are concentrated in four cities, Beijing, Shanghai, Shenzhen and Hangzhou, we run ordered probit regressions using data from these four cities as a robustness check. The results are presented in the last column. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A8. Demand for primary residence by tenure status

(Robustness check with respect to rent_own)

	Primary residence demand of own1					Primary residence demand of own2			
	Heckman	Heckman	1st stage of Heckman	Heckman (50pc)	1st stage of Heckman (50pc)	Heckman	1st stage of Heckman	Heckman (50pc)	1st stage of Heckman (50pc)
Past growth rate_3	0.013**	-0.0045	0.050	0.017***	0.041	0.021	0.024	0.030	0.040***
	(0.007)	(0.009)	(0.03)	(0.005)	(0.04)	(0.01)	(0.02)	(0.02)	(0.01)
Past growth rate_3* Family wealth		0.0016***				-0.00040			
		(0.0004)				(0.0005)			
ln(Price in purchasing year)	-0.19	-0.29	-1.90***	-0.074	-1.41*	-0.60***	-1.30***	-0.86	-1.42***
	(0.2)	(0.2)	(0.7)	(0.1)	(0.9)	(0.2)	(0.3)	(0.7)	(0.2)
City Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Constant	6.16***	6.52***	19.1***	1.73**	17.5**	9.01***	2.94	8.62	1.95
	(1.7)	(1.7)	(6.5)	(0.8)	(8.1)	(2.5)	(2.7)	(5.9)	(3.9)
Rho	0.11	0.093		-0.061		0.28		0.90	
	(0.10)	(0.10)		(0.08)		(0.4)		(1.2)	
Observations	1,891	1,891	1,891	972	972	2,138	2,138	1,027	1,027

Note: As a robustness check, we treat rent_own as either own1 or own2 according to the total number of houses the household owns.“50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A9. Whether to own multiple housing units and how many to own
(Robustness check with respect to rent_own)

	Heckman probit(own2)		Probit based on own	Tobit (Other house value)	
	Own2	1st stage	Own2 (50 pc)	Own2	Own2 (50 pc)
Past growth rate_3	0.016**	-0.25	0.029***	0.099**	0.17***
	(0.008)	(0.2)	(0.008)	(0.04)	(0.03)
Ln(Price in purchase year)	-0.66***	-12.2***	-1.06***	-3.99***	-5.20***
	(0.2)	(4.6)	(0.1)	(0.8)	(0.6)
City Fixed Effect	Y	Y	Y	Y	Y
Constant	-1.12	165***	-1.27	9.49	0.23
	(1.4)	(36)	(2.7)	(8.3)	(14)
Rho	-0.12				
	(0.2)				
Sigma				5.44***	5.45***
				(0.3)	(0.3)
Observations	2,184	2,184	684	1,491	684

Note: As a robustness check, we treat rent_own as either *own1* or *own2*according to the total number of houses the household owns."50 pc" refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2*, we report the probit regression results. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A10.Housing tenure choice

(Robustness check with respect to forward-looking measure of expected capital gain using the hedonic housing price in the survey year as proxy for the expected capital gains)

Variable	Orderedprobit	Probit-own
ln(Price in survey year)	0.88**	-0.30
	(0.35)	(1.18)
Ln(Rent)	-0.25***	-0.41***
	(0.071)	(0.087)
City Amenities	Y	Y
Observations	1,347	846
R2	0.33	0.54

Note: Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A11. Demand for primary residence by tenure status

(Robustness check with respect to forward-looking measure of expected capital gain using the hedonic housing price in the survey year as proxy for the expected capital gains)

	Primary residence demand of own1		Primary residence demand of own2		
	OLS	OLS(50pc)	OLS	OLS	OLS(50pc)
ln(Price in survey year)	5.52	0.57	-13.9***	-27.1***	-30.0***
	(5.48)	(4.02)	(3.49)	(2.77)	(3.99)
ln(Price in survey year)* Family wealth	0.070*			0.28***	
	(0.035)			(0.035)	
Ln(Rent)	0.16**	0.039***	0.36***	0.33***	0.25***
	(0.057)	(0.0070)	(0.10)	(0.098)	(0.039)
City Amenities	Y	Y	Y	Y	Y
Constant	-84.4	-6.09	177***	325***	296***
	(81.0)	(35.2)	(39.4)	(30.4)	(38.4)
Observations	684	317	168	168	105

Note:“50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. We report OLS regression results because the Heckman regression does not converge. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A12-a. Housing tenure choice
(Robustness check with respect to heterogeneity of housing supply elasticity)

Variables	Orderedprobit
Past growth rate_3	0.070*
	(0.038)
Ln (Price in purchase year)	-2.88***
	(0.83)
Elasticity	-0.60***
	(0.22)
Past growth rate_3* Elasticity	-0.00068
	(0.0021)
Observations	1,931
R2	0.23

