Household Migration and Collateral Constraint: Cash-based Housing Resettlement in China*

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Abstract

Collateral constraints reduce household migration to expensive locations by restricting financing for home purchases. This endogenous location choice can amplify the impact of relaxing borrowing constraints. Using China's cash-based shantytown renovation program (2015-2018) as a natural experiment, we provide evidence that cash resettlement – by converting illiquid shanty houses into cash – facilitated household location upgrading and raised house prices in more expensive locations. A dynamic spatial model with collateral constraints confirms that endogenous location upgrading amplified the effect of cash transfer, raising lifetime housing expenditures by nearly 50%, and house price growth in low-tier cities by 9% in 2016-2020.

Keywords: house price, collateral constraint, migration.

JEL classifications: D1, D5, G0, R0.

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1 Introduction

House prices in China have risen dramatically over the past decade. Figure 1 shows that the most salient surge occurred between 2016 and 2020, with average prices increasing by more than 50% in just four years – a magnitude similar to the U.S. house price growth during the 2002-2006 housing boom (Mian and Sufi, 2011). Notably, this increase was not merely a continuation of previous trend – there was a clear acceleration in house price growth in 2016 – but more likely to be triggered by some economic or policy shocks.

A broadly shared interpretation of the U.S. housing boom during 2002-2006 is the important role played by household credit conditions (Mian and Sufi, 2009), and some recent work has tried to quantify the effect of relaxed household credit conditions during the boom (Favilukis et al., 2017; Kaplan et al., 2020). For China's housing boom since 2015, rather than a relaxation in bank mortgage lending conditions, there was another high-profile policy that relaxed many household borrowing constraint around that time – the shantytown renovation program with cash-based resettlement. In this paper, we examine how this program has affected the house price growth in China after 2015. We add to the literature by documenting the amplification role of household migration in the effect of relaxing household borrowing constraint on housing spending because households are more likely to face binding borrowing constraint to buy houses at desired than their originating cities.

Shantytown renovation is an essential part of urban development in many countries.[1] Typically, shantytown renovation involves resettlement of displaced residents followed by the reconstruction of public facilities and real estate properties. In China, the shantytown renovation program has been a key part of the central government policy agenda since 2013. In 2015, in-kind-based resettlement (i.e., property exchange), which has been the primary compensation approach, was partially replaced by the cash-based resettlement, which essentially converts the illiquid shanty houses into cash and enables house-

[1] In case of informal houses, shantytown renovation is also referred to as slum upgrading by UN Habitat. See the report by UN Habitat.

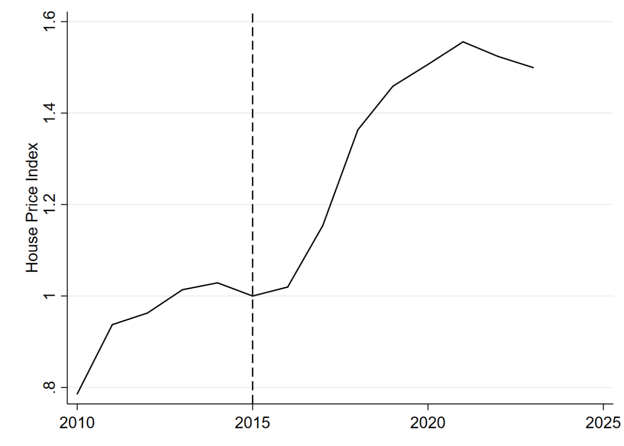


Figure 1: Quality-adjusted House Price Index

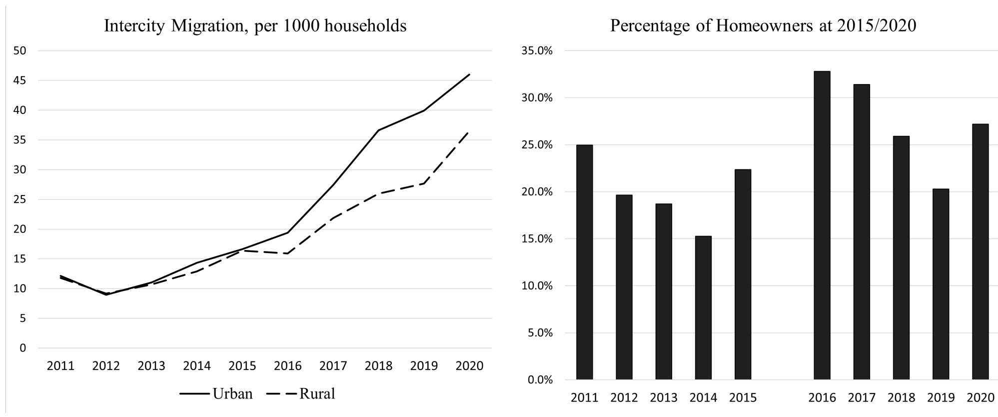
Note: This figure shows the average house price index constructed based on sellers' posted ask prices across different cities during 2010-2023 in China. The index is normalized to be one in 2015. See Section 2.2 for how we adjust for quality to construct the index.

holds to buy better houses. The amount of cash-based resettlement during 2015-2018 totaled more than four trillion RMB.[2] It is believed by the authority and many others that the cash-based resettlement has contributed to the housing boom since 2015.[3]

To motivate our focus on migration, we begin with some aggregate evidence supporting the relevance of migration in shaping the effect of the cash resettlement on the housing markets. Figure 2 Panel (a) shows that intercity migration of urban households accelerated significantly since 2015, whereas migration of rural households, who were not targeted by the program, followed the previous trend. Panel (b) shows that the percentage of intercity urban migrants who own houses in residence cities in 2020 is significantly higher by more than 5% than that in 2015, regardless of when they migrated as indicated by the horizontal axis. These trends suggest that following the cash resettlement, more households migrated to and purchased homes in other cities. Therefore, migration likely plays an important role in the aggregate impacts of the program.

By combining micro-level household survey data from China Population Census of

[2]As comparison, total new house sale during 2011-2015 (2016-2020) was 24.7 (48.7) trillion RMB.
[3]See the report from Reuters.



(a) Intercity Migration (b) Migrant Home ownership

Figure 2: Annual Migration and Migrant Home Ownership

Note: Panel (a) plots the number of intercity migration of urban and rural households for every 1000 urban households, and Panel (b) plots and the fraction of urban immigrant households that own homes at residence in 2015 (2020) conditional on their migration year in the horizontal axis.

2015 and 2020 with data of the shantytown renovation loans, the primary source of financing for cash resettlement, we find strong evidence supporting the effect of the cash resettlement on household migration and housing prices. First, to estimate intercity money flow due to migration of households that receive the cash compensation, we construct a Bartik-style variable assuming that money flow is proportional to the existing migration network in 2015. We find that in cities with higher *loan_dest*, the predicted cash inflow scaled by the local house transaction value in 2014, house prices grew significantly more after 2014. New house supply also increased in these cities, though the effect is temporary and limited in magnitude, reflecting the inelasticity of house supply.

More importantly, the effect of *loan_dest* on local house prices depends on the city-pair house price gap in 2014. Given any destination city, we find a significantly larger impact of *loan_dest* constructed using originating cities with relatively *lower* than using originating cities with relatively *higher* house prices in 2014. This is not because the same actual one dollar inflow from different cities plays different roles in the destination city. Rather, we conjecture that this is because household migration as a result of the cash resettlement is more pronounced between city pairs with large house price gaps than between city pairs with comparable house prices.

The above results echo the "location asset" view developed by Bilal and Rossi-Hansberg (2021) which predicts household location upgrading to more expensive cities with better opportunities in response to the relaxation of their financial constraint. Those non-constrained households have already lived in their desired cities and a further increase in their wealth will not impact their location choice. In our context, households that originate from cities with low house prices and migrate to cities with high house prices are more likely to face binding collateral constraint when buying houses at the destination. Therefore, by relaxing household borrowing constraint, cash resettlement allows households to move to more expensive locations with better opportunities where they previously could not afford to.

Second, we find evidence supporting that money flow through household migration is underlying not only the effect of *loan_dest* on local house prices but also the heterogeneity of such effects with respect to city-pair house price gap. Money flow can occur through two margins: the existing migration network before 2015 and new intercity migration after 2015. Regarding the first margin, we find that among existing immigrants in the same destination city in 2015, the fraction of urban households receiving cash compensation in their originating cities has a significant and positive impact on the probability of these existing migrants to stay and become homeowners in the destination cities in 2020. The existing migrants may still own shanty houses in their originating cities and the cash compensation help them to settle down in their residence cities.

Regarding the second margin, we conduct an event study analysis using the city-pair panel and find that given the same destination city-year, cities with a higher fraction of cash recipients witnessed a significantly larger increase in household emigration to the same destination city in the same year after 2014, but no significant differences before 2014. These results support money flow through both existing and new intercity migration, which contributed to the housing demand in the destination cities.

To investigate whether the resulting household migration also depends on the city-pair house price gap, we find the effects are much more pronounced on both margins – the existing migration network and new intercity migration – for city-pairs with higher house price gap in 2014. The effect is much smaller and insignificant for city-pairs with comparable house prices.

These empirical results point out an important amplification role of migration for the effect of relaxing household borrowing constraint on housing demand. First, When households migrate to cities with higher wage incomes, the wealth effect leads to a discontinuous increase in their housing spending. Second, their borrowing constraint is more likely to bind in these more expensive cities, leading to a higher marginal propensity to spend on housing. We formalize these results in a simple two-location model.

To quantify the effect of cash resettlement and the amplification role of household migration, we build a dynamic spatial general equilibrium model featuring dynamic consumption-savings decisions, collateral constraints, and endogenous migration. In the model, households are born with different bequest of financial and housing wealth and live for a finite number of periods. In each period, they make three decisions: residence location, house purchase or rental, and consumption-savings. Their net debt balance cannot exceed a certain fraction of the market value of their house. Locations differ in terms of its aggregative productivity, amenity, housing stock and new house supply.

We highlight three features of the model that are essential for our mechanisms and differ from some existing literature (Favilukis et al., 2023; Giannone et al., 2023). First, households can own houses located in their non-residence cities. This is to capture migrants that live in other cities but maintain ownership of houses in their originating cities, who will still benefit from cash resettlement in their originating cities.

Second, households have a preference for homeownership. Kaplan et al. (2020) argue that credit conditions may not affect household housing demand if they can rent. With preference for homeownership, households will consume more housing services when owning than when renting the house, and a relaxation of borrowing constraints that makes them homeowners would increase housing demand.

Third, there are two type of houses: normal and shanty. Unlike the normal houses that are fully liquid, shanty houses are illiquid and can only be used for own residence.[4] Therefore, shanty homeowners cannot finance house purchase in other cities by selling their shanty houses, while cash resettlement allows them to do so.

The joint consideration of tenure choice, consumption-savings under incomplete markets, and forward-looking location decisions – combined with rich individual heterogeneity – generates non-linear policy functions over a large state space. We implement a solution method that globally solves households' dynamic problems and tracks household distribution within and across locations over time.

To calibrate the model, we begin with an initial distribution of households with different age, savings, house size, house and residence location, and house type, which we calibrate using the Population Survey Data of 2015. We take one period to be five years and solve for household lifetime decisions given the actual house price path and calibrate the parameters to match some key moments about homeownership and migration in the first period (2016-20).

To reduce computational challenges, we cluster all cities into five locations based on their geographic location and house price in 2015, with house price decreasing from location 1 to location 5. Such cluster largely preserves the geographic dispersion in house price and migration. The number of cash recipients increases monotonically from location 1 to 5, with 0.9% from location 1 and 70.4% from location 5.

Taking the aggregate price path as fixed, we first conduct individual counterfactual analysis to show that the model can deliver our key empirical findings on household location upgrading in response to the cash resettlement. The model predicts that the cash resettlement can reduce out-migration of existing migrant residents in top-tier locations – location 1 by 48%, 2 by 35% and 3 by 18%, consistent with our empirical findings regarding existing migrants. Moreover, the model predicts an increase in out-migration of residents in lower-tier locations – location 5 by 13% and 4 by 4%, echoing our empirical

[4] This illiquidity stems from a critical interplay of insecure property rights, substandard physical conditions, and financial exclusion as we discuss in Section 2.1.

findings regarding new migration.

The core idea of this paper is that households face more binding borrowing constraints when purchasing houses in higher-tier locations and an additional cash transfer can relax the constraint and facilitate location upgrading. We find that for households from location 5 for whom cash resettlement induces a large increase in out-migration rate, without the cash resettlement, they are far from having a binding borrowing constraint if residing in location 5 – their average savings are positive – and much closer to having a binding constraint if residing in higher-tier locations, with an average debt-to-collateral ratio of 0.46. The cash resettlement relaxes their borrowing constraint in these higher-tier locations, with their optimal debt-to-collateral ratio down to 0.24, and such relaxation is large enough for them to smooth consumption and induce location upgrading, mostly to location 4 and 3. In contrast, for households the cash resettlement induces a minimum increase in out-migration rate, the relaxation in their borrowing constraints is not large enough to induce location upgrading.

Next, to investigate household housing expenditures, we define the housing expenditure multiplier as the increase in individual household home purchase spending with relative to without the resettlement, normalized by the amount of compensation they receive. The multiplier tends to exceed one, with an average value of 1.23 in 2016-20. Households from residence location 1 exhibit higher multipliers, since the cash resettlement enables them to purchase homes location 1. Households with shanty houses in locations 4 and 5 also tend to have high multipliers because they are more likely to upgrade to higher-tier locations.

To quantify the role of migration, we consider an alternative resettlement approach – the voucher resettlement – which restricts the households from using the voucher to purchase houses in other locations. Voucher resettlement leads to the same wealth increase but with non-local spending of the transfer shut down. The multiplier is significantly lower without the migration option. In 2016-20, it is 1.12 under voucher versus 1.23 under cash resettlement. The difference enlarges over time as some households receiving the cash compensation postpone their home purchase. Over their lifetime, the multiplier is 1.08 under voucher versus 1.51 under cash resettlement. The endogenous location upgrading would increase household lifetime housing expenditures in response to a cash transfer by nearly 50%.

Finally, to evaluate the aggregate impact of cash resettlement, we consider a counterfactual scenario where the government continues with in-kind resettlement. Compared with the equilibrium price paths under this counterfactual scenario, cash resettlement increased the 2016-20 house price by nearly 9% in location 5, 8.5% in location 4 and 6.5% in location 3. In contrast, as the voucher resettlement retains housing demand mostly in location 5, it would increase the 2016-20 house price in location 5 even more, by 11.5%. Compared to cash resettlement, house price growth in other locations would be lower under voucher resettlement, by 2.0%-2.5% for locations 3 and 4 and 1.0% for location 1 and 2. Overall, the cash resettlement had an important impact on the aggregate house prices in 2016-20. Migration did not significantly increase the nationwide house price growth because the destination locations start with higher house prices and the same dollar amount of spending would generate smaller price impacts.

