

Does Rising House Price Push Chinese Households to “Leverage Up” More?

—A Study from the Perspective of Heterogeneity of House-Buying Motivation

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The rapid rise of leverage in Chinese household sector in recent years has attracted considerable attention, and high housing prices might be the main reason for the phenomenon. Do different house-buying motivations of households give an impetus to it? Researching this problem is of great importance to understand mechanisms for the formation of household leverage and taking targeted housing policies. Theoretical analysis in this paper finds that if house-buying motivation that was speculative was quite obvious, rising housing prices would result in the leverage of non-first-house (NFH) households outpacing that of first-house (FH) households. On this basis, we conducted empirical analysis with a state-owned bank's all housing mortgage loan data on 70 large and medium-sized cities for 2016 and the IV (instrumental variables) and DID (differences-in-differences) methods, and compared the two types of households from the inter-city and intra-city dimensions. The result showed that rising housing prices indeed drive up the debt balance and leverage of NFH households significantly more than those of FH households. Furthermore, our research found that a rise in housing prices has prompted NFH households to be more inclined to make the most use of mortgage policies with no substantial housing difference. To curb excessive leverage increase in the household sector, therefore, apart from regulating high expectations of housing prices, there should be stepped-up credit constraints on NFH households, thus restricting their behavior of excessive speculation.

Keywords: household leverage, rising housing prices, housing purchase motivation, DID method.

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1. Introduction

In the midst of economic transformation, macroeconomic leverage in China was increasing in recent year, in response to which the supervisory authorities have formulated deleveraging policy measures that target local governments and state-owned enterprises (SOEs). Leverage in the household sector seems to have been ignored in the meanwhile. In light of the lessons learned from the 2008 subprime mortgage crisis, it is widely accepted in the Western academia that high leveraging in the household sector is the main cause of an economic recession (Mian and Sufi 2009, 2010, 2011, 2016; Corbae and Quintin, 2015; Mian *et al.*, 2017; Jones *et al.*, 2018) and should be taken very seriously.

According to data released by the People's Bank of China, as of the end of 2019, the household leverage ratio, measured by the ratio of household debt to disposable income, surged from 44.77% in 2007 to 128.59% in 2019, which was close to the peak value (130.88%) before the United States subprime mortgage crisis. If the enormity of private loans which is impossible to tally were taken into account, the problem of high leverage in the country's household sector has in fact arrived at a degree that demands vigilance (Ma *et al.*, 2016; Tian *et al.*, 2018). Home loans have always been an important part of household debt. From 2007 to 2019, the balance of home loans in the household sector rose from RMB 2.7 trillion to RMB 30.07 trillion, nominally increased by 11.14-fold, which grew faster than debt on the whole and from which it is evident that home loans increased obviously faster than other debt. It can be judged, therefore, that the surge in household leverage was largely owing to home loans.

Since the continual increase of household leverage is mainly contributed to by home loans, its change is certain to be strongly correlated with the degree of prosperity of the real estate market. Figure 1 shows the trends in the change of the household home loans-to-disposable income ratio and housing prices, which are the core component of the leverage ratio. Obviously, the household leverage ratio basically changed in keeping with housing prices. In particular, following the introduction of a new round of housing-purchase easing policies ("930 New Deal") across the country in the 3rd quarter of 2014, the household leverage ratio started to increase so fast that it even outpaced housing prices in 2016. So, with the central government discouraging speculative investment in housing, was it caused by the necessary housing demand or demand for speculative investment in housing behind the surge in household leverage? And what is the mechanism behind the increase leveraging of households with different housing-purchase motivations? This concerns how we make sense of the present position of the real estate market and how to formulate effective policy measures against high household leverage.

Domestic research on causes of high household leverage almost takes intrinsic household characteristics as a point of departure and focus on their effects on borrowing behavior of households, which includes differences in demographic

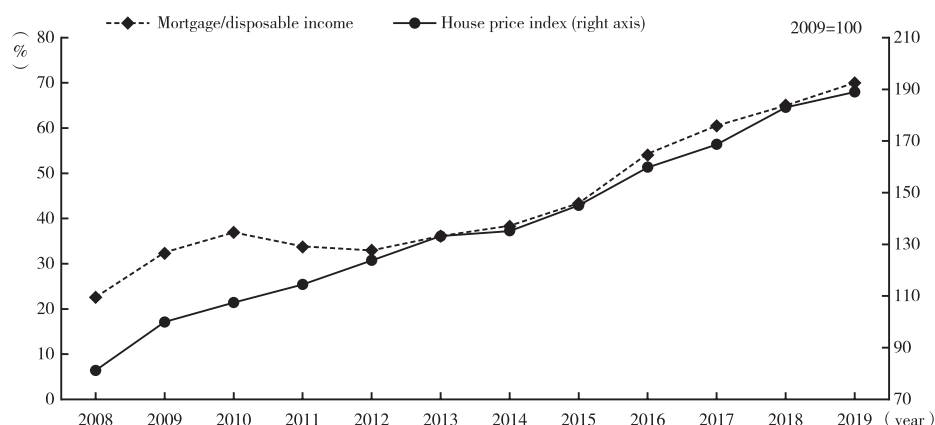


Figure 1. Trends in the Change of Housing Prices and Household Leverage Ratio in China

Source: People's Bank of China and National Bureau of Statistics of China.

characteristics (Chen and Li, 2011), income levels and inequality (Wu *et al.*, 2013; Guo *et al.*, 2016), social capital (Chen and Pan, 2017), and financial literacy (Wu *et al.*, 2018). However, if changes in the macroeconomic environment are taken into consideration, it can be much easier to identify systematic risk hidden in the problem of high household leverage (Mian and Sufi, 2011; Adelino *et al.*, 2016). It is from this perspective that Zhou and Wang (2019) built in their research a correlation between housing prices and household leverage and made the conclusion that rising housing prices drove up housing demand of households and increased their borrowing willingness and risk appetite. Their research has some similarities to this paper, but what is different is that our focus of research is on differences in “leveraging” between households with different house-purchasing motivations (inelastic demand or speculation), with emphasis placed on examining mechanisms behind those differences and analyzing if there is speculation hidden in fast-rising household leverage for the present. Different house-purchasing motivations are the primary structural characteristic of Chinese households purchasing houses with mortgages, and also can reflect reasons underlying the rapid increase in household leverage.