Note: Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A12-b.Demand for primary residence by tenure status
(Robustness check with respect to heterogeneity of housing supply elasticity)

	Primary residence demand of own1				Primary residence demand of own2			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Heckman	Heckman	1st stage of Heckman	OLS (50pc)	Heckman	Heckman	1st stage of Heckman	OLS (50pc)
Past growth rate_3	0.021**	0.0029	0.037	0.019***	0.0015	0.0050	0.039**	-0.058
	(0.0084)	(0.010)	(0.026)	(0.0052)	(0.012)	(0.012)	(0.019)	(0.14)
Past growth rate_3* Family wealth		0.0017***				-0.00035		0.0028
		(0.00044)				(0.00041)		(0.0098)
ln(Price in purchasing year)	-0.30	-0.42**	-1.43**	-0.11	-0.11	-0.095	-1.64***	0.51
	(0.21)	(0.20)	(0.60)	(0.14)	(0.30)	(0.31)	(0.35)	(0.54)
Elasticity	-0.24***	-0.21***	-0.15	0.037***	-0.27***	-0.28***	-0.33***	0.0091
	(0.043)	(0.044)	(0.17)	(0.0073)	(0.079)	(0.082)	(0.083)	(0.014)
Past growth rate_3* Elasticity	-0.0029**	-0.0031**	-0.0017	-0.00023	0.0012	0.0012	-0.00036	0.0044**
	(0.0015)	(0.0014)	(0.0022)	(0.0016)	(0.0017)	(0.0017)	(0.0016)	(0.0018)
City Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y
Constant	5.56***	5.86***	15.3**	1.98**	6.70***	6.71***	4.74*	2.86
	(1.68)	(1.64)	(6.29)	(0.89)	(2.15)	(2.15)	(2.45)	(2.95)
Rho	0.084	0.050			0.23	0.23		
	(0.11)	(0.12)			(0.21)	(0.20)		
Observations	1,638	1,638	1,638	8453	1,886	1,886	1,886	161

Note:“50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. We use OLS regression in col(4) and col(8) because the Heckman regression does not converge. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A13. Whether to own multiple housing units and how many to own
(Robustness check with respect to heterogeneity of housing supply elasticity)

	Heckman probit(own2)		Probit based on own	Tobit (Other house value)
	Own2	1st stage	Own2 (50 pc)	Own2
Past growth rate_3	0.015*	-0.65**	0.022**	0.10**
	(0.0082)	(0.29)	(0.011)	(0.046)
Ln (Price in purchase year)	-0.61***	-10.1***	-0.97***	-4.06***
	(0.20)	(3.76)	(0.19)	(0.88)
Elasticity	-0.22***	-7.92***	-12.1	-1.25***
	(0.055)	(2.20)	(8.35)	(0.28)
Past growth rate_3* Elasticity	0.00045	0.10***	0.0030	-0.0016
	(0.0013)	(0.031)	(0.0029)	(0.0062)
City Fixed Effect	Y	Y	Y	Y
Constant	-1.06	199***	5.52	9.74
	(1.52)	(48.3)	(6.87)	(8.48)
Rho	-0.19			
	(0.19)			
Sigma				5.44***
				(0.33)
Observations	1,931	1,931	684	1,491

Note:“50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2*, we report the probit regression results. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A14. Housing tenure choice

(Robustness check with respect to heterogeneity of families with unmarried boys)

Variable	Orderedprobit	Probit-own
Past growth rate_3	0.073*	-0.21
	(0.038)	(0.19)
Ln (Price in purchase year)	-2.88***	-9.56**
	(0.83)	(4.57)
Unmarried boys dummy	0.16*	-0.22
	(0.083)	(0.29)
Past growth rate_3*Unmarried boys dummy	-0.016***	-0.0030
	(0.0030)	(0.012)
Observations	1931	1859
R2	0.23	0.57

Note: Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A15.Whether to own multiple housing units and how many to own
(Robustness check with respect to heterogeneity of families with unmarried boys)

	Heckman probit(own2)		Probit based on own	Tobit (Other house value)	
	Own2	1st stage	Own2 (50 pc)	Own2	Own2 (50 pc)
Past growth rate_3	0.020***	-0.22	0.033***	0.12***	0.18***
	(0.0068)	(0.19)	(0.0072)	(0.039)	(0.035)
Ln(Price in purchase year)	-0.60***	-8.84**	-1.07***	-3.98***	-5.23***
	(0.22)	(4.17)	(0.10)	(0.81)	(0.66)
Unmarried boys dummy	0.38***	-0.25	0.18	1.74***	0.39
	(0.096)	(0.29)	(0.17)	(0.50)	(0.56)
Past growth rate_3*Unmarried boys dummy	-0.021***	-0.0022	-0.015	-0.10***	-0.034
	(0.0067)	(0.012)	(0.011)	(0.030)	(0.031)
City Fixed Effect	Y	Y	Y	Y	Y
Constant	-1.84	158***	-1.39	7.98	0.15
	(1.59)	(37.1)	(2.67)	(8.16)	(14.2)
Rho	-0.21				
	(0.20)				
Sigma				5.42***	5.45***
				(0.33)	(0.31)
Observations	1931	1931	684	1491	684

Note: “50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2*whose wealth is above the 50th percentile, we report the results of the probit regression instead.