Literature Review Our paper is related to three strands of literature. First, we contribute to the literature on the role of household financial constraint in the housing market. Over one decade after the Great Financial Crisis of 2007-09, triggered by the housing bust following a housing boom in U.S., a consensus has emerged regarding the crucial role of household credit conditions for the housing boom-bust cycle, thanks to the influential work by Mian and Sufi (2009, 2011), Mian et al. (2013), Di Maggio and Kermani (2017), Justiniano et al. (2019) and many others. Yet there is less consensus on the degree to which changes in household credit conditions can explain the housing boom, especially when competing with the explanation based on expectations, another driving force that has been central to study the house price fluctuations (Piazzesi and Schneider, 2016). For example, Favilukis et al. (2017) constructs a quantitative general equilibrium model of housing with business cycle risks and heterogeneous wealth distribution and find a large effect of relaxing household financing constraints on the house prices. Justiniano et al. (2019) make similar points and distinguishes credit supply from credit demand. In contrast, Kaplan et al. (2020) find that shifts in beliefs about future housing demand are the dominant force behind the observed swings in house prices and changes in credit conditions have virtually no effect on house prices and rents.

We add to the literature by introducing endogenous migration to the analysis. We document the relevance of migration following a relaxation in household borrowing constraint and demonstrate that household migration can amplify the effect of relaxed borrowing constraint on housing demand with a dynamic spatial model.

Second, we add to the large literature on household migration and the economic and welfare implications (Redding and Rossi-Hansberg, 2017). Among this literature, there are relatively few quantitative studies that allows forward-looking agents with consumption-saving decisions. Our framework is most related to papers on the interaction between household migration and wealth or financial constraint. Bilal and Rossi-Hansberg (2021) is the first paper to consider location choices in a consumption-smoothing framework. Their model predicts location upgrading in response to positive income shocks for financially constrained households, which aligns well with our empirical results. Our model differs from theirs in mapping what is the cost and benefit of a location – they consider location cost as the rent while we think of it as the house price, and they do not consider wage income as the future benefit while we do. The distinction may have important quantitative consequences. Giannone et al. (2023) study how wealth and access to financial markets can work as a risk buffer to mitigate household migration response to risk and calibrate the model using data from Canada. Favilukis et al. (2023) evaluate the housing affordability policies in New York and allows endogenous migration to and out of New York. We contribute to this literature by constructing a similar model allowing intercity house ownership and heterogeneity in house liquidity and calibrate the model using micro-level migration data in China.

Third, we link to the literature on the housing market in China. The recent downturn of the housing market has attracted much concern about potential risks of the real estate sector. Chang et al. (2023) document a paradox between surging land and property prices and plummeted transaction volume during 2020-2022 and attribute this paradox to active management of land and housing prices by local governments. Related to spatial spillover, Deng et al. (2022) exploit the local home purchase restrictions to study the effect of out-of-town home demand and policy spillovers.

The paper is organized as follows. We describe the background and data in Section 2, report the empirical evidence in Section 3, show the simple model to illustrate the core idea in Section 4, lay out the fully dynamic spatial general equilibrium model in Section 5, and report the quantitative results in Section 6. We conclude in Section 7.

2 Institutional Details and Data

2.1 Institutional Background

The shantytown renovation program became a key part of the central government policy agenda since 2013, when Premier Li Keqiang took office. At his first press conference, he pledged that his administration would renovate over 10 million units of shanty homes. Shantytown renovation typically involves resettlement of displaced residents followed by reconstruction of public facilities and real estate properties. There are two major ways of resettlement. In-kind-based resettlement (i.e., property exchange) compensates displaced residents with alternative housing, whereas cash-based resettlement offers displaced residents with cash to purchase homes from the housing market as they wish.

In-kind resettlement used to be the primary compensation method before 2015. In 2015, several real estate policies led to an unprecedented level of home inventories held by home developers especially in lower-tier cities, with total floor area of inventories rising to 7.36 billion square meters, while new housing sales in 2015 only totaled 1.28

billion square meters.[5] To reduce housing inventory, Beijing started replacing in-kind resettlement with cash compensation, under which the displaced residents would become home buyers in the housing market. From 2014 to 2017, the proportion of cash-based resettlement in shantytown renovations increased steadily. It was 9% in 2014, rose to 28% in 2015, further climbed to 48.5% in 2016, and peaked at 53.9% in 2017.[6]

To support the cash-based resettlement, People's Bank of China (PBoC) provided policy banks, primarily China Development Bank (CDB), with a long-term, low interest rate funding source through the Pledged Supplementary Lending (PSL) facility. These funds were then extended to local governments for the shantytown renovation projects. From 2014 to 2018, PBoC injected over 3.5 trillion RMB via PSL, and CDB extended around 4.0 trillion RMB of shantytown renovation loans.

The cash-based resettlement program effectively addresses the profound illiquidity inherent in shantytown housing by converting these largely non-tradable assets into cash, often at valuations exceeding their impaired market potential. The illiquidity of shantytown housing stems from multiple reasons. First, many shanty homes were historically built on land with ambiguous ownership, and lack the official deeds required for formal market participation and bank mortgage financing (He et al., 2019; Yang et al., 2023). Second, houses in shantytowns often suffer from substandard construction, significant disrepair, and a lack of essential amenities, rendering them uncompetitive compared to formal housing alternatives (Wu, 2016; Hussain et al., 2021). [7]

With the implementation of cash compensation, real estate prices increased significantly and the nationwide level of home inventories decreased over time. By mid-2018, the central government began to reduce the cash resettlement rate and CDB halted funding for new shantytown renovation projects.[8]

[5] See the report from Guotai Junan Securities.

[6] See the news article from People's Daily.

[7] Using secondary market transaction data from CityRE, covering 19 major cities from 2015 to 2018, we find that the average turnover ration (sales volume to stock ratio) for shantytown properties is only 5.83% of that of ordinary secondary market apartments. For more information regarding the illiquidity of shantytown housing, see also discussions by local government officials from Sichuan, Tianjin, and Jilin.

[8] See the news article from Reuters.

2.2 Data

This section describes the three data sets used in our paper: i) shantytown renovation loan data from CDB; ii) National Population Census data from the National Bureau of Statistics (NBS); iii) housing market data from various sources.

Shantytown renovation loan data. The primary funding for resettlement in shantytown renovation projects comes from policy banks, mostly notably from CDB.[9] Figure 3 plots the distribution of shantytown renovation loans issued by CDB. Consistent with the timing of the cash resettlement policy, the contract signing dates of these loans concentrate in the period of 2014-2018, which accounts for 91.9% of the number of all loans and 85.07% of the total loan amount. Loans granted out of the period of 2014-2018 are also used to finance shantytown renovation projects, but primarily not for the purpose of cash-based resettlement. We focus on the period of 2014-2018 and aggregate the actual withdrawal amount of all loans signed during 2014-2018 to the city level as the measure of the total size of cash-based resettlement.[10]

National Population Census data. To measure household migration, we utilize a representative sample of the National 1% Population Survey Data of 2015 and a representative sample of the National Population Census of 2020 from the National Bureau of Statistics. The 2015 (2020) sample covers approximately 0.22 (0.15) million urban households. For each household, we observe detailed demographics such as age, residence address, hukou registration type, hukou city, homeownership status, house conditions and migration year (if applicable) at the time of the survey. We identify intercity migration by comparing household residence city with their hukou city. We focus on urban households because shantytown renovation programs mostly engage with households

[9] Another policy bank, the Agricultural Development Bank of China, also provided some credit support. According to the report from China Securities, CDB accounts for more than 80% of all shantytown renovation loans from policy banks.

[10] Cash resettlement began widely adopted since 2015. We include loans signed in 2014 to measure cash resettlement because a significant number of loan contracts were signed in 2014 with the funds released in 2015. Among these loans, we exclude 11% (4,132/34,966) of the loans that were designated as for provincial-level shantytown projects, for which we cannot identify the specific city of the projects.

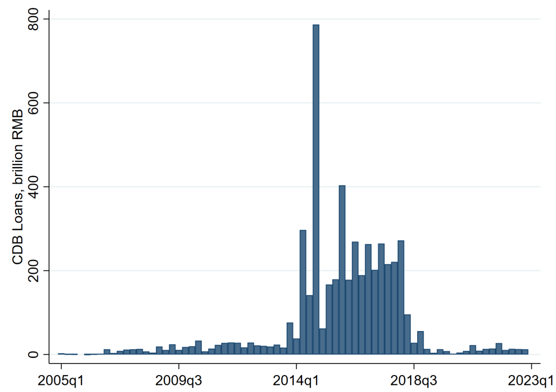


Figure 3: Quarterly Amount of CDB Loans Granted

Note: This figure plots the amount of CDB shantytown renovation loans granted in each quarter.

Table 1: Data Summary

	Mean	St. Dev.	Obs
hp	1.174	0.336	4484
hq	0.063	0.056	3598
loan_dest	0.058	0.051	264
loan_orig	0.925	0.970	264
LocalRecipient/N	0.090	0.094	328
stay	0.438	0.71	5881
own	0.232	0.461	5881
migration/N	0.064	0.203	95,120

Note: This table reports summary statistics of our data. See Table A.1 for variable definition.

in shanty urban areas.

Housing market data. We combine housing market data from multiple sources. First, we get the total transaction area and value of all new homes at the city-year level from the WIND database, a leading financial data provider in China. First, we construct a quality-adjusted house price index based on the house sellers' posted ask prices from CityRE during 2010-2023, a leading data provider for the Real Estate sector in China (Deng et al., 2022). Specifically, following Fang et al. (2016) and Chen et al. (2017), we adopt the hedonic price approach to generate the house price index for each city by running the following regression:

$$\log(ask_{i,b,c,t}) = \theta_{c,t} + \alpha_b + \varepsilon_i,$$

where $\log(ask_{i,b,c,t})$ is the ask price for house unit i in building block b in city c and year t, $\theta_{c,t}$ is the city-by-year fixed effect capturing the quality-free house price appreciation, α_b is the building block fixed effect, and ε_i is the error term. This approach controls for quality change resulting from differences in building blocks over time. The quality-adjusted house price index normalized to be one in 2014 is calculated as:

$$hp_{c,t} = \frac{\exp(\hat{\theta}_{c,t})}{\exp(\hat{\theta}_{c,2014})} \tag{1}$$

Table 1 reports statistics for key variables used in this paper and Table A.1 in the appendix provides definition for these variables.

3 Empirical Facts

In this section, we document the housing market responses to cash resettlement in other cities and give direct evidence supporting that money flow through migration is underlying such responses. Importantly, cash resettlement primarily leads to location upgrading. i.e., it facilitates household migration to more expensive locations where they previously could not afford to and pushes up house prices in these locations.

3.1 Housing Market Responses

3.1.1 Measurement

We begin with defining the housing market outcome variables and the treatment of cash-based resettlement. In the following notations, t denotes the year; $o, d, i \in \mathbf{N}$ denote the city, with o denoting migrants' originating cities (i.e., hukou cities), d denoting migrants' destination cities, and i denoting generic cities.

For the housing market outcomes, we use our quality-adjusted house price index normalized to be one in 2014, hp_{it}, as the measure of price changes and the new house supply scaled by the initial housing stock, hq_{it}, as the measure of incremental supply.[11]

To measure the size of cash resettlement at the loan originating cities relative to the size of the local housing market, we calculate $Loan_o$, the accumulated withdrawal amount of CDB shantytown renovation loans granted during 2014-2018, and scale it by the new house transaction value in 2014:

$$loan\_orig_o = \frac{Loan_o}{Sale_{o,14}}.$$

It is challenging to measure the amount of cash carried by migrant households to other cities after the families receive the cash compensation, since we cannot track exactly where the cash recipients go or send the money. We construct a Bartik style variable, assuming money flow is proportional to the existing migration network in 2015. The migration flow induced by the cash resettlement should correlate strongly with the existing migration network, given that some common factors such as the relationship network and bilateral migration cost would affect both types of migration. However, this Bartik style variable can deviate from actual money flow because the treated households are not a representative sample of the population, and how households migrate in response to increased financial wealth is conceptually different from the migration induced by various other shocks. We will perform heterogeneity analysis to document household destination choices after receiving the cash compensation.

Specifically, denote the total number of urban households from the originating (hukou) city o by N_o, among which $M_{o,d}$ reside in city d in 2015. Assume the total amount of cash flow from city o to d is proportional to $Loan_o \cdot \frac{M_{o,d}}{N_o}$. We then aggregate $Loan_o \cdot \frac{M_{o,d}}{N_o}$ across originating cities and scale it by the new house transaction value in 2014:

$$loan\_dest_d = \frac{1}{Sale_{d,14}} \sum_{o \neq d} Loan_o \cdot \frac{M_{o,d}}{N_o}$$

[11] We aggregate the size of urban houses across all households in the Population Census of 2015 to measure the housing stock at the beginning of 2015 and then calculate the housing stock in other years with the annual sale area of new houses and area of requisitioned houses. We identify urban houses by excluding those located in villages.

For simplicity, in calculating *loan_orig* and *loan_dest*, we do not account for the timing of CDB loans. This is because households may adjust their current behaviors in anticipation of future cash resettlement, and we cannot attribute their responses solely to realized cash resettlement.

Table 1 reports the summary statistics. The size of cash-based resettlement in the originating cities is about 92.5% of the new house transaction value in 2014. Money flow to the destination cities as captured by *loan_dest*, is about 5.8% of the new house transaction value in 2014. Again, note that *loan_dest* is not an unbiased estimator of the actual money flow. Throughout, we will focus on *loan_dest*, which is at the core of our paper, and use *loan_orig* and some other variables as controls for robustness checks.

3.1.2 Baseline Results

To study whether the spatial diffusion of cash resettlement through household migration has a material impact on the housing market in the destination cities, we perform the following event study analysis:

$$y_{i,t} = \sum_{\tau \neq 2014} \mathbf{1}_{t=\tau} \cdot \left(\beta_\tau \cdot loan\_dest_i + \Gamma_\tau \cdot Control_i\right) + \delta_i + \theta_{p(i),t} + \epsilon_{i,t}, \quad (2)$$

where β_τ captures the effect of the proxied cash inflow in year τ, δ_i controls for time-invariant city fixed effect, $\theta_{p(i),t}$ controls for any shocks at the province-year level, and $\epsilon_{i,t}$ is the error term. For robustness, we also allow for differential time trend after 2014 by including a set of city-level controls, including $loan\_orig_i$, logarithm of urban population, average urban wage income, GDP, new house sale area, house prices, and house inventory scaled by new sale area, all measured in 2014, along with an indicator for whether the city has ever imposed home purchase restrictions (Deng et al., 2022). Inclusion of these controls barely changes the estimation results. Nonetheless, we report baseline results with these controls.

Figure 4 reports the estimation results. Cities with differential *loan_dest* exhibit no significant difference in the dynamics of house prices and new house supply before

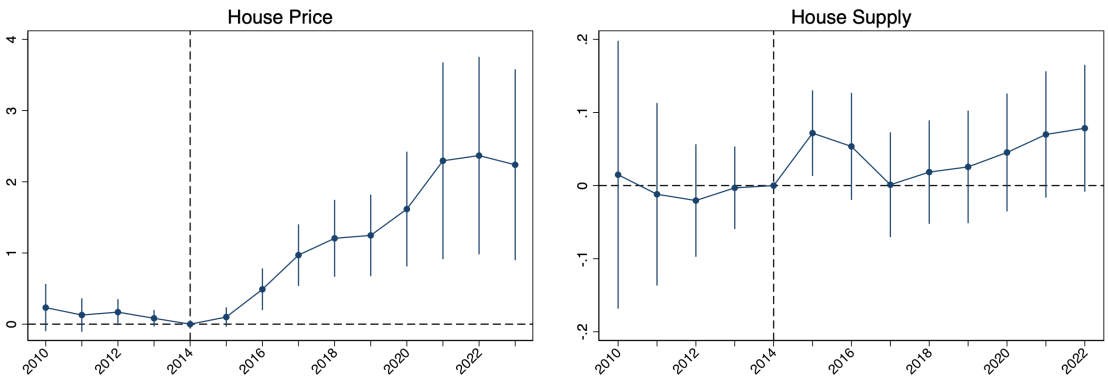


Figure 4: Housing Market Responses at Destination Cities

Note: This figure plots the 95% confidence interval of the event study coefficient estimates regarding the effect of *loan_dest* on the housing market at the destination cities, including house prices and house supply. Standard errors are clustered by cities.