The remaining sections of this paper are as follows: Part 2 builds a model of optimal house choices of households and theoretically analyzes whether the mortgage change of households with different house-purchasing motivations is identical in the case of rising house prices; Part 3 is about the source of data used for empirical analysis, variables explanation, and identification strategies; Part 4 examines inter-city effects of rising house prices on household leverage; Part 5 goes on to look into intra-city effects of rising house prices on household leverage; and Part 6 presents conclusions and policy suggestions.

2. Theoretical Basis for the Impact of Rising House Prices on Household Leverage with Different House-Purchasing Motivations¹

To investigate into mechanisms by which rising house prices affects household leverage, we introduced the mortgage factor into the optimal house choice model of Kaplan *et al.* (2016) in building a correlation between house prices and household leverage, and then we expounded further from differences between FH households and NFH households.

As Kaplan *et al.* (2016) did in their study with regard to the household utility function, we assumed that the goal of households is to maximize utility by making choices relating to consumer spending and house retention. The form of utility function is:

$$\max \left\{ E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \frac{\left[(C_{j,\tau})^{\chi} (Q_{j,\tau})^{1-\chi} \right]^{1-\sigma}}{1-\sigma} \right\}, j=1, 2$$

where, $j=1, 2$ stand for FH households and NFH households, respectively; β stands for the discount rate; σ is the coefficient of relative risk aversion for consumers, where households exist indefinitely; χ is the parameter of households' preference for general goods, representing the share of general goods consumption in utility; $C_{j,t}$ corresponds to households' consumer spending of general goods; $Q_{j,t}$ corresponds to real estate that households possess in the term t , with houses bringing to households corresponding residential utility.

2.1. Decision-Making of FH Households

Both FH and NFH households purchase houses within the term t . It is assumed that FH households' house-purchasing motivation is inelastic demand and that they will not sell the houses they have purchased in the short term. NFH households have different forms of disposal for houses they have purchased, subject to their different house-purchasing motivations. The two types of households face different constraints beginning in the term t .

To FH households, their budget constraint in the term t is:

$$C_{1,t} + P_t^h Q_{1,t} + A_{1,t} = Y_{1,t} + (1+r) A_{1,t-1} + D_{1,t}$$

Also, they are subject to the bank's credit constraint:

¹ To save space, from this section detailed theoretical deduction is omitted the process of, which is available on demand, by email, to interested readers.

$$D_{1,t} \leq (1 - \lambda_1^m) P_t^h Q_{1,t}$$

where, λ_1^m is the rate of first mortgage repayment that the bank requires of them; $A_{1,t}$ is financial wealth that FH households own (to Chinese households, primarily savings); $Y_{1,t}$ is disposable income of households; P_t^h is the house price in the term t ; $D_{1,t}$ is the mortgage payments of FH households in the term t , and the rate of return for financial wealth they held in the previous term is r .

FH households began repaying mortgages in the term $t+1$, and it is assumed, as things constant in China, that they adopt the mortgage form of “equal loan repayment” (the mortgage repayment in each repayment term is equal in amount). Therefore, the borrower is aware in the term t of the mortgage in its duration, and so the budget constraint after the term t is:

$$C_{1,i} + mD_{1,t} + A_{1,i} + \delta_h P_{1,t}^h Q_{1,t} = Y_{1,i} + (1+r) A_{1,i-1}, \quad i = t+1, t+2, \dots, T$$

where, m ($0 < m < 1$) stands for the ratio of mortgage repayment to the mortgage in each term for households with inelastic demand; δ_h is the rate of house depreciation, which stands at the expenditure end for the rate of repairing the current house; and T stands for the continued term during which no house transaction is made. In the model, therefore, their optimal decisions in the term t take into account intertemporal situations, and they maximize utility of the current term by choosing consumer spending $C_{1,t}$, the size of the house purchased $Q_{1,t}$, the amount of financial wealth held $A_{1,t}$, and the mortgage $D_{1,t}$.

The discount rate here is set as the reciprocal of the risk-free rate of return, namely $\beta(1+r) = 1$ (Kiyotaki and Moore, 1997; Gertler and Karadi, 2011; Kaplan *et al.*, 2016), and it is assumed that there are no income constraints and house transaction costs. We may arrive at:

$$C_{1,t}^* + \phi D_{1,t} = Y_{1,t}^* + \phi (1 - \lambda_1^m) P_t^h Q_{1,t} \quad (1)$$

Therefore, the equation of FH households' optimal decision-making behavior is:

$$D_{1,t} = \phi^{-1} (Y_{1,t}^* - C_{1,t}^*) + (1 - \lambda_1^m) P_t^h Q_{1,t} \quad (2)$$

where,

$$\phi = \left[m \frac{(1+r)^T - 1}{r \times (1+r)^T} - 1 \right]$$

$$Y_{1,t}^* = E_t \sum_{\tau=t}^T (1+r)^{t-\tau} Y_{1,\tau} + (1+r) A_{1,t-1} + (1+r)^{t-T} A_{1,t-1}$$

$$C_{1,t}^* = \left(\frac{1}{\chi} + \sum_{i=t+1}^T (1+r)^{t-i} \right) C_{1,t}$$

From the formulas (1) and (2), owing to FH households being of inelastic demand, their future decision-making will not affect their “leveraging” behavior in the current term, and the mechanism by which rising house prices drives FH household leverage is quite intuitive; because of rising house prices, when other conditions remain unchanged, homebuyers of this type have to increase leverage.