Table A16. Housing tenure choice
(Robustness check with restriction policies)

Variable	Orderedprobit
Past growth rate_3	0.078**
	(0.039)
Ln (Price in purchase year)	-1.71*
	(0.87)
Restriction policies	-0.75**
	(0.34)
Past growth rate_3* Restriction policies	-0.022
	(0.020)
Observations	1,931
R2	0.25

Note: Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A17.Demand for primary residence by tenure status

(Robustness check with restriction policies)

	Primary residence demand of own1					Primary residence demand of own2			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Heckman	Heckman	1st stage of Heckman	Heckman (50pc)	1st stage of Heckman (50pc)	Heckman	Heckman	1st stage of Heckman	OLS (50pc)
Past growth rate_3	0.012	-0.0059	0.043*	0.015***	0.032	0.0093	0.011	0.038**	0.013
	(0.0077)	(0.011)	(0.025)	(0.0038)	(0.031)	(0.011)	(0.013)	(0.017)	(0.0074)
Past growth rate_3* Family wealth		0.0016***					-0.00014		
		(0.00044)					(0.00035)		
ln(Price in purchasing year)	-0.20	-0.31	-0.051	-0.40**	0.45	0.19	0.19	-1.02***	-0.12
	(0.22)	(0.22)	(0.81)	(0.16)	(0.86)	(0.38)	(0.38)	(0.27)	(0.27)
Restriction policies	-0.53*	-0.52*	-0.35	-0.20	-0.40	0.030	0.027	-0.78***	0.25
	(0.30)	(0.30)	(0.39)	(0.27)	(0.54)	(0.36)	(0.36)	(0.26)	(0.18)
Past growth rate_3* Restriction policies	0.021	0.021*	-0.040***	0.020*	-0.038**	-0.022*	-0.021	0.0072	-0.012
	(0.013)	(0.013)	(0.016)	(0.010)	(0.017)	(0.013)	(0.014)	(0.014)	(0.0098)
City Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Constant	5.62***	5.98***	11.1**	2.32***	10.1*	5.01**	5.02**	2.15	1.63**
	(1.26)	(1.22)	(5.58)	(0.69)	(5.93)	(2.01)	(2.04)	(1.70)	(0.66)
Rho	0.16	0.12		-0.0037		0.32	0.32		
	(0.12)	(0.12)		(0.088)		(0.44)	(0.43)		

Observations	1,638	1,638	1,638	828	828	1,886	1,886	1,886	728

Note:“50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. We use OLS regression in column (9) because the Heckman regression does not converge. Other controls are the same as those in the main regressions but are not reported here in order to save space.

Table A18. Whether to own multiple housing units and how many to own
(Robustness check with restriction policies)

	Heckman probit(own2)		Probit based on own	Tobit (Other house value)	
	Own2	1st stage	Own2 (50 pc)	Own2	Own2 (50 pc)
Past growth rate_3	0.017**	-0.18	0.028***	0.11***	0.18***
	(0.0073)	(0.15)	(0.0084)	(0.036)	(0.030)
Ln(Price in purchase year)	-0.61***	-14.1***	-1.01***	-1.94***	-3.75***
	(0.22)	(5.20)	(0.17)	(0.92)	(0.76)
Restriction policies	-0.47**	9.19***	-0.46*	-3.37***	-2.53**
	(0.20)	(2.76)	(0.24)	(0.91)	(1.28)
Past growth rate_3* Restriction policies	0.015	-0.59***	0.017**	0.049	0.046
	(0.0095)	(0.18)	(0.0078)	(0.043)	(0.052)
City Fixed Effect	Y	Y	Y	Y	Y
Constant	-1.48	282***	-1.17	2.33	-0.052
	(1.44)	(64.1)	(2.70)	(8.13)	(14.1)
Rho	-0.11				
	(0.21)				
Sigma				5.41***	5.44***
				(0.34)	(0.32)
Observations	1931	1931	684	1491	684

Note: “50 pc” refers to the regression where we exclude families whose wealth is below the 50th percentile level. Since the Heckman probit regression does not converge for the group of *own2*, we report the results of the probit regression instead.