2014, supporting the parallel trend assumption for the event study analysis. After 2014, cities with higher *loan_dest* experienced significantly faster house price growth than those with lower *loan_dest*. Cities with higher *loan_dest* also appear to experience larger growth in house supply, although the effect seems only temporary and quite limited in its magnitude, likely reflecting the inelasticity of house supply. The increase in house price and quantity supports a positive impact of cash resettlement from other cities on the housing demand in the destination cities. Because of the limited responses in house supply, we will focus on house prices in the rest of the paper.

3.1.3 Heterogeneous Response

Household migration in response to increased financial wealth is conceptually different from the migration decisions of average households, which can be triggered by various shocks. Bilal and Rossi-Hansberg (2021) develops the "location as an asset" hypothesis that predicts household location upgrading to more expensive cities with better opportunities in response to a relaxation of their financial constraint. In contrast, households that are not financially constrained should already reside in their preferred cities, and a further increase in their wealth will not affect their location choice.

In our context, migrants moving to cities with higher house prices than their originating cities are more likely to face binding borrowing constraints when purchasing homes at the destination. Thus, by relaxing household borrowing constraints, cash resettlement should have a stronger effect on household migration between city pairs with larger house price gaps. As a result, for the housing market in a given destination city, cash resettlement from cities with lower house prices should generate a larger impact on house prices than cash resettlement from cities with comparable house prices.

To investigate how the effect of *loan_dest* on local house prices varies with the city-pair house price gap, we decompose *loan_dest* into two groups based on the whether the city-pair house price gap, $\frac{HP_{d,14}}{HP_{o,14}}$, falls above or below the median value $p50$:

$$loan\_dest_d^h = \frac{1}{Sale_{d,14}} \sum_{o \neq d, HP_{d,14}/HP_{o,14} > p50} Loan_o \cdot \frac{M_{o,d}}{N_o}, \tag{3}$$

$$loan\_dest_d^l = \frac{1}{Sale_{d,14}} \sum_{o \neq d, HP_{d,14}/HP_{o,14} < p50} Loan_o \cdot \frac{M_{o,d}}{N_o}. \tag{4}$$

If money flow does not depend on the city-pair house price gap, then both $loan\_dest_d^h$ and $loan\_dest_d^l$ reflect actual money flow to city d and they shall be equally important in affecting house prices in the destination cities. If, in contrast, money only flows between city pairs with relative large house price gap, then only $loan\_dest_d^h$ reflects actual money flow to city d and we shall observe a much stronger effect of $loan\_dest_d^h$ than $loan\_dest_d^l$.

We test the prediction by modifying Equation (2) to allow the treatment effect of loan inflow to differ by the city-pair house price gap:

$$hp_{i,t} = \sum_{\tau \neq 2014} \mathbf{1}_{t=\tau} \cdot \left(\beta_\tau^h \cdot \cdot loan\_dest_i^h + \beta_\tau^l \cdot loan\_dest_i^l + \Gamma_\tau \cdot Control_i \right) + \delta_i + \theta_{p(i),t} + \epsilon_{i,t}, \tag{5}$$

To see if the differences in coefficient estimates are statistically significant, we rearrange Equation (5) into:

$$hp_{i,t} = \sum_{\tau \neq 2014} \mathbf{1}_{t=\tau} \cdot \left((\beta_\tau^h - \beta_\tau^l) \cdot loan\_dest_i^h + \beta_\tau^l \cdot loan\_dest_i + \Gamma_\tau \cdot Control_i \right) + \delta_i + \theta_{p(i),t} + \epsilon_{i,t}, \tag{6}$$

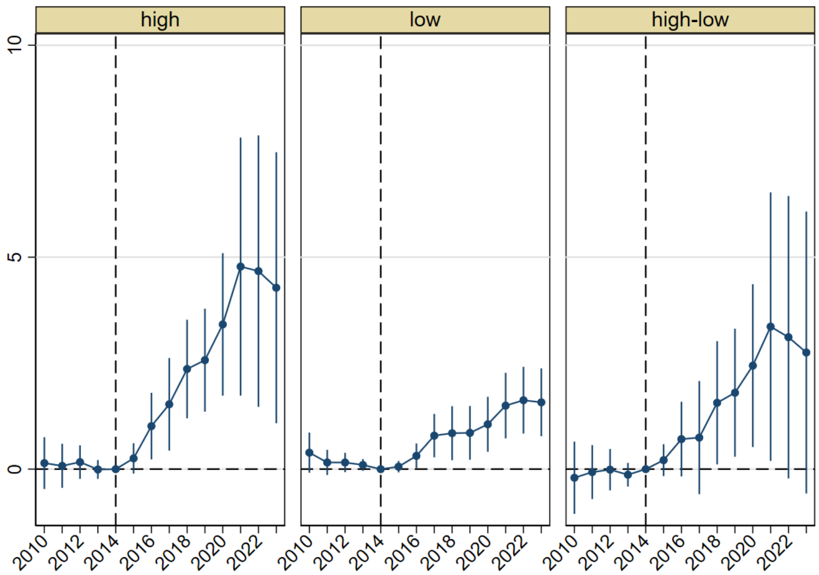


Figure 5: House Price Response to *loan_dest* by Loan Originating Cities

Note: This figure plots the 95% confidence interval of the event study coefficient estimates of $loan\_dest^h$ (first graph), $loan\_dest^l$ (middle graph) and their differences (right graph). Standard errors are clustered by cities.

Figure 5 reports the coefficient estimate for $(\beta^h_\tau, \beta^l_\tau)$. The first two graphs show that consistent with our conjecture, the effect of $loan\_dest^h_i$ is much larger than the effect of $loan\_dest^l_i$. The last graph shows that the estimates of $\beta^h_\tau - \beta^l_\tau$ is not only positive but also statistically significant. Note that the different effect of $loan\_dest^h_d$ and $loan\_dest^l_d$ is not because the same actual one dollar inflow from different cities plays different roles in the destination city. Rather, this is because money flow between city pairs with large house price gap is more pronounced than between city pairs with comparable house prices. We provide direct evidence on this claim in the next section.

3.2 Money Flow and Household Migration

We now give direct evidence supporting that household migration is underlying not only the effect of *loan_dest* on local house prices but also the heterogeneity of the effect with respect to city-pair house price gap. Money flow through migration can occur via two margins: the existing migration network before 2015 and additional household migration post 2015. We provide supporting empirical evidence on both margins.

3.2.1 Measurement

To measure the extent of treatment on the households, we calculate the fraction of urban households that receive the cash compensation for each originating city. We first estimate the total number of urban households receiving the cash compensation in city o as:

$$LocalRecipients_o = \frac{Loan_o}{\lambda \bar{H}_o P_{o,14}}, \tag{7}$$

where $Loan_o$ is the total amount of CDB loans for cash resettlement, $\bar{H}_o$ is the average size of shanty houses based on the Population Census of 2015, and $P_{o,14}$ is the house price in 2014. The parameter λ adjusts for the differential compensation rate relative to the local house price, which we set to 0.7.[12] We then scale $LocalRecipients$ by N_o, the number of urban households originating from city o, and examine how $\frac{LocalRecipients_o}{N_o}$, the fraction of urban households from city o that received cash compensation, affects the migration patterns of these households after 2015.

3.2.2 Money Flow Through Existing Migrants

Individuals who left their originating city o before 2015 could still benefit from cash resettlement in city o if either they or their parents maintain ownership of shanty houses in city o when the cash resettlement occurred. The Population Census data in 2020 enables us to examine, for the existing migrant households that left their originating cities before 2015, whether cash resettlement in their originating (hukou) cities, $\frac{LocalRecipients_o}{N_o}$, affects their residence and homeownership status in 2020.

[12] We estimate λ by regressing the average cash compensation per square meter, which is calculated from the CDB loan data, on $P_{o,14}$, the city's house price in 2014. In case the λ estimate is biased, $LocalRecipients$ will be biased but still proportional to the actual number of cash recipient households, and our cross-sectional analysis remains valid.

Specifically, we conduct the following cross-sectional regression analysis:

$$y_{o,d} = \beta \cdot \frac{LocalRecipients_o}{N_o} + \delta_d + \theta_{p(o)} + \epsilon_{o,d} \tag{8}$$

We consider two dependent variables: (1) $stay_{o,d}$, which is the share of existing migrants from o to d that remained in the destination city d at the end of 2020, and (2) $own_{o,d}$, the share of existing migrants from o to d that not only remained but also became home owners in destination city d at the end of 2020. As reported in Table 1, the average value of $stay$ is 0.438 and the average value of own is 0.232.

We control for the destination city fixed effect δ_d to absorb any destination city-level factors that may affect the immigrants' stay and home-purchasing decisions, such as hukou or other home purchase restrictions. With δ_d, Equation (8) examines how the cash resettlement in their originating cities affects household status in the same destination city. We also control for the originating province fixed effect $\theta_{p(o)}$ to control for large economic heterogeneity across different provinces.

Baseline Results. Table 2 Panel A reports the results. In Column (1)-(2), $\frac{LocalRecipients_o}{N_o}$ has a significant and positive effect on the fraction of existing urban migrants in 2015 that stayed and became homeowners in the destination cities in 2020. A one standard deviation increase in $\frac{LocalRecipients_o}{N_o}$ would increase $stay$ by 8.1% and own by 3.6%, which are economically important as compared to the mean of 43.8% and 23.2%, respectively.

In Column (3)-(4), we conduct placebo tests by repeating the same analysis for rural migrants. Rural households mostly own houses in the rural areas. Since the shantytown renovation program only targets shanty houses in the urban areas, rural households do not benefit from cash resettlement. Accordingly, we do not find any significant effect of cash resettlement on the rural migrants. This result can help role out any city-pair economic linkages that drive the urban household location and homeownership results.

Heterogeneous Effect. To verify that money flow is more pronounced between city pairs with larger house price gaps, we divide all the city pairs with non-zero urban migrants before 2015 into two groups based on the relative housing price gap in 2014,

Table 2: Intercity Money Flow Through Existing Migrants

Panel A: Baseline Results

	(1)	(2)	(3)	(4)
Hukou:	urban	urban	rural	rural
Dep Var:	stay	own	stay	own
LocalRecipients/N	0.860***	0.379***	0.22	-0.008
	(3.59)	(2.61)	(1.30)	(-0.07)
Origin Province FE	Yes	Yes	Yes	Yes
Destination City FE	Yes	Yes	Yes	Yes
Pseudo-R2	0.173	0.109	0.28	0.228
Obs	5881	5881	2800	2800

Panel B: Heterogeneity with City-pair House Price Gap

	(1)	(2)	(3)	(4)	(5)	(6)
House Price Gap:	high	high	low	low	All	All
Dep Var:	stay	own	stay	own	stay	own
LocalRecipients/N	1.222***	0.422**	0.392	0.296	0.392	0.296
	(3.62)	(2.23)	(1.36)	(1.34)	(1.38)	(1.36)
LocalRecipients/N · High					0.83*	0.126
					(1.93)	(0.44)
Origin Province-High FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination City-High FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R2	0.21	0.16	0.11	0.086	0.188	0.124
Obs	2918	2918	2938	2938	5856	5856

Note: This table shows conditional on those urban households that have migrated to other cities before 2015, how the size of the cash-based resettlement in their originating cities affects the fraction that stay or own homes in the destination cities in 2020 (Panel A), and how such effects depend on the city-pair house price gap (Panel B). Standard errors are clustered by originating cities. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

$\frac{HP_{d,14}}{HP_{o,14}}$, and then estimate Equation (8) on these two subsamples separately.

Table 2 Panel B reports the estimation results. In Column (1)-(2), we find a significant and positive impact of cash resettlement in the household originating cities on their probability of staying and becoming home owners in destination cities if the city-pair house price gap is relatively high. In contrast, in Column (3)-(4), the coefficient estimates are both smaller and insignificant for city pairs with relatively low house price gap. To see if the difference in the effect is statistically significant, in Column (5)-(6) we perform the estimation using the full sample and interact $\frac{LocalRecipients}{N}$ with a dummy variable $High$, which equals one if the house price gap is higher than the median and zero otherwise. The coefficient estimate of the interaction term is statistically significant for *stay*, but not large enough to be statistically significant for *own*. These results are consistent with our hypothesis that households who migrate to cities with relatively high house prices are more likely to face binding borrowing constraints when purchasing local houses. Only with the cash compensation will they be able to buy the local houses and settle down.

3.2.3 New Intercity Migration

Household choice of residence location is affected by their ability to afford houses at that location. This holds true even for households that initially choose to rent, as in the future when they decide to purchase a house, they tend to purchase the house at their current residence location because relocating to a different city entails migration costs.[13]

Given the effect of housing affordability on household residence choice, the cash-based resettlement could result in new intercity migration. Without the cash resettlement, due to the profound illiquidity inherent in shantytown houses as we discussed in Section 2.1, households would not be able to sell their shanty houses for enough money to afford another house in their desired cities. As a result, they are locked in their originating cities. With the cash resettlement, their shantytown houses are converted to cash, which enables the household to purchase houses in their desired cities.

To test this prediction, we investigate the treatment effect of cash resettlement on the emigration of local urban households. Specifically, we calculate $m_{o,d,t}/N_o$, the share of urban households that migrate from city o to city d in year t, and then conduct event study analysis on the city-pair panel data with the following specification:[14]

[13]The migration costs seem quite substantial to deter frequent relocation. Using the Population Census data of 2020, we find that among those that did not live in their originating (hukou) city in 2015, in 2020 85% of them stayed in the same residence city, 7.7% returned to their originating cities, and only 7.1% went to a third city.