2.2. Decision-Making of NFH Households

2.2.1. NFH Households with Inelastic Demand

To some NFH households, they purchase houses to improve their living condition or as wedding houses for their children. Their house-purchasing motivation is in effect also of inelastic demand, and it may be assumed that they will not sell houses they have purchased in the short run. Therefore, if they purchase houses in the term t , their budget constraint in the term is:

$$C_{2,t} + P_t^h Q_{2,t} + A_{2,t} = Y_{2,t} + (1+r) A_{2,t-1} + (1-\delta_h) P_t^h Q_{2,t-1} + D_{2,t}$$

Also, they are subject to credit constraints:

$$D_{2,t} \leq (1-\lambda_2^m) P_t^h Q_{2,t}$$

$D_{2,t}$ stands for mortgage repayments in the term t . λ_2^m is the lowest rate of first mortgage repayment for NFH households, $\lambda_2^m > \lambda_1^m$. Beginning in the term $t+1$, their budget constraint is similar to that of FH households:

$$C_{2,i} + mD_{2,i} + A_{2,i} + \delta_h P_i^h Q_{2,i} = Y_{2,i} + (1+r) A_{2,i-1}, \quad i = t+1, t+2, \dots, T$$

Under the same assumptions, like FH households, their optimal choice in the term t is:

$$C_{2,t}^* + \phi D_{2,t} = Y_{2,t}^* + \phi (1-\lambda_2^m) P_t^h Q_{2,t} \quad (3)$$

Upon utility maximization, their optimal decision-making equation is:

$$D_{2,t} = \phi^{-1} (Y_{2,t}^* - C_{2,t}^*) + (1-\lambda_2^m) P_t^h Q_{2,t} \quad (4)$$

Obviously, the mechanism by which rising house prices drives their leverage is the same as that for FH households; because of rising house prices, when other conditions remain unchanged, homebuyers of this type have to increase leverage.

2.2.2. Speculative NFH Households

To NFH households purchasing houses for speculative purposes, in each term they may choose to sell houses they purchased in the previous term for profits, which requires them to pay mortgage installments for the previous term once for all. Their budget constraint form is:

$$C_{2,t} + P_t^h Q_{2,t} + A_{2,t} + (1 + r_m) D_{2,t-1} = Y_{2,t} + (1 - \delta_h) P_t^h Q_{2,t-1} + (1 + r) A_{2,t-1} + D_{2,t}$$

Also, they are subject to credit constraint:

$$D_{2,t} \leq (1 - \lambda_2^m) P_t^h Q_{2,t}$$

where r_m is the mortgage rate.

Under the same assumptions, therefore, their optimal decision-making equation after utility maximization in the term t :

$$D_{2,t} = \frac{1}{1 + r_m} (Y_{2,t+1}^* - C_{2,t+1}^*) + \frac{1 - \delta_h}{1 + r_m} E_t (P_{t+1}^h) Q_{2,t} \quad (5)$$

where,

$$C_{2,t+1}^* = E_t \sum_{\tau=t+1}^{\infty} \frac{(1+r)^{t+1-\tau}}{\chi} C_{2,\tau}$$

$$Y_{2,t+1}^* = E_t \sum_{\tau=t+1}^{\infty} (1+r)^{t+1-\tau} Y_{2,\tau} + (1+r) A_{2,t}$$

From the formula (5), it is obvious that to speculative house-purchasing households, the mechanism by which house prices drive their leverage correlates with profits expected from a rise in house prices in the future: When future house prices are expected to rise, they will increase leverage in the current term, and the more houses they own, the bigger utility brought about by selling more houses in the future.

2.3. Comparative Analysis

In analyzing the impact of rising house prices on household leverage, to households

of inelastic demand, by differentiating the formulas (2) and (4) in relation to house prices, we get:

$$\frac{\Delta D_{1,t}}{\Delta P_t^h} = (1 - \lambda_1^m) Q_{1,t} \quad (6)$$

$$\frac{\Delta D_{2,t}}{\Delta P_t^h} = (1 - \lambda_2^m) Q_{2,t} \quad (7)$$

Let the leverage ratio be the ratio of household debt to disposable income:

$$L_{i,t} = \frac{D_{i,t}}{Y_{i,t}}, \quad i = 1, 2$$

By dividing both sides of the formulas (2) and (4) with disposable income and differentiating house prices, we arrive at:

$$\frac{\Delta L_{1,t}}{\Delta P_t^h} = (1 - \lambda_1^m) \frac{Q_{1,t}}{Y_{1,t}} \quad (8)$$

$$\frac{\Delta L_{2,t}}{\Delta P_t^h} = (1 - \lambda_2^m) \frac{Q_{2,t}}{Y_{2,t}} \quad (9)$$

Comparing the formulas (6) and (7) with (8) and (9), we find that when other conditions are identical, so long as they purchase houses out of inelastic demand, the impact of rising house prices on household leverage increase lies in the minimum rate of first mortgage repayment. Because this rate is lower for FH households, their leverage increase is higher.