[14]In case not all family members migrated to other cities, we use the migration status of the family head

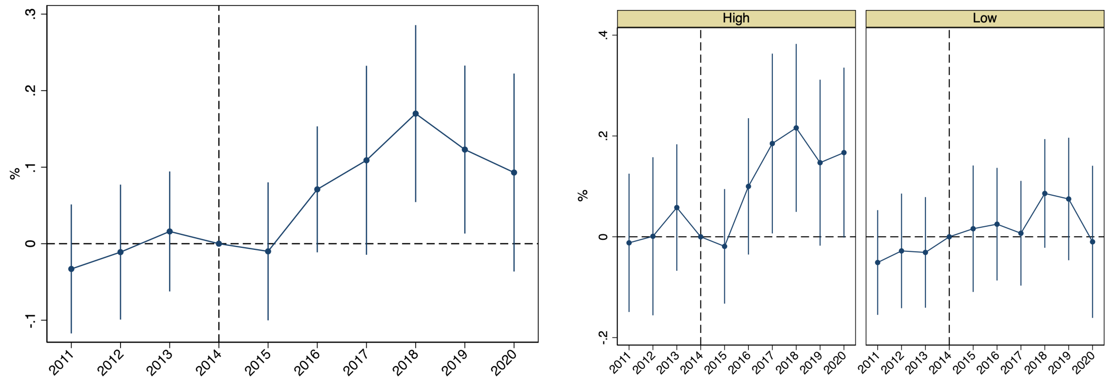
$$\frac{m_{o,d,t}}{N_o} = \sum_{\tau \neq 2014} \beta_\tau \cdot \mathbf{1}_{t=\tau} \cdot \frac{LocalRecipients_o}{N_o} + \alpha_{o,d} + \theta_{p(o),t} + \gamma_{d,t} + \Gamma_t \cdot Controls_{o,d,t} + \epsilon_{o,d,t} \tag{9}$$

In Equation (9), we use 2014 as the base year and include the city-pair fixed effect $\alpha_{o,d}$ and the originating province-by-year fixed effect, $\theta_{p(o),t}$, to control for large heterogeneity across different provinces. In addition, we include $\gamma_{d,t}$, the destination city-by-year fixed effect, to control for any time-varying factors in the destination city that might affect household migration, such as hukou and home purchase restrictions. With $\alpha_{o,d}$, $\theta_{p(o),t}$ and $\gamma_{d,t}$, the estimation investigates how cash resettlement across cities within the same province impact changes in household migration to the same destination city after 2015. Moreover, we include additional controls for robustness, including the previous tendency of households moving from o to d, $\sum_{2011 \leq t \leq 2014} \frac{m_{o,d,t}}{N_o}$, and whether city o and d are directly connected via the high-speed railway in year t.

Baseline Results. Figure 6 Panel (a) plots the estimated coefficients $\{\hat{\beta}_\tau\}$. The coefficient estimates are both insignificant and close to zero before 2014, supporting the parallel trend assumption for event studies. After 2014, we find a significant and positive treatment effect, indicating that cities with more households receiving the cash compensation experience more household migration. The effect peaked around 2018 and diminished afterwards, consistent with the timing of the cash resettlement as shown in Figure 3. To interpret the coefficient, if *LocalRecipients* is an unbiased estimator for the number of cash-receiving households, approximately 18% of the cash-receiving households have migrated to other cities by the end of 2020.

In Figure A.1 in the Online Appendix, we further investigate the demographics of households that migrate in response to the cash resettlement. We find that these households are primarily of working age and relocating to other cities in pursuit of higher wages, rather than, for instance, retired parents moving to live with their children. The estimation reveals that among the 18% cash-receiving households that migrated to other

to identify household migration.



(a) Baseline Results (b) Heterogeneity with House Price Gap

Figure 6: Cash-based Resettlement and Intercity Migration

Note: This figure plots the 95% confidence interval of the effect of $\frac{LocalRecipient}{N}$ on the city's urban household intercity migration. Standard errors are clustered by cities.

cities by 2020, 14% are under 40 years old at the time of migration, 15% state the migration reason to be employment in the destination city, and almost none are parents migrating to where their children were living.

We can perform a back-of-the-envelope calculation to assess whether money flows through existing and new intercity migrants are equally important. Based on the coefficient estimate of $\hat{\beta}$ in Column (1) of Table 2, we multiply the number of existing intercity migrants before 2015 with $\hat{\beta} \cdot \frac{LocalRecipients}{N}$ to estimate how many migrant households remained in their destination cities in 2020 as a result of the cash resettlement in their originating cities, which is about 2,076 on average across different originating cities. Similarly, we multiply $LocalRecipients$ by 18/100 to estimate how many households were induced to migrate during 2016-2020 by the cash resettlement, which is about 5,630 on average across originating cities. This exercise suggests that the two channels – money flow through existing migration network and by inducing new migration – are likely of similar importance, though their resulting housing spending per household may differ.

Heterogeneous Effect. Similarly, to verify that the effect on new intercity migration is more pronounced between city pairs with larger house price gaps, we divide the city pairs into two groups based on $\frac{HP_{d,14}}{HP_{o,14}}$, and then estimate Equation (9) with these two subsamples separately.

Figure 6 Panel (b) reports the coefficient estimates for β_τ for the two subsamples separately. Consistent this our conjecture, the increase in intercity migration is much more pronounced between city pairs with relatively larger house price gap. There is barely any effect on intercity migration between cities with relatively low house price gap.[15] When we conduct the Differences-in-Difference estimation and interact the post-treatment variable with the dummy variable *High* indicating whether the city-pair house price gap is higher than the median value, we find that the difference in effect between city pairs with high and low house price gaps is statistically significant.[16]

Overall, these results support that a relaxation in household borrowing constraint leads to household location upgrading, which channels money flow from relatively cheaper to relatively more expensive cities. This pattern explains why only cash re-settlement in originating cities with relatively low house prices impact the house prices in the destination cities.

4 A Simple Model

The empirical results draw the following picture: a group of households received a significant amount of cash and migrated to cities with higher house prices (and better opportunities), where they previously could not afford to settle down and buy houses. House prices in these destination cities increased as a result.

These patterns point out an important amplification role of migration in the effect of relaxing household borrowing constraint on housing demand. When households migrate to cities with higher wage incomes, the wealth effect leads to a discontinuous

[15]The effect on intercity migration does not increase monotonically with the city-pair house price gap, though. The effect is mostly driven by migrants from non-capital cities in inland provinces to their provincial capitals and coastal cities. We do not find any effect on migration to the very top cities, i.e., Beijing, Shanghai and Shenzhen.

[16]See Table A.2 in the Online Appendix.

increase in their housing spending. Moreover, their borrowing constraint is more likely to bind in these more expensive cities, leading to a higher marginal propensity to spend on housing. We formalize these arguments with a simple two-location model.

4.1 Setup

There are two locations indexed by $\ell \in \{H, L\}$, where house price P_ℓ and wage income w_ℓ are higher in location H than in L. Households begin with an initial wealth b_0 which follows a cumulative distribution function $F(b_0)$ with support $(0, \bar{b_0})$. We assume $\bar{b_0}$ is sufficiently large to encompass the most general cases.

For simplicity, we assume that households choose housing demand h at $t = 0$. Households may leverage housing purchases through borrowing, subject to a collateral constraint limiting net borrowing $(-b_t)$ to a fraction of housing value in any period. We assume $\beta R = 1$, where β is the household discount factor and R is the gross return on savings, to simplify the intertemporal optimization problem.

The household's optimization problem, conditional on location ℓ, is as follows:

$$V_\ell(b_0) = \max_{h, \{b_t, c_t\}} \sum_{t \geq 0} \beta^t \cdot (\log(c_t) + \log(h))$$

$$\text{s.t. } b_0 = c_0 + b_1/R + P_\ell h \tag{10}$$

$$b_t + w_\ell = c_t + b_{t+1}/R \quad \text{for any } t \geq 1 \tag{11}$$

$$-b_t \leq (1 - \bar{\omega}) P_\ell h \quad \text{for any } t \geq 1 \tag{12}$$

Equation (10) is the household budget equation at $t = 0$, i.e., they allocate initial wealth b_0 on consumption, savings and house spending. Equation (11) is their budget equation for $t \geq 1$, in which they earn local wage income w_ℓ and make consumption-savings decisions. Equation (12) is the borrowing constraint, i.e., net borrowing in all periods cannot exceed $1 - \bar{\omega}$ fraction of the household purchase value.

Note that given b_1, it is optimal to set $b_t = b_1$ and $c_t = b_1(1 - \frac{1}{R}) + w_\ell$ for $t \geq 1$. If b_1 satisfies the borrowing constraint, all b_t under the optimal choice satisfies the borrowing constraint. Therefore, we only need to consider the collateral constraint for b_1.

Moreover, denoting lifetime labor income as $W_\ell = \sum_{t=1} \frac{w_\ell}{R^{t-1}}$, we can express the budget constraint (11) with the lifetime budget equation:

$$W_\ell + b_1 = \sum_{t=1} \frac{c_t}{R^{t-1}}$$

Solve the optimal consumption-saving decisions without the collateral constraint, and substitute the optimal solution into the collateral constraint for b_1, we can find that the collateral constraint is binding if and only if:

$$b_0 \leq \widehat{b_0} \equiv \frac{2 - 2\beta + \bar{\omega}\beta}{2 - \bar{\omega}} W_\ell \tag{13}$$

The threshold level of initial wealth at which the collateral constraint binds is denoted by $\widehat{b_0}$. The collateral constraint is more likely to bind for households with lower initial wealth (b_0) or higher wages (W_ℓ) because higher-income households demand larger homes, but their limited initial wealth may be insufficient to meet the required down payment, leading to a binding borrowing constraint.

4.2 Migration and Housing Spending

We compare two scenarios. In the first scenario, all households stay in location L. In the second scenario, households can choose whether or not to migrate to location H. We are interested in how the option to migrate to location H affects household marginal increase in housing spending following a marginal increase in their initial wealth b_0.

We first analyze household location decisions when they are free to move. We focus on the case where the relatively wealthy households that do not face binding collateral constraint prefer to reside in location H, while those relatively poor households facing binding collateral constraint choose to reside in location L. This spatial sorting holds under the following parameter assumptions. Because the incremental utility from higher wage incomes diminishes with the household initial wealth, there also exists a cutoff, $\check{b}_0$, such that households with $b_0 > \check{b}_0$ prefer to reside in cheap location L. We assume $\check{b}_0$ is greater than $\widehat{b_0^H}$, the wealth threshold for the collateral constraint to bind at H.

Assumption 1. *We assume: (1)* $2\log(\frac{W_H}{W_L}) > \log(\frac{P_H}{P_L})$*; (2)* $\beta\log(\frac{W_H}{W_L}) < \log(\frac{P_H}{P_L})$*; (3)* $\check{b}_0 > \widehat{b_0^H}$ *where* $\check{b}_0 \equiv \frac{1}{R}\frac{W_H - W_L\cdot(P_H/P_L)^{1/2}}{(P_H/P_L)^{1/2}-1}$ *and* $\widehat{b_0^H} = \frac{2-2\beta+\bar{\omega}\beta}{2-\bar{\omega}}W_H$*; (4)* $\bar{b}_0 < \check{b}_0$*.*

Proposition 1. *With Assumption 1, there exists a threshold* $\widetilde{b_0}$ *such that households with* $b_0 < \widetilde{b_0}$ *choose to live in location L while those with* $b_0 \in (\widetilde{b_0}, \check{b}_0)$ *choose to live in location H.*

Intuitively, when the borrowing constraint is not binding, households can smooth consumption to benefit from higher future wage incomes in location H. Such benefit outweighs the cost of higher house prices if $2\log(\frac{W_H}{W_L}) > \log(\frac{P_H}{P_L})$. In contrast, with binding borrowing constraint, households cannot smooth current consumption and can only benefit from higher wage incomes in H through future consumption. This benefit is smaller than the cost of higher house prices if $\beta\log(\frac{W_H}{W_L}) < \log(\frac{P_H}{P_L})$. Therefore, with Assumption 1, households with small initial wealth prefer location L while households with enough initial wealth prefer location H.

Proposition 2. *Compared to the scenario in which households cannot migrate, the aggregate increase in housing consumption resulting from a marginal unit of wealth transfer is strictly higher when households can freely migrate.*

Intuitively, a wealth increase results in two types of changes in housing consumption. The first type concerns those marginal households with wealth b_0 smaller than but close to $\widetilde{b_0}$. These households will migrate to location H following a marginal increase in wealth. Upon migration, given higher wage incomes in location H, they will experience a discontinuous increase in housing consumption. The second type concerns households with wealth b_0 greater than $\widetilde{b_0}$. These households will not alter their location decisions with additional wealth. But, with migration option, they will migrate to location H, and their marginal propensity to consume housing is strictly higher when residing in location H than in L, because their collateral constraint is more binding in location H.

5 Quantitative Spatial General Equilibrium Model

How much did the cash-based resettlement program contribute to China's housing boom since 2015? How important was migration in shaping the program's effects? To answer these questions, we extend the simple model to a dynamic spatial general equilibrium model featuring multiple locations, overlapping generations, and dynamic decisions. We then calibrate the model and conduct quantitative analysis.

5.1 Model Setup

Time is discrete. There is a set of locations, $\mathcal{L} = \{1, 2, \ldots, L\}$. We use ℓ and d to index a generic location, and o to index the house location. Locations differ in productivity $Z_{\ell,t}$, housing supply $H_{\ell,t}$, and amenities A_ℓ, with the first two varying over time.

5.1.1 Households

Demographics. In each period, there are some finitely lived households. Age is indexed by $a = \{1, 2, \ldots, \bar{a}\}$. Households begin working at age 1, survive to the next period with probability $p(a)$ for age $a < \bar{a}$, and die with certainty at age $\bar{a}$. Upon death, they leave bequests of housing and assets (or debt) to the newborns who replace them.

Endowment. In period t, household i receives earning of $(1-\tau)z_{i,t}G(a_i)W_{\ell,t}$, where $G(a_i)$ is an age-specific factor that captures the hump-shaped pattern of earning over the life-cycle, $z_{i,t}$ is idiosyncratic income risk that evolves stochastically over time, $W_{\ell,t}$ is the effective wage in location ℓ in period t, and τ denotes the income tax rate.

Households can save or borrow at interest rate R and own houses. There are two types of housing assets: normal ($k = 1$) and shanty ($k = 0$). Households can rent or purchase normal houses, while shanty housing can be occupied but not traded.[17] The cash resettlement converts some illiquid shanty houses into cash.

[17] We discuss the sources of shanty house illiquidity in Section 2.1.

Preferences. Household consumes housing services h and consumption good c, which serves as the numeraire of our economy. In addition, household enjoys amenities in both residence location ℓ and house location o, denoted by $\widetilde{A}_{\ell,o} = \frac{A_\ell + A_o}{2}$, with the latter capturing hometown connections.[18] The period utility is multiplied by $e(a)$, capturing deterministic changes in family size and composition over the life cycle.

To capture homeownership preferences, we assume that living in one's own house of size h provides $\psi^h h$ effective housing services, whereas living in a rented house of size h provides only h housing services. Living in one's own house also generates additional utility of $\zeta^h(a)$. Furthermore, those lacking homeownership incur a utility loss ξ^h, which governs the decision of those locking homeownership to purchase houses.

Migration. Households can migrate at period end. We assume that household residence location ℓ and house location o can differ, in which case they rent houses in ℓ. Given ℓ and o, the cost of moving to d and purchasing houses in o' in the next period is:

$$\tau_1(a) \cdot \mathbf{1}_{d \neq \ell} + \tau_2 \cdot \mathbf{1}_{o' \neq o} + \tau_3 \cdot \mathbf{1}_{d \notin \{\ell, o\}},$$

The first term is an age-specific cost applied when a household changes residence location. The second term applies when a household changes house location, which captures the disutility associated with losing the hometown connection when households settle and own property in a new location. The third term governs the empirical pattern that a substantial share of migrants return to their hukou locations. Hence, when households move back to their house location o, migration cost is lower by τ_3.

Finally, prior to moving, each household draws an i.i.d. location preference shock ϵ_d from a Type-I Extreme Value distribution with zero mean and scale parameter ν.