Given the present social expectations of “rising, never falling” house prices, speculative households’ adaptive expectations dominate, so $\frac{\Delta E_t(P_{t+1}^h)}{\Delta P_t^h} > 1$ (Kuang, 2010), a differentiation of the formula (5) in relation to house prices results in:

$$\frac{\Delta D_{2,t}}{\Delta P_t^h} > \left(\frac{1 - \delta_h}{1 + r_m} \right) Q_{2,t} \quad (10)$$

$$\frac{\Delta L_{2,t}}{\Delta P_t^h} > \left(\frac{1 - \delta_h}{1 + r_m} \right) \frac{Q_{2,t}}{Y_{2,t}} \quad (11)$$

A comparison of the formulas (6) and (10) with (8) and (11)¹ suggests that the impact of rising house prices on speculative households' level of leverage lies in their profitability of houses sold in the future, given identical other conditions, expected rising house prices will lead speculative NFH households to increase leverage more than FH households.

On the whole, the degree to which NFH households' leverage increase is impacted by house prices is subject to the percentage of speculative households. We assume that, of NFH households, the percentage of speculative households is q . When other conditions are identical, the impact of house prices on NFH households' leverage increase is:

$$q \left(\frac{1 - \delta_h}{1 + r_m} \right) + (1 - q)(1 - \lambda_2^m)$$

And the impact of house prices on FH households' leverage increase is:

$$(1 - \lambda_1^m)$$

Therefore, so long as q is bigger than a certain number, on the whole, NFH households will increase their leverage due to rising house prices more than FH households.²

Given the general environment at the time where there was widespread optimism about house prices, the above analysis may lead to the hypothesis: Rising house prices drive household leverage up, and owing to their conspicuous speculation, NFH households would increase leverage significantly higher than FH households do.

Because our sample data is cross-sectional data and changes in house prices occurred in cities, there are two dimensions of testing. The first is testing in the inter-city dimension, namely testing the average impact that the change of house prices in different cities had on household leverage increase. The hypothesis to be tested is that the difference in the extent of leverage driven up by house prices for NFH households in different cities is greater than that between FH households. The second is testing in the intra-city dimension. To NFH and FH households living in one city, there is no change in data on house prices, but empirically speaking, this section still need to design a strategy by which to identify the impact of rising house prices on

¹In China, $\frac{(1 - \delta_h)}{(1 + r_m)} > (1 - \lambda^m)$ is always tenable when it comes to the depreciation rate of general houses, house mortgage rate, and the minimum rate of first mortgage repayment as prescribed by policies.

²In our model, we considered the extreme case, i.e. when there is the biggest difference in the minimum rate of first mortgage repayment between FH households ($\lambda_1^m = 0.2$, accumulation fund loan in 2016) and NFH households ($\lambda_2^m = 0.7$, a percentage of households in Beijing, Shanghai, Guangzhou and Shenzhen in 2016), the assumed conclusion is tenable so long as q is bigger than 78.17%. In reality, it is certain that a number far smaller than this percentage can satisfy the conclusion.

the difference in the extent of leverage between two types of households. Therefore, the hypothesis to be tested is that in the same one city, the average house price-driven increase of NFH household leverage is higher than that of FH household leverage, too.

3. Data Source, Variables Explanation, and Identification Strategy

3.1. Data Source

The sample of this study is mainly derived from a state-owned bank's all house mortgage data on 70 large and medium-sized cities for 2016, and other city-level data came from the China Land and Resources Statistical Yearbooks, the China City Statistical Yearbooks, local statistical yearbooks, and CEIC databases. Data from the bank include basic information on residents who purchased a house in the year with a mortgage as mortgage, first mortgage repayment, mortgage rate, monthly mortgage repayment, mortgage term, date of mortgage released, mortgage-granting bank branch, total house price, house area, annual income, and the number of houses they possessed, as well as demographic information like borrowers' age, gender, and levels of education. The bank's total mortgage volume accounted for 13% of the country's total, so it was representative. In data processing, to prevent interference from outliers, we first wiped off individuals whose family income information was missing or zero, mortgage rate and year-end mortgage balance was smaller than or equal to zero, house area was zero or more than 500m², mortgage plus first repayment exceeded the total house price, or education information was missing, and we proceeded to get rid of individuals who didn't comply with Chinese banks' mortgage restrictions—for instance, their first mortgage repayment was below 20%, their monthly family income was below two times the monthly mortgage repayment, or their age as applicants were below 18 or older than 65. Finally, we got information on 558826 valid individuals.

3.2. Variables Explanation

3.2.1. Explained Variables

Our samples are cross-sectional data, and after the easing of house-purchase policies, the household leverage ratio rose rapidly in 2016 (Figure 1). Therefore, we chose the debt balance and the leverage ratio (measured as the ratio of the mortgage balance to family income) of borrowing families in 2016 as explained variables. The data itself suggests, in effect, that residents' year-end mortgage balance and leverage

ratio both represent an “increment”¹, and this accords with the definition of explained variables given in the study of Mian and Sufi (2011).

3.2.2. Explanatory Variables

We chose variable the logarithm of the average house price in 2016 of a city where house-purchasing residents lived as the core explanatory, which is represented as the average selling price in the year of commercial houses in the city. Our sample contained information on all mortgage-granting bank branches. We matched the cities where those bank branches operated with cities in which borrowing citizens lived. According to information on commercial house sales (sales volume/area) in those cities, which was contained in the China City Statistical Yearbooks, local statistical yearbooks, and CEIC databases, we arrived at the average house prices in those cities in 2016.

Besides, we controlled such family information on borrowers as family income, gender, age, and level of education, area of houses purchased, and mortgage information like mortgage rate, rate of first repayment (first repayment/total house price), and mortgage term. The quadratic term of age was added, considering that the age structure might have effects on individual behavior of increasing leverage; there were 6 levels of education, namely elementary, junior secondary, senior secondary, undergraduate, and postgraduate education, to which 1, 2, 3, 4, 5 and 6 were assigned in the shown order; the house status variable was a virtual variable, and its value was 1 when a purchased house was the first house of an individual, or else it was 0. We also controlled a group of characteristic variables concerning the cities in the year so as to mitigate omitted-variable bias as much as possible (Lu *et al.*, 2015). This variables group covered other important factors that simultaneously affected house prices and households purchasing a house with a mortgage, including: (1) labor productivity of a city, measured by the logarithm of per capita GDP, signifying how developed the city is; (2) economic growth of a city, measured by the rate of GDP growth, signifying how fast the city is developing; (3) consumption of urban residents, measured by the logarithm of per capital retail sales of consumer goods, reflecting the consumption propensity of a city’s residents; (4) employment intensity of a city, measured by the population employed in the secondary and tertiary industries divided by the logarithm of the built-up area, an indicator that measures house supply and demand—the greater the employment intensity, the higher the house prices; (5) living condition of urban

¹ To FH residents, this mortgage balance and leverage ratio represent their increment in 2016; to NFH residents, even if they had a mortgage to repay, their debt repaid in the year as prescribed by their mortgage contract was much small in relation to their new mortgage now, and so their year-end mortgage balance may also be seen as their debt increment in 2016 and, if their family income didn’t fluctuate drastically in the neighboring two years, the leverage ratio also approximately stands for their leverage increment in 2016.

residents, measured by the logarithm of the per capita residential land area, an indicator that reflects a city's real estate market sentiment; (6) urban credit condition, measured by the logarithm of per capita year-end loan balance denominated in renminbi at financial institutions; (7) urban infrastructure, measured by the logarithm of per capita paved-road area; and (8) urban environment condition, measured by the logarithm of per capita park green area. The infrastructure and environment indicators reflect the degree of livability of a city. Data on urban characteristic variables came from the China City Statistical Yearbooks and local statistical yearbooks of corresponding cities.

3.2.3. Endogenous and Instrumental Variables

There was obvious endogeneity between house prices in a city and households purchasing houses with a mortgage. On the one hand, there is reverse causality, i.e. households purchasing a house with a mortgage drove up demand on the local real estate market, which in return elevated overall house prices in the city; on the other hand, though we controlled as much as possible a group of city-level variables for which information could be acquired, theoretically possibility existed that there were still unobserved variables which simultaneously affected the city's house prices and households purchasing a house with a mortgage. Therefore, we adopted the IV method so as to mitigate endogenous estimator bias.

On the selection of IVs, we borrowed from some scholars' research: land supply in a city is an appropriate IV for house prices (Lu *et al.*, 2015; Tong and Liu, 2018), and the smaller land supply, the higher level of house price (Chen and Yang, 2013). We choose as IV the per capita area of land supplied for housing construction of cities in 2015. Data on the areas of land supplies for housing construction in cities came from the China Land and Resources Statistical Yearbooks, and the per capita area of land used for housing construction in cities was calculated by using the ratio of the areas of land supplied for housing construction in cities to their year-end permanent population. Because, in China, land used for commercial house development must be supplied in the form of land transfer and both land use and transfer in cities are strictly controlled by local governments, house land supply is a government policy variable which is strongly exogenous. Of course, there is concern that an increase in the per capita area of land supplied for residential purposes may affect resident borrowing by means of promoting economic development. However, since we controlled a series of variables concerning urban economic development, the problem may to a great extent be avoided. Moreover, because we used the previous year's per capita area of land supplied for housing construction as an IV, the possibility that house prices in returned affected the area of land supplied for residential purposes was reduced.¹

¹ Given the limited space, descriptive statistics concerning variables are omitted, which are available to interested readers on request.

3.2.4. Possible Sample Selection Bias

Given the point of departure for this paper and its theoretical basis, our research is focused on different types of households purchasing a house with a mortgage so as to test the difference in the extent of household leverage driven by urban house prices, and what the sample recorded was just information residents who purchased a house with a mortgage borrowed from the bank. As for those households who for various reasons were unable to borrow from a bank but had to turn to private loans, it was nearly impossible for us to obtain their true information. However, according to research conducted by Zhou and Wang (2019) using CFPS (China Family Panel Studies)¹ data, they also drew the conclusion that rising house prices drove Chinese household leverage up, and found that the increase of leverage was largely derived from bank loans. As for other individuals that it was impossible for the sample to cover, for example, households that purchased a house without increasing leverage and those unwilling to buy a house, even if they had mortgage repayments to make before 2016, their actual leverage in 2016 might reduce with mortgage repayments made in the year. However, that was based on repayment provisions on mortgage contracts they signed in the year, which had nothing to do with house prices that this study is focused on.