Households' Decisions. Households have perfect foresight over aggregate variables such as wages, rents, and house prices. At the end of each period, after drawing the location preference shock, the household decides for the next period, where to live and

[18] The hometown connection may be due to, for instance, people's parents still residing or their children going to school in location o.

whether to rent, purchase a new house, or stay in their own house. To avoid tracking multiple housing locations for one household, we assume households must sell existing houses if and only if they purchase a new one. In what follows, we first characterize the continuation value at the beginning of any period given household residence and house location and then document their migration choices at the period end.

At the beginning of period t, any household i is characterized by age $a_{i,t}$, residence location $\ell_{i,t}$, a house carried over from the previous period with size $h_{i,t}$, location $o_{i,t}$ and type $k_{i,t}$, and cash $w_{i,t}$. Cash consists of liquid assets $b_{i,t}$ and current earnings, i.e., $w_{i,t} = b_{i,t} + (1-\tau)z_{i,t}G(a_{i,t})W_{\ell_{i,t},t}$. To simplify notation, we drop the household index i. Given the household state vector $s_t = (a_t, w_t, h_t, o_t, k_t)$ and the current and previous residence location ℓ and ℓ_{-1}, the household's value function is given by

$$V_{\ell_{-1},\ell}(s_t) = \begin{cases} \max\{V_{R,\ell}(s_t), V_{O,\ell}(s_t), V_S(s_t)\} - \tau_1(a_t)\cdot \mathbf{1}_{\ell\neq\ell_{-1}} & \text{if } \ell = o_t, \\ \max\{V_{R,\ell}(s_t), V_{O,\ell}(s_t) - \tau_2\} - (\tau_1(a_t)+\tau_3)\cdot \mathbf{1}_{\ell\neq\ell_{-1}} & \text{if } \ell \neq o_t. \end{cases} \tag{14}$$

In the above Equation, $V_{R,\ell}(s_t)$ denotes the value of renting at ℓ, $V_{O,\ell}(s_t)$ the value of purchasing a new house at ℓ, and $V_S(s_t)$ the value of staying in previously owned house, an option available only when $\ell_t = o_t$. When the household changes housing location, $V_{O,\ell}(s_t)$ is adjusted by deducting the migration cost τ_2. The household makes the optimal tenure choice to maximize the value function.

The Bellman equation for $V_{O,\ell}(s_t)$, the value of purchasing home at ℓ, is as follows:

$$\begin{aligned} V_{O,\ell}(s_t) = \max_{\{c,h,b_{t+1}\}} \; & e(a_t)u(c,\psi^h h, \widetilde{A}_{\ell,\ell}) + \zeta^h(a_t) + p(a_t)\beta\mathbb{E}_{\epsilon_{t+1}}\Big[\max_{d\in\mathcal{L}}\Big\{\mathbb{E}_{z_{t+1}}[V_{\ell,d}(s_{t+1}) \mid b_{t+1}] \\ & + e(a_{t+1})\nu\epsilon_{d,t+1}\Big\}\Big] + (1-p(a_t))\cdot\varphi(b_{t+1} + h_{t+1}P_{o_{t+1},t+1}k_{t+1}) \\ s.t.\; & c + hP_{\ell,t}(1+\tau^{h,b}+\delta^h) + \frac{1}{R}b_{t+1} = w_t + h_tP_{o_t,t}k_t(1-\tau^{h,s}) - F_{b,t} \\ & b_{t+1} \geq -(1-\bar{\omega})P_{\ell,t}h, \; h \geq \underline{h} \\ & w_{t+1} = b_{t+1} + (1-\tau)z_{t+1}G(a_{t+1})W_{d,t+1}, \; h_{t+1} = h, \; o_{t+1} = \ell, \; k_{t+1} = 1, \; a_{t+1} = a_t + 1. \end{aligned} \tag{15}$$

Given the decision to purchase a new house at location ℓ, the household chooses consumption c, house size h and savings b_{t+1} to maximize expected utility. Because the household will live in the newly purchased house, he enjoys housing service of $\psi^h h$ and an additional utility of $\zeta^h(a_t)$. With probability $p(a_t)$, the household survives and chooses d, the residence location for period $t+1$, that offers the highest expected value. The expectation over z_{t+1} is because z_{t+1} is realized after migration. With probability $1 - p(a_t)$, the household dies and leaves a bequest, which includes liquid assets and the liquidated value of the house.

The first constraint represents the budget equation. The household spends cash w_t and proceedings from selling previous houses $h_t P_{o_t,t} k_t (1 - \tau^{h,s})$, where $\tau^{h,s}$ denotes the housing sales tax, on consumption c, new home purchase h at location ℓ, and asset position b_{t+1}. Home purchase incurs a deed tax $\tau^{h,b}$ on housing purchases, and a per-unit maintenance cost of δ^h. To capture the interest rate spread between saving and borrowing, we define an additional financial cost of borrowing as $F_{b,t} = \iota \cdot \mathbf{1}_{b_{t+1}<0} |b_{t+1}|$.

In addition to the budget constraint, debt to be paid in the next period cannot exceed a fixed fraction of the current value of the house, with the haircut on collateral denoted by $\overline{\omega}$. We also impose a minimum size requirement $\underline{h}$ on the new house.

The Bellman equations for $V_{R,\ell}(s_t)$ and $V_S(s_t)$ are analogous to Equation (15) and presented in Appendix C. Renters allocate their cash-on-hand across consumption, rental housing services, savings, and their own housing maintenance costs. Those that live in their previously acquired house make consumption-savings decisions, after paying the housing maintenance costs. In all cases, the collateral constraint must be satisfied.

Conditional on the state variables s_{t+1} and the residence location ℓ at period t, the share of households moving to location d in period $t+1$ is:

$$\mu(d|\ell, b_{t+1}, s_{t+1} \backslash \{w_{t+1}\}) = \frac{\exp\left(\frac{1}{\nu}\frac{1}{e_{a_{t+1}}}\mathbb{E}_{z_{t+1}}[V_{\ell,d}(s_{t+1}) \mid b_{t+1}]\right)}{\sum_{d'} \exp\left(\frac{1}{\nu}\frac{1}{e_{a_{t+1}}}\mathbb{E}_{z_{t+1}}[V_{\ell,d'}(s_{t+1}) \mid b_{t+1}]\right)}. \tag{16}$$

Note that at the time of migration, households do not observe their productivity z_{t+1}; w_{t+1} will be determined after they migrate and observe z_{t+1}.

5.1.2 Production and Equilibrium

Goods. We assume a linear production function in labor. Competitive equilibrium implies that wages equal the labor productivity, i.e., $W_{\ell,t} = Z_{\ell,t}$.

Houses. We assume that in each location, house stock is supplied as follows,

$$H_{\ell,t} = B_{\ell,t} P_{\ell,t}^{\rho^h}, \tag{17}$$

where $B_{\ell,t}$ is a time-varying supply shifter that captures changes in land supply and land zoning, and ρ^h is the housing supply elasticity.

We assume that rental supply comes from the rich speculators, whose required return rate from investing and renting houses equals the risk-free rate R plus some premium v. In equilibrium, we have the following condition between house price and rent,

$$R_{\ell,t} = P_{\ell,t}(1 + \tau^{h,b}) - (1 - \tau^{h,s})(1 - \delta^h)\frac{P_{\ell,t+1}}{R + v}. \tag{18}$$

Equilibrium. Given an initial distribution of households, a competitive equilibrium of our dynamic economy is a sequence of prices $\{W_{\ell,t}, P_{\ell,t}, R_{\ell,t}\}$ such that the housing, rental, and labor markets clear in every location and in every period.

5.2 Quantification

In this section, we quantify our dynamic spatial general equilibrium model. The joint consideration of tenure choice, consumption-savings under incomplete markets, and forward-looking location decisions – combined with rich spatial and individual heterogeneity – generates non-linear policy functions over a large state space.[19] We implement a solution method that globally solves household's dynamic problem given aggregate states. We then track the distribution of individual states within and across locations, starting from an initial distribution. Once aggregated, this distribution, in turn, informs the equilibrium behavior of aggregate states.

[19] We cannot implement dynamic hat-algebra for counterfactual analysis, which requires policy functions to be log-linear in state variables, as in Caliendo et al. (2019) and Kleinman et al. (2023).

Time Horizon and Space. Each period in our model represents five years. We take 2016–2020 as the first period, corresponding to the time when the cash-based resettlement program was implemented. We directly construct the pre-2016 distribution of individual states based on the representative sample of the National 1% Population Survey Data of 2015 and the China Household Finance Survey data of 2015 and 2017, as detailed in Appendix D.1.

Given the computational challenges, we pool all the cities to form five locations based on their house prices in 2015. Location 1 consists of the top three cities – Beijing, Shanghai and Shenzhen, whose house prices far exceed other cities. Location 2 consists of the capital cities and another two cities with comparable house prices from the five most developed coastal provinces.[20] Location 3 consists of the other cities in these provinces. Location 4 and 5 consist of the capital and non-capital cities of other provinces, respectively.[21] Online Appendix Figure A.4 shows that this clustering largely preserves the geographic dispersion in house prices and, more importantly, the majority of household migration. Between 2016 and 2020, migration across these five locations accounts for 77% of all intercity migration. The percentage of households receiving the cash resettlement program ($LocalRecipients/N$) increases almost monotonically from location 1 to location 5 – 0.5% in location 1, 3.0% in 2, 2.8% in 3, 7.6% in 4, and 9.1% in 5.[22]

We calibrate our baseline economy with the cash-based shantytown renovation program under the following paths of wages and prices. We use observed real house prices and real wages prior to 2021 and extrapolate future real house prices and real wages.[23] We then aggregate the city-level prices and wages to the location level using population-weighted average values. With the time sequence of $\{W_{\ell,t}, P_{\ell,t}\}$ and $\{R_{\ell,t}\}$ computed

[20] These include Tianjin,Jiangsu, Zhejiang, Fujian and Guangdong. The two non-capital cities are Wenzhou and Xiamen.

[21] We exclude four autonomous regions and three most distant provinces (Hainan, Gansu and Qinghai). By 2015, migration to and from these regions and provinces account for only 10% of all intercity migration.

[22] Roughly 70.4% cash recipients are in location 5, 17.8% in 4, 8.1% in 3, 2.8% in 2, and 0.9% in 1.

[23] We assume that real house prices and real wages in all locations grow at the same rate as the real GDP long-term forecasts by OECD until 2060 and at the annual rate of 1% onwards. See OECD's real GDP long-term forecast here.

using Equation (18), we solve household's dynamic problems and construct the corresponding model-implied moments.

Calibration. A subset of parameters is calibrated based on values from the existing literature or externally determined without solving the model. The remaining parameters are internally calibrated to ensure that the model replicates key empirical moments related to wealth distribution, tenure choice, and migration behavior. In what follows, we briefly discuss the main calibrated parameters, leaving a detailed description to Appendix D.1. Table A.3 in the Online Appendix provides the full list of parameters and related data moments.

To discipline household housing-related behaviors, we calibrate $\zeta^h(a)$ to match the life-cycle profile of homeownership. The calibrated values are significantly lower for young than middle-aged groups, reflecting the increasing propensity to own a home with age. The utility loss due to lack of homeownership, ξ^h, is calibrated to match the estimated share of cash recipients that purchase new normal housing in their current residence during 2016-20. We calibrate the housing service multiplier ψ^h to match the ratio between the average size of own-occupied and renter-occupied houses.

To govern household migration patterns, we calibrate the age-dependent migration cost $\tau_1(a)$ to match the average out-migration profile over the life cycle. The additional migration cost of changing housing location, τ_2, is calibrated to match the observed share of households that change housing locations. Finally, we calibrate τ_3 to match the models bilateral migration shares as closely as possible to their empirical counterparts.

For house supply, we calculate the supply shifter $\{B_{\ell,t}\}$ as residuals to clear the housing market for all (ℓ, t) in the baseline economy with the cash-based resettlement. We estimate the house supply elasticity ρ^h using *loan_dest* as a demand shifter.

Model Fitness. Table A.3 in the Online Appendix demonstrates that our model closely replicates the key targeted moments in the data. Figure 7 presents additional moments

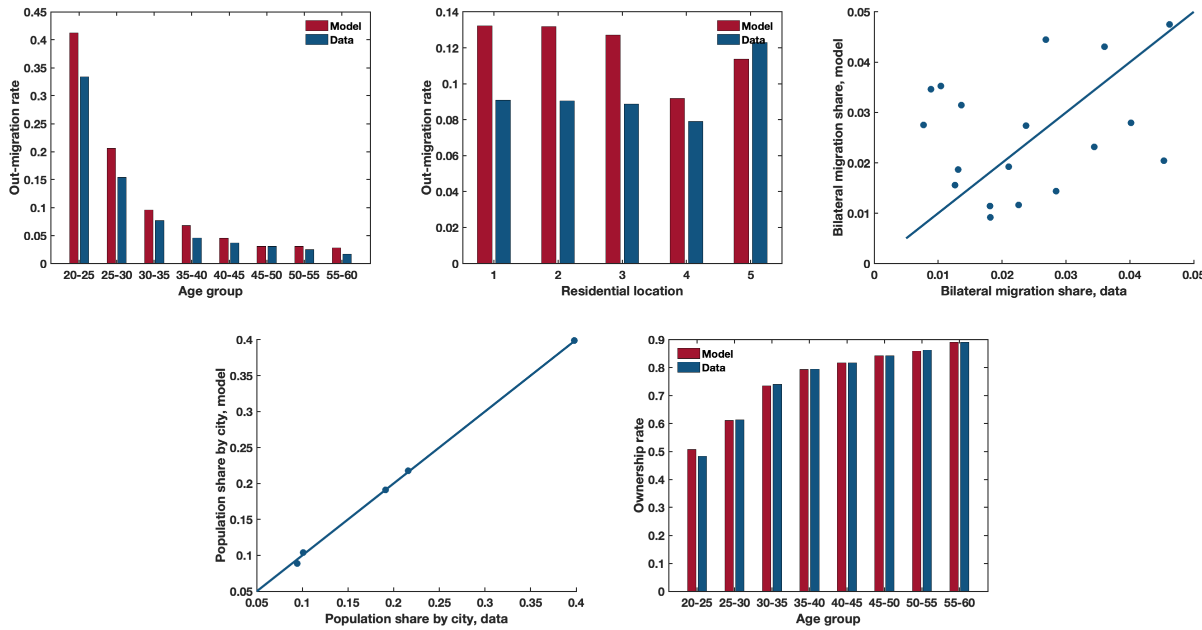


Figure 7: Key Moments: Model versus Data

Note: This figure shows how the model fits the data in several key moments during 2016-2020.

for the first period of 2016 – 2020, including out-migration rates by age and by housing location, bilateral migration shares, population by location, and homeownership rates by age. The first three moments validate the models ability to capture household migration behavior, while the homeownership profile confirms that the model accurately represents lifetime housing tenure decisions.

6 Quantitative Results

6.1 Individual Counterfactual Analysis

In the model, the cash-based resettlement converts the illiquid shanty houses into cash, allowing households to spend anywhere they want. To examine whether the model can deliver our key empirical findings in Section 3, we first analyze individual household migration and home purchasing decisions in response to the cash resettlement, taking as fixed the observed aggregate path of wages, house prices and rents.

Next, to isolate the role of migration, we consider an alternative resettlement approach by imposing the following restriction: households that receive the cash transfer cannot purchase normal housing outside their original shanty house locations.[24] We refer to this approach as "voucher resettlement," in the sense that households receive a voucher that can only be spent locally. Voucher resettlement leads to the same wealth increase but with non-local spending of the transfer shut down. Given the observed aggregate price paths, we re-solve individual households dynamic optimization problem – defined by Equations (14), (15), (27), and (28) – under the voucher resettlement. The differences in household behaviors between cash and voucher resettlement reflect the role of migration.

6.1.1 Effect of Cash Resettlement

In Figure 8, we plot household out-migration decisions during the first period (i.e., 2016 – 2020) for each initial residence location in 2015 separately. For each initial residence location and destination choice, the three bars correspond to the share of migrant treated households under no resettlement, cash, and voucher resettlement, with different colors representing different tenure choices in the new destination.

We first examine whether the model's predictions align with our key empirical findings that cash resettlement reduces location downgrading and facilitates location upgrading. In Figure 8, the first panel for residence location 1 shows that compared to no resettlement, cash resettlement reduces the share of treated households that migrate to lower-tier locations by more than 40% in total, with more than 30% purchasing normal houses in location 1 (see Figure A.6 in Appendix D.2). We find similar patterns in the second panel for residence location 2 with a smaller effect, and no such patterns for the other lower-tier locations. When restricting to migrant households (those with houses in non-residence locations), cash resettlement reduces out-migration from location 1 by

[24] The restriction holds throughout their lifetime, but not for their children.

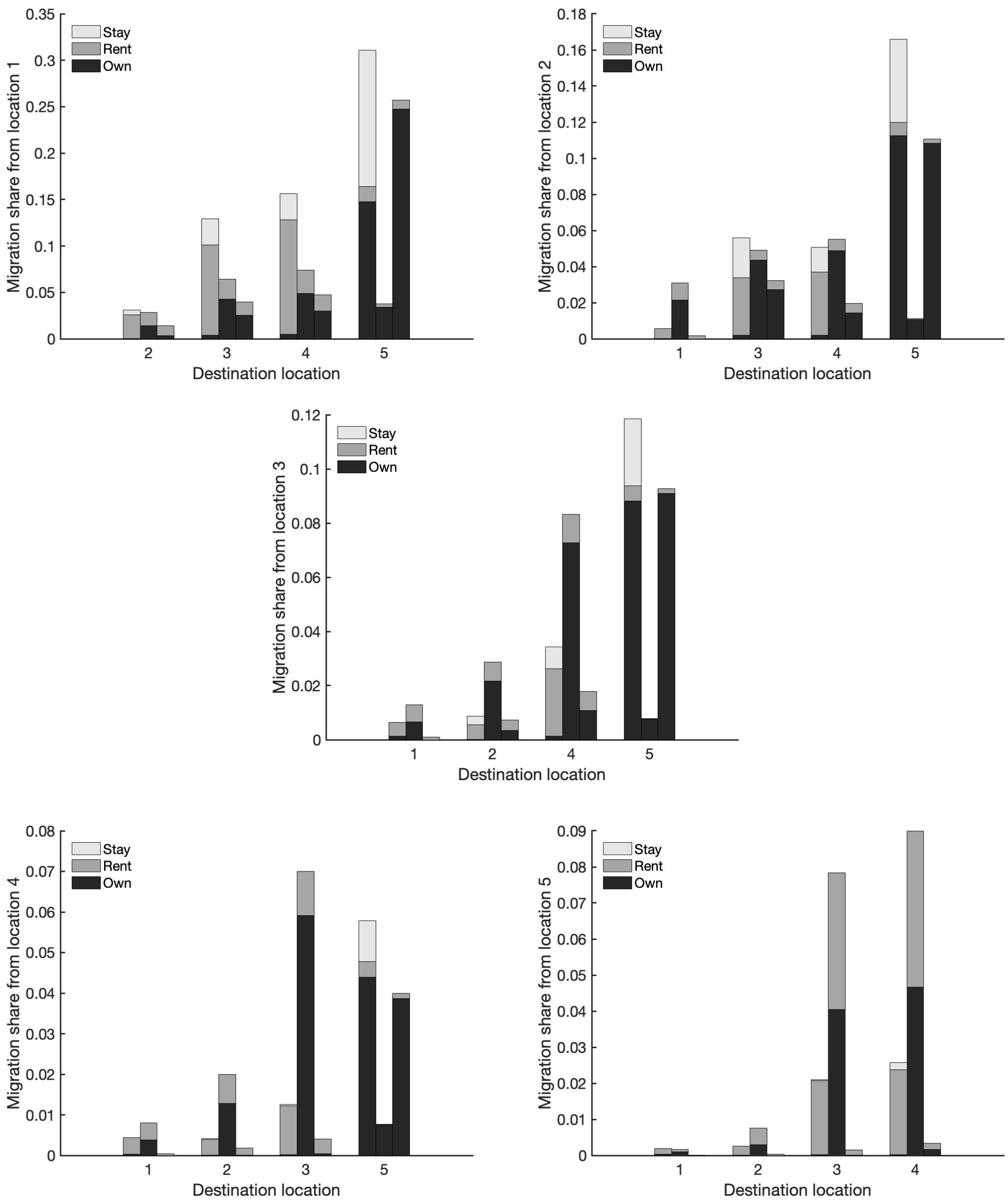


Figure 8: Household Migration and House Tenure Choice: Cash versus Voucher

Note: For each initial residence location in 2015, this figure plots the share of treated households that migrate to each location in 2016 – 2020, with the three bars corresponding to no resettlement, cash resettlement, and voucher resettlement, and different colors representing different tenure choices in the new destination.

48%, location 2 by 35%, and location 3 by 18%. These predictions echo our empirical findings regarding existing migrants in Section 3. If anything, the model underestimates the effect on existing migrants.

The last panel for residence location 5 shows that compared to no resettlement, cash resettlement leads to more migration to location 3 and 4 by about 13% in total, with about 9% purchasing local houses. The cash compensation was not large enough to induce upgrading to location 1 and 2, which is also what we find empirically. We find similar location upgrading patterns for households residing in location 4, with the effect being slightly smaller. When restricting to non-migrant households (those with houses in residence locations), cash resettlement increases out-migration from location 5 by 13% and location 4 by 4%. These results echo our empirical findings regarding new migration in Section 3. If anything, the model underestimates the effect on new migration.

Figure 8 also shows the migration and house tenure choices of treated households under voucher resettlement. Compare to cash resettlement, voucher resettlement will limit household location upgrading. The first panel shows that among treated households in location 1 in 2015, over 25% would return to their housing location 5 and use the voucher to purchase houses under the voucher resettlement. Under cash resettlement, however, instead of moving to location 5, most of these households now remain in top-tier location 1, and some move to locations 2, 3, and 4.

Switching to low-tier cities, the last panel shows that with the restriction to spend only locally, very few treated households in location 5 upgrade to higher-tier locations under the voucher settlement. Among those who remain in location 5, 90% purchased new houses in 2016-20 from Figure A.6. In contrast, the cash resettlement leads to substantial changes in migration decisions: 17% of these households relocate to locations 3 and 4, and among these migrants, half purchase new housing in the destination.

6.1.2 Migration and the Collateral Constraint

The core idea of this paper is that households face more binding borrowing constraints when purchasing houses in higher-tier locations and hence choose to stay in lower-tier locations. Additional cash transfer relaxes the constraint and facilitates location upgrading. Upon migration, households will spend more on housing services.

To illustrate the above point in the quantitative model, we examine household borrowing constraints in lower- versus higher-tier locations with versus without the cash resettlement. Specifically, for households residing in location 5 in 2015, we calculate their optimal choice of savings over housing asset value in 2016-20, b/ph, conditional on home purchase in location $d \in \{1, 2, 3, 4, 5\}$ under cash and no resettlement separately. We focus on treated households in location 5, as 70.2% of cash recipients resided in location 5 in 2015. We define marginal households as those for whom the cash resettlement induces an increase in out-migration probability above the 80th percentile. Non-marginal households are those for whom the increase falls below the 20th percentile.

In Table 3, we report the average b/ph by household groups, resettlement status and locations. In the first row, without cash resettlement, most marginal households are far from having a binding borrowing constraint if residing in location 5 – their average savings are positive. In contrast, if they go to other locations, they would be much closer to having a binding constraint especially in higher-tier locations, which explains why they choose not to go there. The average debt-to-collateral value weighted by the migration probability is 0.46. In the second row, cash resettlement relaxes their borrowing constraint in all locations. Such relaxation plays a minimum role for location 5 as households are already not constrained there, but is large enough for them to smooth consumption in other locations and induce location upgrading, mostly to 4 and 3.

The third and forth row report the same statistics for non-marginal households. The borrowing constraints are relatively more binding for them than marginal households. Even under cash resettlement, the relaxation in their borrowing constraints is not large enough to induce location upgrading, and hence they do not respond by migrating.

Table 3: Migration and Collateral Constraint

	Resettlement	5	4	3	2	1	4-1
Marginal households	No Cash	0.09	-0.43	-0.46	-0.66	-0.70	-0.46
	Cash	0.66	-0.21	-0.24	-0.60	-0.70	-0.24
Non-marginal households	No Cash	-0.23	-0.52	-0.54	-0.69	-0.70	-0.54
	Cash	-0.01	-0.38	-0.43	-0.67	-0.70	-0.42

Note: This table shows the average value of household optimal choice of savings over housing asset (b/ph) conditional on purchasing new homes in 2016-20, by different household groups, resettlement status and locations.

6.1.3 The Housing Expenditure Multiplier

To further investigate household housing expenditures, we define the following measure of housing expenditure multiplier as the increase in individual household home purchase spending with versus without the resettlement, normalized by the amount of compensation they receive.[25]

We highlight some patterns of the multiplier under cash resettlement in 2016-20, with details presented in Figure A.7 in Appendix D.2. First, the multiplier tends to exceed one, with mean value of 1.23. This amplification arises because, after receiving the cash, households may draw on personal savings or obtain mortgage financing, enabling them to spend beyond the transfer amount. Second, there is substantial variation in the multiplier across households, with a standard deviation of 0.53. In particular, the multiplier tends to be higher for young and wealthy households, as they are more likely to become homeowners and purchase larger homes. Households from residence location 1 exhibit higher multipliers, since the cash resettlement enables them to purchase homes location 1. Households with shanty houses in locations 4 and 5 also tend to have high multipliers because they are more likely to upgrade to higher-tier locations.

Households may gradually transition into homeownership rather than purchasing homes immediately after receiving the transfer, especially those that upgrade their loca-

[25] The home purchase spending is zero for those that choose to rent over the specified period of time.

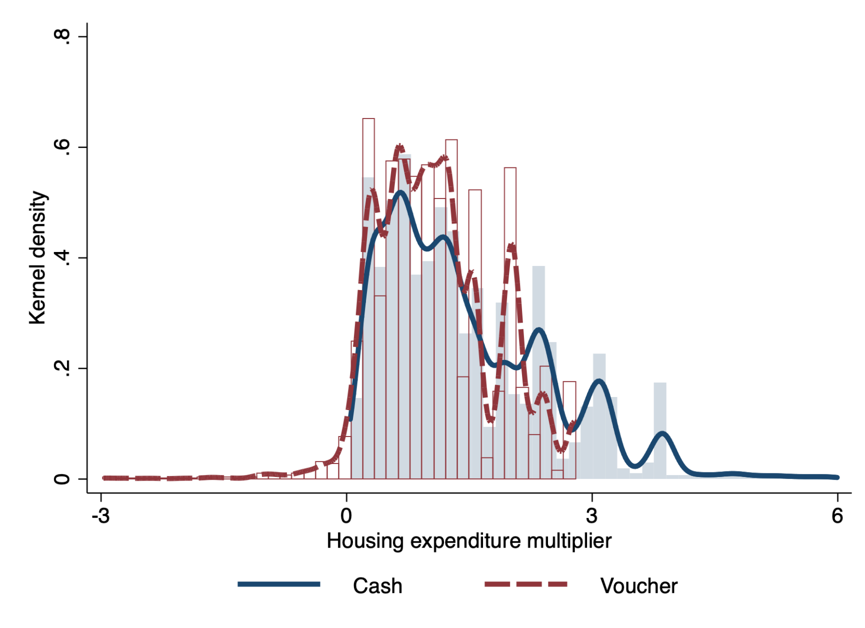


Figure 9: Lifetime Housing Expenditure Multiplier: Cash versus Voucher

Note: This figure plots the lifetime housing expenditure multiplier across all treated households under cash and voucher resettlement.

tions. We track household home purchase decisions across states over time and compute their lifetime housing expenditure multiplier. This multiplier is defined as the expected present value of total lifetime home purchase expenditures (discounted to the first period of 2016 - 2020) with versus without resettlement, normalized by the compensation amount.

Figure 9 presents the distribution of the lifetime multiplier across treated households under cash and voucher resettlement separately. The distribution shifts more to the right under cash relative to voucher resettlement, with some households exhibit a multiplier over 3. The average lifetime multiplier is 1.51 under cash versus 1.08 under voucher resettlement. The endogenous location upgrading would increase household lifetime housing expenditures in response to a cash transfer by nearly 50%.

To summarize, the individual counterfactual exercises support our core argument that cash resettlement facilitates location upgrading, which amplifies the increase in household housing expenditures in response to the cash resettlement. In the next section, we solve for the general equilibrium to show how this increased spending contributes to the post-2015 housing boom.

6.2 General Equilibrium Results

To quantify the effect of cash resettlement on post-2015 house price growth, we consider a counterfactual scenario with in-kind resettlement, i.e., displaced households receive houses of the same size in the same location. We assume the houses they receive are also illiquid, as these houses are typically embedded with transaction restrictions over an extended period of time. On the supply side, we assume cash resettlement per se did not change the house supply relative to the in-kind resettlement, as the government requisitioned the same amount of land regardless of the resettlement approach. The equilibrium house supply would still be different due to the price elasticity of house supply. To highlight the role of migration networks, we also compute the equilibrium path of house prices in an economy with voucher settlement.[26]

Figure 10 shows the percentage change in house prices over time for each location, relative to the scenario with in-kind resettlement. The cash resettlement contributes significantly to house price growth – particularly in low-tier location 5, where price is nearly 9% higher during 2016-20 and remain elevated thereafter. The cash resettlement also leads to notable price increases in locations 3 and 4 by 6.5% and 8.5% respectively during 2016-20.

Compared to the cash resettlement, the voucher resettlement, by locking housing demand in the housing location, increases house prices in location 5 even more, by 11.5%, since about 70.4% of cash recipients have houses in location 5. House prices in all the other four locations will be lower, by 2.0%-2.5% for locations 3 and 4 and by about 1.0%

[26]We consider a 200-period counterfactual price path, assuming after which the counterfactual prices converge back to the price path of the baseline economy with cash resettlement. For each guessed counterfactual path, we solve households' dynamic optimization problems, update the distribution of household states, and compute aggregate housing demand. We then use the discrepancy between housing demand and supply, as defined in Equation (17), to iteratively update the path of house prices.