4. Inter-City Effects of Rising House Prices: Empirical Strategy and Result Analysis

4.1. Impact of Rising House Prices on Household Leverage: Overview

The empirical strategy here is intended to evaluate the first dimension of our research assumptions: whether the difference in leverage increase between NFH households was significantly higher than that between FH households indifferent cities. Therefore, we have to first examine if the leverage (including debt and leverage increase) of households purchasing a house with a mortgage in cities with high house prices was high, too, which is the premise of theoretical basis for our research. Because the house-purchasing behavior of a particular household is not something continuous in time, we conducted only a cross-sectional analysis of house-purchasing behavior in 2016. Just as mentioned before, house prices are strongly endogenous, and so we employ IVs for TSLS (two stage least square) estimation. Given our aforesaid theoretical basis and borrowing from the econometric model of Mian and Sufi (2011), our regression formula is:

$$\Delta \widehat{Borrowing}_{ic} = \alpha + \beta \widehat{\ln HP}_c + \theta X_{ic} + v_{ic} \quad (12)$$

¹ Random sampling from CFPS survey data included all types of households, and so there was almost no problem of sample selection bias.

$$\ln HP_c = \omega + \gamma IV_c + \delta X_{ic} + \varepsilon_{ic} \quad (13)$$

where, $\Delta Borrowing_{ic}$ stands for the change in the debt (expressed as the natural logarithm of the year-end mortgage balance in regression) or the leverage ratio (year-end mortgage balance/household income) of the household i in the city c , X_{ic} includes controlled variables with regard to household information, mortgage information, and city characteristics, and $\ln HP_c$ (House Price) stands for the natural logarithm of house prices in the city c in 2016. The IV for house prices, IV_c , is the per capita area of land supplied for housing construction in the city c in 2015. The formula (12) is the second stage of TSLS regression. Table 1 gives the results of second-stage regression of IVs, where all regression is weighted according to urban permanent population, and standard errors are heteroscedasticity-robust and clustered at city level.

Table 1. Inter-City Effects of the Impact of Rising House Prices on Household Leverage: Results of Second-Stage Regression of IVs

Variable	In debt balance			Leverage ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
In house price	0.319** (0.139)	0.289*** (0.091)	0.346*** (0.104)	1.054** (0.527)	0.835** (0.333)	0.896** (0.399)
Household information	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Mortgage information	Uncontrolled	Controlled	Controlled	Uncontrolled	Controlled	Controlled
City characteristics	Uncontrolled	Uncontrolled	Controlled	Uncontrolled	Uncontrolled	Controlled
Observed value	558826	558826	558826	558826	558826	558826
R ²	0.597	0.762	0.764	0.204	0.541	0.545

Note: Regression is weighted according to permanent populations of cities; in the brackets are cluster robust standard errors; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In the table, the first three columns and the second three columns show regression results of the explained variables of debt (year-end mortgage balance) and leverage ratio; the columns (1) and (4) control only information at household level, the columns (2) and (5) add on this basis controlled variables of mortgage information, and the columns (3) and (6) control once again the aforesaid information on city characteristics. The regression results suggest that, both debt and the leverage ratio are significantly positive when the estimated coefficient of house prices is at the statistical level of at least 5%, indicating that the higher house prices, the greater degree of household leverage—and this coincides with research conclusions of Zhou and Wang (2019).

Table 2 provides the first-stage results of TSLS regression, with the columns (1), (2) and (3) corresponding to controlled variables shown in Table 1. In all circumstances, the coefficient of the per capita area of land supplied for housing construction is significantly negative at the statistical level of 1%, indicating significant negative

correlation between land supply and house price levels—which coincides with the results of land supply IVs adopted in research by Chen and Yang (2013), Lu *et al.* (2015), and Tong and Liu (2018). On the other hand, the statistic values of the weak IV, F, after controlling the effects of other factors, are all greater than empirical value 10, indicating that the IVs selected for this paper are suitable and that no weak IVs exist.

Table 2. Impact of Rising House Prices on Household Leverage: Results of First-Stage Regression of IVs

Variable	ln house price		
	(1)	(2)	(3)
Per capita area of land supplied for housing construction	−0.630*** (0.198)	−0.540*** (0.170)	−0.434*** (0.087)
Household information	Controlled	Controlled	Controlled
Mortgage information	Uncontrolled	Controlled	Controlled
City characteristics	Uncontrolled	Uncontrolled	Controlled
Observed value	558826	558826	558826
R ²	0.408	0.517	0.814
First-stage value of F	10.118	10.035	25.122

Note: Regression is weighted according to permanent populations of cities; in the brackets are cluster robust standard errors; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2. Impact of Rising House Prices on Household Leverage: FH and NFH Households

In order to test the first dimension of the research assumptions, we grouped the households according to whether they were FH households, and adopted the regression models of the formulas (12) and (13) to verify specific effects of rising house prices. The columns (1), (2), (3) and (4) in Table 3 give the impact of house prices on FH and NFH household debt and leverage change; all regression is weighted according to permanent populations of prefecture-level cities; standard errors are heteroscedasticity-robust and clustered at city level. According to the results, for every 1% rise in house prices, debt of FH households in the city additionally increased 0.31% on average, and the leverage ratio additional rose 0.77%; the numbers for NFH households were 0.55% and 1.47%, respectively. From the size of regression coefficients, house prices impacted leverage of NFH households significantly more than that of FH households.

Next, we examine if such difference is significant. By consulting the econometric model of Mian and Sufi (2011), and still under the TSLS framework, we add to the formulas (12) and (13) the interaction term of house prices and the virtual variable for the status of houses that households purchased, arriving at:

$$\Delta \text{Borrowing}_{ic} = \alpha + \beta \widehat{\ln HP}_c + \tau \widehat{\ln HP}_c \times NFH_{ic} + \sigma NFH_{ic} + \theta X_{ic} + v_{ic} \quad (14)$$

$$\ln HP_c = \omega + \gamma IV_c + \phi IV_c \times NFH_{ic} + \mu NFH_{ic} + \delta X_{ic} + \varepsilon_{ic} \quad (15)$$

where, NFH_{ic} is the virtual variable for the status of houses purchased by the household i in the city c ; when it has a value of 1, it represents the household being a NFH household. The regression results are given in the last two columns of Table 3. All regression is weighted according to permanent populations of prefectural-level cities, and standard errors are heteroscedasticity-robust and clustered at city level. The results showed that the coefficients of the interaction term were all significantly positive, indicating that households who purchased their non-first houses increased leverage significantly more than did FH households, an outcome that verified the first dimension of our assumption in the foregoing section.