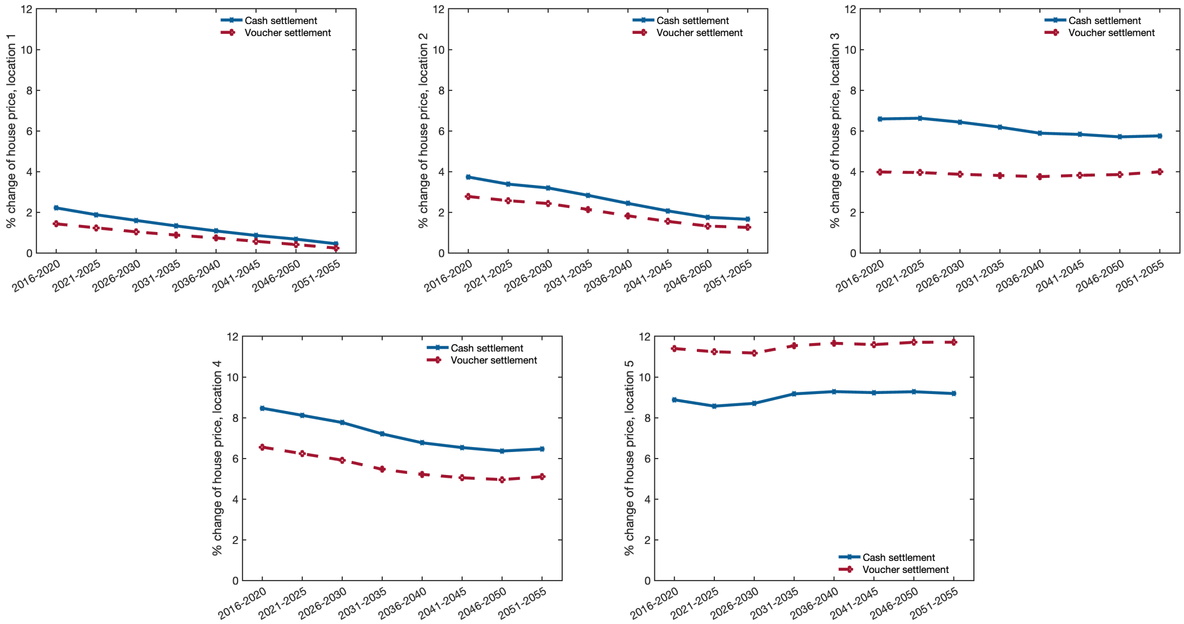


Figure 10: Cash Resettlement and House Price Growth

Note: This figure plots the equilibrium house price growth by different locations under the cash and voucher resettlement.

for location 1 and 2. This indicates that a substantial portion of the increased housing demand in these locations originates from households with shanty houses in location 5. After receiving cash compensation in their hometown, these households relocate to higher-tier locations and purchase new homes there, driving up prices in those areas.

7 Conclusion

In this paper, we examine how the shantytown renovation program under cash-based resettlement has affected the housing market in China after 2015. The reduced-form analyses suggest that the cash-based resettlement relaxed household borrowing constraint and allowed them to migrate to more expensive locations with house prices that they previously cannot afford to buy a house. This has increased housing demand in destination cities and enlarged spatial dispersion of house prices in China after 2015.

We quantify the impacts of the program by constructing and estimating a dynamic spatial general equilibrium model with endogenous migration and collateral constraint. We highlight the crucial role of endogenous migration in understanding the effect of relaxing borrowing constraint because it affects the number of households with binding constraint as they desire to migrate to more expensive cities.

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Online Appendix

A More Empirical Results

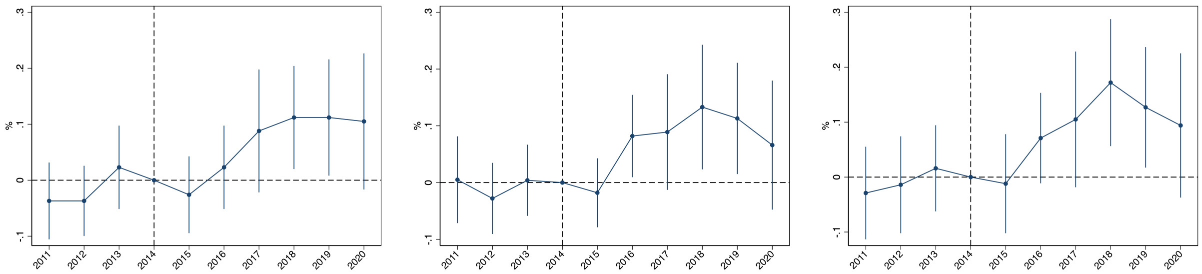
A.1 Data

Table A.1: Variable Definition

Variable	Definition
hp	quality-adjusted house price index normalized to be one in 2014.
hq	new house supply (minus requisition) scaled by urban housing stock at year beginning.
loan_orig	the local amount of CDB (China Development Bank) loans scaled by housing market transaction value in 2014.
loan_dest	the inflow of CDB (China Development Bank) loans scaled by housing market transaction value in 2014.
LocalRecipients/N	fraction of local urban households that receive the cash-based resettlement.
stay	fraction of existing migrants in 2015 that remains in the same destination city in 2020.
own	fraction of existing migrants in 2015 that remains and becomes homeowners in the same destination city in 2020.
migration/N	annual urban household migration scaled by the number of urban households in originating city in 2014.

A.2 New Intercity Migration

We investigate the demographics of households that migrate in response to the cash resettlement. We hypothesize that these households are primarily of working age and relocating to other cities in pursuit of higher wages, rather than, for instance, retired parents moving to live with their children. To test this hypothesis, we restrict to migrant households for whom: (1) the family head was under 40 years old at the time of migration, (2) the stated reason for migration was employment in the destination city, and (3)



(a) Age $<$ 40 (b) Migration for Working (c) Non-followers

Figure A.1: Robustness Checks for Intercity Migration

Note: This figure plots the 95% confidence interval of the effect of $\frac{LocalRecipient}{N}$ on the city's urban household intercity migration. We restrict to households with age smaller than 40, claiming migration for working purposes, and with no family member coming to the destination city before, respectively. Standard errors are clustered by cities.

no other family members had migrated to the same destination city before the family head in that year. We then repeat the estimation of Equation (9) using these subsets of migrants.

Figure A.1 reports the results. We find similar effect as shown in Figure 6, regardless how we restrict the migrant households. In terms of the magnitude, the estimated coefficients indicate that among the 18% cash-receiving households that migrated to other cities by 2020, 14% are under 40 years old at the time of migration, 15% state the migration reason to be employment in the destination city, and almost none are parents migrating to where their children were living.

Table A.2 shows the DID estimation results where we interact the post-treatment variable with the dummy variable *High* indicating whether the city-pair house price gap is higher than the median value. The difference in effect between city pairs with high and low house price gaps is statistically significant as shown in Column (3).

A.3 Spatial Dispersion of House Prices

One implication of the heterogeneous effect with respect to the city-pair house price gap is that, cities with higher house prices should be more affected by the spatial diffusion

Table A.2: Intercity Migration and City-pair House Price Gap

Dep Var: migration/N,%	(1)	(2)	(3)
Price Gap:	High	Low	All
Post·LocalRecipients/N	0.156***	0.055	0.055
	(3.01)	(1.43)	(1.45)
Post·LocalRecipients/N·High			0.101*
			(1.73)
City-pair FE	Yes	Yes	Yes
Origin Province-Year-High FE	Yes	Yes	Yes
Destination City-Year-High FE	Yes	Yes	Yes
Controls-High	Yes	Yes	Yes
Adjusted-R2	0.5665	0.2412	0.5277
Obs	47350	47450	94800

Note: This table shows the effect of $\frac{LocalRecipient}{N}$ on the citys urban household intercity migration. We divide the sample into two groups based on the house price gap between destination and originating cities in 2014. Standard errors are clustered by originating cities. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

of the cash resettlement, as these cities have larger house price gap with other cities. In contrast, cities with lower house prices shall be less affected through the migration network. To test this implication, we divide the cities into two groups based on their house prices in 2014 and estimate Equation (2) using these two subsamples separately.

Figure A.2 shows the results. Consistent with our prediction, in cities with higher house prices, the effect of *loan_dest* is much larger than in cities with low house prices in 2014. The differences in the coefficient estimates, as reported in the last graph, are all statistically significant except that in 2015.

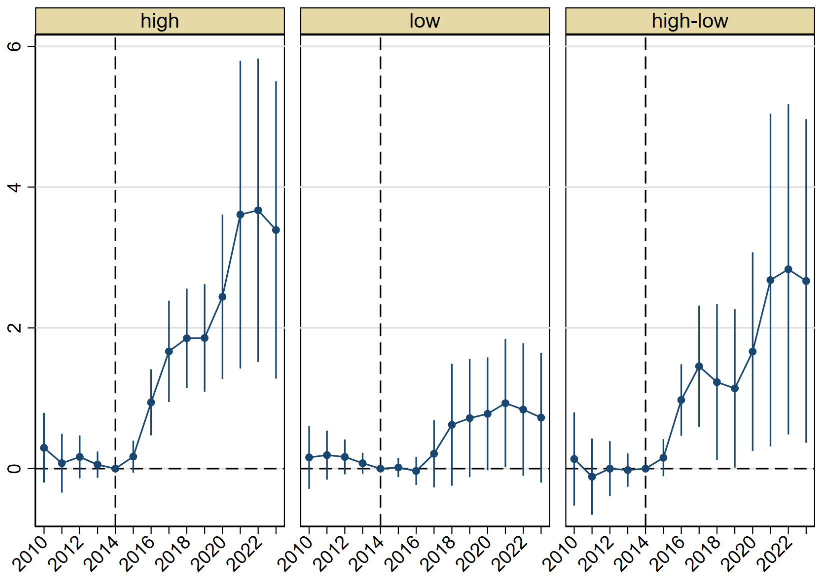


Figure A.2: House Price Response at Destination Cities by House Price

Note: This figure plots the 95% confidence interval of the event study coefficient estimates of *loan_dest* on the house prices at the destination cities for cities with high house price, low house price, and the difference of the coefficient estimates. Standard errors are clustered by cities.

B Proof for the Two-location Model

Proof for Proposition 1

Proof. When the collateral constraint is not binding, a household's value function from living in location ℓ is

$$V_\ell^u(b_0) = \frac{2}{1-\beta}\log(b_0 + W_\ell/R) - \frac{1}{1-\beta}\log(P_\ell) + \text{Constant} \tag{19}$$

When the collateral constraint is binding, as $\frac{b_0}{W_\ell} \to 0$, the housing expenditure $P_\ell h \to \frac{1}{2-\beta}\frac{b_0}{1-\beta+\beta\bar{\omega}}$ and consumption $c_0 \to \frac{1-\beta}{2-\beta}b_0$, and as a result,

$$V_\ell^c(b_0) \overset{\frac{b_0}{W_\ell}\to 0}{\longrightarrow} \frac{2-\beta}{1-\beta}\log(b_0) + \frac{\beta}{1-\beta}\log(W_\ell) - \frac{1}{1-\beta}\log(P_\ell) + \text{Constant} \tag{20}$$

With the first inequality in Assumption 1, for $b_0 \in [0, \check{b}_0)$, we have $V_H^u(b_0) > V_L^u(b_0)$. With the second inequality in Assumption 1, for sufficiently small b_0, we have $V_H^c(b_0) < V_L^c(b_0)$.

The value function from residing in location ℓ is given by:

$$V_\ell = \mathbf{1}(b_0 \geq \frac{2-2\beta+\bar{\omega}\beta}{2-\bar{\omega}}W_\ell)\cdot V_\ell^u + \mathbf{1}(b_0 < \frac{2-2\beta+\bar{\omega}\beta}{2-\bar{\omega}}W_\ell)\cdot V_\ell^c$$

Therefore, there exists a cutoff value $\widetilde{b_0}$ such that $V_L > V_H$ if and only if $b_0 < \widetilde{b_0}$. □

Denote the value function at location ℓ with binding and non-binding constraint by V_ℓ^c and V_ℓ^u, respectively. With Assumption 1, we have $V_H^u > V_L^u$ for $b_0 < \check{b}_0$ and $V_H^c < V_L^c$ for small enough b_0. There are two cases depending on whether $\widetilde{b_0}$ is greater or smaller than $\widehat{b_0^L}$, the threshold wealth for the collateral constraint to be binding at location L. In the first case as shown in the left graph of Figure A.3, as b_0 increases, the household first becomes unconstrained in location L before migrating to location H, where they face binding collateral constraint. In the second case as shown in the right graph of Figure

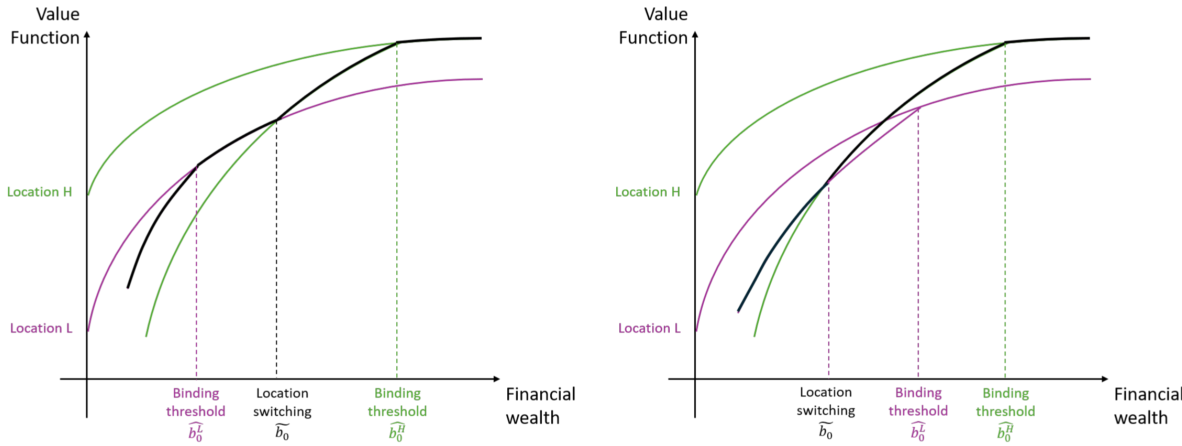


Figure A.3: Location Value Function and Migration

A.3, as b_0 increases, the household transitions from being constrained in location L to being constrained in location H.

To see Proposition 2, we first fix the location and examine household marginal propensity to consume housing given a marginal increase in their initial wealth b_0. Such propensity depends on whether or not the collateral constraint is binding. We have the following lemma.

Lemma 1. *Given household location, the marginal propensity to consume housing satisfies the following properties:*

(1) It is higher when the collateral constraint is binding than when it is not binding. Specifically, $\frac{\partial P_\ell h}{\partial b_0} > \frac{1}{2}$ *when condition (13) holds and* $\frac{\partial P_\ell h}{\partial b_0} = \frac{1}{2}$ *when condition (13) does not hold.*

(2) In case the collateral constraint is binding, $\frac{\partial P_\ell h}{\partial b_0}$ *is higher when b_0 is lower or W_ℓ is higher.*

Proof. If the collateral constraint for b_1 is non-binding, optimal housing consumption is:

$$P_\ell h = \frac{b_0 + W_\ell / R}{2} \tag{21}$$

The marginal propensity to spend on housing is:

$$\frac{\partial P_\ell h}{\partial b_0} = \frac{1}{2}. \tag{22}$$

That is, households allocate half of additional wealth to housing when unconstrained.