Finally, by excluding the impact of the gender factor and the factor of the cities' policy stimuli for local real estate markets, and changing house-price estimation indicators and leverage estimation indicators, we conducted robustness tests, which led to still robust results.¹

Table 3. Impact of Rising House Prices on Household Leverage: FH and NFH Households
(estimation with IVs)

Variable	First house		Non-first house		Total	
	ln debt balance	Leverage ratio	ln debt balance	Leverage ratio	ln debt balance	Leverage ratio
	(1)	(2)	(3)	(4)	(5)	(6)
Ln house price	0.305*** (0.113)	0.774* (0.430)	0.548*** (0.069)	1.465*** (0.232)	0.323*** (0.108)	0.824** (0.420)
ln house price× non-first house					0.169*** (0.048)	0.493** (0.229)
Non-first house					-1.549*** (0.455)	-4.583** (2.163)
Household information	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Mortgage information	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
City characteristics	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observed value	509829	509829	48997	48997	558826	558826
R ²	0.760	0.536	0.778	0.593	0.765	0.545

Note: Regression is weighted according to permanent populations of cities; in the brackets are cluster robust standard errors; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Intra-City Effects of Rising House Prices: Empirical Strategy and Result Analysis

5.1. Average Treatment Effect of Rising House Prices Impacting Household Leverage: FH and NFH Households

On the basis of having analyzed the impact of inter-city rising house prices on

¹ Given the limited space, robustness test results are omitted, which are available to interested readers on request.

leverage of households with different house-purchasing motivations, we will further test the second dimension of the theoretical assumption: when house prices rise, NFH households in the same city still increase leverage significantly more than FH households. Our empirical strategy here is to identify the difference in the purely house price-driven increase of debt and leverage ratio for NFH households in one same city in relation to FH households. The preceding empirical results have shown that the higher the per capita area of land supplied for housing construction in a city in the previous term, the lower house prices in the next term. Thus, we consult the DID (differences-in-differences) design method of Mian and Sufi (2011), and the regression model that need be estimated is:

$$\Delta Borrowing_{ic} = \alpha_c + \beta_0 X_{ic} + \beta_1 NFH_{ic} + \beta_2 NFH_{ic} \times LP_{2016,c} + \varepsilon_{ic} \quad (16)$$

where X_{ic} stand for urban fixed effects relating to the city c , and represents the household information and mortgage control variable of the household i living in the city c . The interaction terms is the interaction of the purchased-house status virtual variable (stands for NFH households) and the degree of shortage of land supplied in cities¹, and so the coefficient of the interaction term is the variance to be estimated. Because urban fixed effects absorb urban characteristic information, in regression we will no longer include variables related to urban information.

Table 4. Intra-City Effects of the Impact of Rising House Prices on Household Leverage: FH and NFH Households

Variable	ln debt balance	Leverage ratio	ln area of house purchased	ln unit price of house purchased	ln rate of first mortgage repayment
	(1)	(2)	(1)	(2)	(3)
Degree of shortage of land supply × Non-first houses	0.111*** (0.038)	0.278** (0.135)	0.057 (0.044)	0.031 (0.031)	−0.047*** (0.013)
Non-first houses	−0.177** (0.084)	−0.493 (0.297)	−0.151* (0.087)	0.039 (0.059)	0.089*** (0.024)
Household information	Controlled	Controlled	Controlled	Controlled	Controlled
Mortgage information	Controlled	Controlled	Controlled	Controlled	Controlled
Urban fixed effects	Controlled	Controlled	Controlled	Controlled	Controlled
Observed value	558826	558826	558826	558826	558826
R ²	0.771	0.561	0.277	0.801	0.961

Note: Regression is weighted according to permanent populations of cities; in the brackets are cluster robust standard errors; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

¹ As in our sample the highest per capita area of land supplied for housing construction in cities is no greater than 2.5m², we define the degree of shortage of land supply as 2.5 minus per capita area of land supplied for housing construction. This indicator is highly positively correlated to house prices and, when substituted in regression for house prices, avoids endogeneity, which accords with the form of conversion given by Mian and Sufi (2011).

As shown by the columns (1) and (2) in Table 4, regression is weighted according to permanent populations of prefectural-level cities, and standard errors are heteroscedasticity-robust and clustered at city level. The column (1) shows the difference in the change of debt that households in one same city who had purchased houses out of different motivations had when house prices increased, and the coefficient of the interaction term is significantly positive at the statistical level of 1%, indicating that in one same city NFH households saw their debt increase 11.1% higher than FH households owing to the impact of rising house prices. The column (2) shows the difference in the change of leverage that households had as a result of rising house prices, and the coefficient of the interaction term is significantly positive at the statistical level of 5%, indicating that in one same city NFH households saw their leverage increase 27.8% higher than FH households owing to the impact of rising house prices. The results in Table 4 have verified the second dimension of our research assumptions: Rising house prices prompt NFH households to increase leverage more than do NFH households in the same city.

5.2. Further Discussion

Our next question to be addressed is: Is more “leverage” on the part of NFH households owing to behavior of inelastic demand like purchasing a house to improve living condition or near a school, or behavior of pure speculation?

To answer this question, we also use the experiment design though as in the formula (1) and, according to information contained in the sample which may reflect those preferences, select the area, actual unit price, and the rate of first mortgage repayment for houses that households purchased, as explained variables to examine possible motivations behind leveraging on the part of NFH households. Given actual situations in the country, we think that purchasing houses with a bigger area or a higher unit price may correspond to the motivation for NFH households purchasing a house to improve their living condition or purchasing a school-district house as an inelastic demand. If there is no obvious difference between houses purchased, to what extent mortgage policies (restrictions on lowest rates of first mortgage repayment) are utilized may reflect speculation. As shown by the columns (4) and (5) in Table 4, regression results after other conditions have been controlled are weighted according to permanent populations of prefectural-level cities, and standard errors are heteroscedasticity-robust and clustered at city level.

Obviously, the coefficients of interaction terms in the columns (3) and (4) are not significant, suggesting that, given rising house prices, there is no significant difference in the area and unit price of the house purchased with a mortgage between NFH households and FH households. The coefficients of interaction terms in the column (5) are significantly negative at the statistical level of 1%, indicating that rising house prices prompt NFH households to make a lower first mortgage repayment. And in

reality, because the lowest rate of first mortgage repayment for NFH households is required to be higher on average than that for FH households, the foregoing results suggest, too, that they are more inclined to make use of mortgage policies to the full. On the whole, therefore, when house prices rise, there is no obvious difference in the house purchased between the two types of households, but NFH households are more inclined to take advantage of mortgage policies, reflecting from another angle the speculativeness of leveraging on the part of NFH households. Moreover, there are still some NFH households who purchase a house out of inelastic demand, but who for various reasons have not enough money, and so it is possible for them to borrow money as close to the boundary of restrictions on the rate of first mortgage repayment as possible. In our sample, however, NFH households earned about twice on average as much as FH households, and there was no substantive difference in houses purchased. And, given that households purchasing a house out of inelastic demand generally would make preparations beforehand, we have reason to believe that the percentage of households who without enough money had to increase leverage to purchase a house was presumably not high and thus has little effect on our conclusions.

5.3. Result Analysis

In the United States, the rising household leverage in consequence of the real estate bubble prior to the subprime mortgage crisis attended the growth of consumption, because US households were allowed to obtain a loan by re-mortgaging the appreciation of their houses and consequently some households with low credit were able to increase consumption by re-mortgaging their houses (Mian *et al.*, 2013). In China, by contrast, houses purchased with a mortgage cannot be re-mortgaged and people generally have not the habit of mortgaging their houses in favor of consumption, so the rising household leverage was not attended by consumption growth and in effect consumption in the corresponding period instead remained sluggish (Tian *et al.*, 2018). According to the above results, we can say, therefore, that rising house prices drive up NFH households' debt and leverage ratio, which is basically reflective of their conspicuous motivation for speculative purchase of houses. And the mechanism therein also reflects the institutional character of the country's financial market. In our sample, NFH households had higher income, age and education on average than FH households. Generally speaking, households with higher income and a higher level of education have a comparatively strong demand for wealth growth, but, because China's financial market, unlike those in Western developed countries, is not sound in terms of depth, breadth and performance as it is expected, these households have no other better investment channel than to purchase houses as an important means of asset management. Once they expect house prices to keep rising, they are bold to hike up leverage and even frequently purchase

and sell commercial houses to make profits. Of course, there may involve quite a big risk. Once the real estate market suffers a comparatively strong adverse impact, those households in possession of multiple houses and with a higher level of leverage would see their wealth and liquidity decrease drastically, which in return would increase their probability of mortgage default and give rise to systematic risk.

6. Conclusions and Policy Suggestions

In recent years, Chinese household leverage and house prices have been on the rise, with the former remarkably surging in 2016. Mortgages are the primary part of household debt, and so if optimism on the real estate market caused speculation of house buyers and consequently drove up household leverage came to our particular attention.

This paper first built an optimal house choice model by which to theoretically correlate changes in house prices to the borrowing behavior of households with different house-purchasing motivations. The conclusion drawn from the model is: When NFH households are quite obviously speculative, rising house prices play a bigger role in their hiking up leverage than to FH households.

We then employed a state-owned bank's mortgage data on residents in 70 large and medium-sized cities, upon correcting sample bias, to verify our assumptions from inter-city and intra-city dimensions. Endogeneity-controlled regression results show that high house prices prompt NFH households to increased debt and leverage more than FH households. The above results were still significant after gender effects were controlled and leverage and house price indicators changed. Then we used the DID method to estimate the effects of rising house prices on NFH households additionally increasing leverage in the same city. The results showed that NFH households increased debt and leverage more than FH households did. This indicate that real estate market prosperity that makes the general public have optimistic expectations of rising house prices will step up household leverage. The paper further found that, while NFH households purchased houses with an area and unit price not higher than those of houses that FH households purchased, they were more inclined to choose a lower first mortgage repayment, a further proof of the speculativeness of NFH households purchasing a house with a mortgage.

The central government regulates the real estate market in a way that it wants the real estate market to neither produce a too big a bubble nor drive up leverage of the real economy to the extent of transferring risk to the real economy. Therefore, this study provides a definite operational suggestion on regulating the real estate market: The key to addressing high household leverage lies in suppressing speculative house-purchasing demand of NFH households. The authorities should, in taking measures, consider achieving two effects: altering inelastic expectations that the general public have of "rising, never falling" house prices, and sustaining credit constraints on NFH households.

By so doing, the growth rate of household leverage can be slowed quite remarkably.

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