When the collateral constraint is binding, the optimal housing consumption is:

$$P_\ell h = \frac{1}{4}\left(\frac{(1+\beta)b_0}{1-\beta+\beta\bar{\omega}} + \frac{(2-\beta)W_\ell}{1-\bar{\omega}} - \sqrt{\left(\frac{(1+\beta)b_0}{1-\beta+\beta\bar{\omega}} + \frac{(2-\beta)W_\ell}{1-\bar{\omega}}\right)^2 - \frac{8b_0}{1-\beta+\beta\bar{\omega}}\frac{W_\ell}{1-\bar{\omega}}}\right) \tag{23}$$

In this case, the marginal propensity to consume on housing, $\frac{\partial P_\ell h}{\partial b_0}$, is the following:

$$\frac{\partial P_\ell h}{\partial b_0} = \frac{b_0(1-\bar{\omega})(1+\beta)^2 - \left(2-\beta+\beta^2\right)W_\ell(1-(1-\bar{\omega})\beta)}{-4(1-\bar{\omega})(1-(1-\bar{\omega})\beta)^2\sqrt{\left(\frac{b_0(1+\beta)}{1-(1-\bar{\omega})\beta} + \frac{(2-\beta)W_\ell}{1-\bar{\omega}}\right)^2 - \frac{8b_0W_\ell}{(1-\bar{\omega})(1-(1-\bar{\omega})\beta)}}} + \frac{1+\beta}{4-4(1-\bar{\omega})\beta}. \tag{24}$$

We first examine the monotonicity of $\frac{\partial P_\ell h}{\partial b_0}$ under the binding collateral constraint.

$$\frac{\partial^2 P_\ell h}{\partial b_0 \partial W_\ell} = \frac{2b_0(1-\beta)\beta W_\ell}{\begin{pmatrix} (b_0(\bar{\omega}-1)(\beta+1) - (\beta-2)W_\ell((\bar{\omega}-1)\beta+1))^2 + \\ 4b_0(1-\bar{\omega})(1-\beta)\beta W_\ell(1-(1-\bar{\omega})\beta) \end{pmatrix}\sqrt{\left(\frac{b_0(\beta+1)}{(\bar{\omega}-1)\beta+1} + \frac{(\beta-2)W_\ell}{\bar{\omega}-1}\right)^2 + \frac{8b_0W_\ell}{(\bar{\omega}-1)((\bar{\omega}-1)\beta+1)}}}$$

$$\frac{\partial^2 P_\ell h}{\partial b_0^2} = \frac{2(\beta-1)\beta W_\ell^2}{\begin{pmatrix} (b_0(\bar{\omega}-1)(\beta+1) - (\beta-2)W_\ell((\bar{\omega}-1)\beta+1))^2 + \\ 4b_0(1-\bar{\omega})(1-\beta)\beta W_\ell(1-(1-\bar{\omega})\beta) \end{pmatrix}\sqrt{\left(\frac{b_0(\beta+1)}{(\bar{\omega}-1)\beta+1} + \frac{(\beta-2)W_\ell}{\bar{\omega}-1}\right)^2 + \frac{8b_0W_\ell}{(\bar{\omega}-1)((\bar{\omega}-1)\beta+1)}}}$$

Because $\beta \in (0,1)$ and $\bar{\omega} \in (0,1)$, We have $\frac{\partial^2 P_\ell h}{\partial b_0 \partial W_\ell} > 0$ and $\frac{\partial^2 P_\ell h}{\partial b_0^2} < 0$. These results imply that, for a given b_0, households with higher wages (W_ℓ) exhibit a stronger propensity to spend on housing consumption when receiving additional wealth. Conversely, for a given W_ℓ, households with lower initial wealth exhibit a stronger propensity to spend on housing consumption when receiving additional wealth. Intuitively, households with higher wages and lower initial wealth are more constrained by the collateral constraint, leading to a heightened marginal propensity to consume on housing.

Since the marginal propensity to consume on housing, $\frac{\partial P_\ell h}{\partial b_0}$ decreases with household wealth when the collateral constraint is binding, to show $\frac{\partial P_\ell h}{\partial b_0} > \frac{1}{2}$, it is sufficient to show this relationship holds at the cutoff wealth $\widehat{b_0}$. If $\frac{\partial P_\ell h}{\partial b_0}\mid_{b_0=\widehat{b_0}} > \frac{1}{2}$, then $\frac{\partial P_\ell h}{\partial b_0} > \frac{1}{2}$ whenever the collateral constraint is binding.

Substitute $\widehat{b_0}$ for b_0 in Equation (24), we have the following:

$$\frac{\partial P_\ell h}{\partial b_0}\mid_{b_0=\widehat{b_0}}=\frac{1-\beta+\beta\bar{\omega}}{2(1-\beta)+\beta\bar{\omega}^2}>\frac{1}{2}$$

The last inequality is because $0<\bar{\omega}<1$ and $0<\beta<1$.

□

Intuitively, when the collateral constraint is not binding, households optimally allocate half of their additional wealth to housing expenditure. In contrast, when the collateral constraint binds, households lack sufficient wealth to meet the down payment of desired housing consumption. In this case, the marginal propensity to spend on housing consumption is greater than one half for two reasons. First, an increase in housing consumption following a wealth increase relaxes the collateral constraint, allowing for additional net borrowing to finance housing consumption. Second, the marginal budget available for spending at $t=0$ is allocated between current goods consumption and lifetime housing consumption, with the latter carries more weight than the former, and hence the household will allocation disproportionally more on housing than on goods consumption. Moreover, when b_0 is lower or W_ℓ is higher, the collateral constraint is more binding, and thereby $\frac{\partial P_\ell h}{\partial b_0}$ is higher.

Proof for Proposition 2

Proof. As we will show below, households will spend weakly more on housing consumption in response to a positive wealth transfer when they can migrate, regardless of their initial wealth b_0. Therefore, the proposition holds regardless of the distribution of the wealth transfer across different households. To ease notation, below we consider a uniform distribution of the wealth transfer across households.

In the absence of migration, all households remain in location L. The aggregate marginal propensity to spend on housing consumption is given by:

$$\text{MPH}_1=\int_0^{\bar{b_0}}\frac{\partial P_L h}{\partial b_0}dF(b_0)=\int_0^{\widehat{b_0^L}}\frac{\partial P_L h}{\partial b_0}dF(b_0)+\int_{\widehat{b_0^L}}^{\bar{b_0}}\frac{1}{2}dF(b_0),$$

where $\frac{\partial P_L h}{\partial b_0}$ is determined by Equation (24) for $\ell = L$.

When migration is allowed, households can choose their location. We first consider the case illustrated in the left graph of Figure A.3. The aggregate marginal propensity to spend on housing consumption is given by:

$$\text{MPH}_{2\text{a}} = \int_0^{\widehat{b_0^L}} \frac{\partial P_L h}{\partial b_0} dF(b_0) + \int_{\widehat{b_0^L}}^{\widetilde{b_0}} \frac{1}{2} dF(b_0) + f(\widetilde{b_0}) \left(P_H h - \frac{b_0 + W_L/R}{2} \right) + \int_{\widetilde{b_0}}^{\widehat{b_0^H}} \frac{\partial P_H h}{\partial b_0} dF(b_0) + \int_{\widehat{b_0^H}}^{\bar{b_0}} \frac{1}{2} dF(b_0),$$

where $\frac{\partial P_L h}{\partial b_0}$ and $\frac{\partial P_H h}{\partial b_0}$ are determined by Equation (24) for $\ell = L$ and $\ell = H$, respectively, and $P_H h$ is determined by Equation (23).

We compare MPH_1 (no migration) with $\text{MPH}_{2\text{a}}$ (migration allowed), the difference is as follows:

$$\text{MPH}_{2\text{a}} - \text{MPH}_1 = \int_{\widetilde{b_0}}^{\widehat{b_0^H}} \left(\frac{\partial P_H h}{\partial b_0} - \frac{1}{2} \right) dF(b_0) + f(\widetilde{b_0}) \left(P_H h - \frac{b_0 + W_L/R}{2} \right) \tag{25}$$

The first term of (25) is strictly positive by Lemma 1. This term captures those that choose to reside in location H facing binding borrowing constraint, and an marginal increase in their wealth would lead to more housing consumption spending than if they had stayed in location L.

The second term of (25) captures those switchers, i.e., those that used to be indifferent about migration and choose to migrate in response to the wealth transfer. Upon migration, their housing consumption jumps from $\frac{b_0 + W_L/R}{2}$ to $P_H h$. We will show this jump is positive.

Consider the previous optimization problem of these marginal households. As their collateral constraint is not binding, the first-order conditions with respect to c_0 and $P_\ell h$ is:

$$\frac{1}{c_0} - \frac{\beta R}{1-\beta} \frac{1}{W_L + b_1} = 0$$
$$\frac{1}{1-\beta} \frac{1}{P_\ell h} - \frac{\beta R}{1-\beta} \frac{1}{W_L + b_1} = 0$$

Upon migration, consider the first-order conditions evaluated at the household previous optimal choice. The only difference is that now W_L is replaced by W_H. Because

$W_L < W_H$, the opportunity cost of increasing c_0 and $P_\ell h$, which is lower future consumption, is smaller, and hence the above two equations will be positive, meaning that it is optimal for the households at location H to further increase c_0 and $P_\ell h$. Therefore, the optimal housing consumption $P_H h$ shall be greater than the previous housing consumption, $\frac{b_0+W_L/R}{2}$.

Then, in the case illustrated in the left graph of Figure A.3, the increase in housing consumption when migration is allowed is:

$$\text{MPH}_{2\text{b}} = \int_0^{\widetilde{b_0}} \frac{\partial P_L h}{\partial b_0} dF(b_0) + f(\widetilde{b_0})\,(P_H h - P_L h) + \int_{\widetilde{b_0}}^{\widehat{b_0^H}} \frac{\partial P_H h}{\partial b_0} dF(b_0) + \int_{\widehat{b_0^H}}^{\bar{b_0}} \frac{1}{2} dF(b_0),$$

where $\frac{\partial P_L h}{\partial b_0}$ and $\frac{\partial P_H h}{\partial b_0}$ are determined by Equation (24) for $\ell = L$ and $\ell = H$, respectively, and $P_H h$ and $P_L h$ are determined by Equation (23), respectively.

We compare MPH_1 (no migration) with $\text{MPH}_{2\text{b}}$ (migration allowed), the difference is as follows:

$$\text{MPH}_{2\text{b}} - \text{MPH}_1 = f(\widetilde{b_0})\,(P_H h - P_L h) + \int_{\widetilde{b_0}}^{\widehat{b_0^L}} \left(\frac{\partial P_H h}{\partial b_0} - \frac{\partial P_L h}{\partial b_0} \right) dF(b_0) + \int_{\widehat{b_0^L}}^{\widehat{b_0^H}} \left(\frac{\partial P_H h}{\partial b_0} - \frac{1}{2} \right) dF(b_0) \quad (26)$$

The first term of (26) captures the switchers, who migrate to location H yet remain constrained. Their housing consumption jumps from $P_L h$ to $P_H h$. Below we will show this change is positive.

The second and third term of (26) captures the differential marginal propensity to consume housing services between those facing binding constraint in location H and those with the same wealth in location L. By Lemma 1, both terms are strictly positive.

To show the first term, $P_H h - P_L h$, is strictly positive, consider the previous optimization problem of these marginal households. We can replace c_0 and b_1 with the budget equation and the collateral constraint, and then the first-order condition with respect to the housing consumption, $P_\ell h$, is as follows:

$$\frac{1}{1-\beta}\frac{1}{P_\ell h} - \frac{\beta}{1-\beta}\frac{1-\bar{\omega}}{W_\ell - (1-\bar{\omega})P_\ell h} - \frac{1-\beta+\beta\bar{\omega}}{b_0 - (1-\beta+\beta\bar{\omega})P_\ell h} = 0$$

Upon migration, consider the first-order conditions evaluated at the household previous optimal choice. The only difference is that now W_L is replaced by W_H. Because $W_L < W_H$, the opportunity cost of increasing housing consumption, which is higher debt and lower future consumption, is lower after migration, meaning that it is optimal for the households at location H to further increase $P_\ell h$. Therefore, the optimal housing consumption $P_H h$ shall be greater than the previous housing consumption, $P_L h$.

□

C Quantitative Model

Renter's problem. For a household that chooses to rent in location ℓ, the owned house in location o_t is set aside. The household then makes consumption-savings decisions and chooses the amount of housing services to rent. That is,

$$
\begin{aligned}
V_{R,\ell}(s_t) = \max_{\{b_{t+1},c,h\}} \; & e(a_t)u(c,h,\widetilde{A}_{\ell,o_t}) - \xi^h \cdot \mathbf{1}_{h_t=0} + p(a_t)\beta \mathbb{E}_{\epsilon_{t+1}}\left[\max_{d\in\mathcal{L}}\left\{\mathbb{E}_{z_{t+1}}[V_{\ell,d}(s_{t+1})|b_{t+1}] + e(a_{t+1})\nu\epsilon_{d,t+1}\right\}\right] \\
& + (1-p(a_t))\cdot\varphi(b_{t+1} + h_{t+1}P_{o_{t+1},t+1}k_{t+1}) \\
s.t.\; & c + hR_{\ell,t} + \frac{1}{R}b_{t+1} + P_{o_t,t}h_t\delta^h = w_t - F_{b,t} \\
& b_{t+1} \geq -(1-\bar{\omega})P_{o_t,t}h_t,\; h \geq \underline{h}_R \\
& w_{t+1} = b_{t+1} + (1-\tau)z_{t+1}G(a_{t+1})W_{d,t+1}, h_{t+1} = h_t,\; o_{t+1} = o_t,\; k_{t+1} = k_t,\; a_{t+1} = a_t + 1.
\end{aligned} \tag{27}
$$

In the budget constraint, in addition to consumption and rental housing expenditures, the household must also pay maintenance costs for the owned house in location o_t. We assume that there is a minimum size requirement for renting, denoted by $\underline{h}_R$.

Stayer's problem. If a household chooses to live in their previously owned house, which is feasible only when $\ell = o_t$. He/she only optimizes in consumption-savings decisions after paying the cost of housing maintenance. That is,

$$
\begin{aligned}
V_S(s_t) = \max_{\{b_{t+1},c\}} \; & e(a_t)u(c, \psi^h h_t, \widetilde{A}_{\ell,\ell}) + \zeta^h(a_t) + p(a_t)\beta \mathbb{E}_{\epsilon_{t+1}}\left[\max_{d\in\mathcal{L}}\left\{\mathbb{E}_{z_{t+1}}[V_{\ell,d}(s_{t+1})|b_{t+1}] + e(a_{t+1})\nu\epsilon_{d,t+1}\right\}\right] \\
& + (1-p(a_t))\cdot \varphi(b_{t+1} + h_{t+1}P_{o_{t+1},t+1}k_{t+1}) \\
s.t.\; & c + \frac{1}{R}b_{t+1} + P_{o_t,t}h_t\delta^h = w_t - F_{b,t} \\
& b_{t+1} \geq -(1-\bar{\omega})P_{o_t,t}h_t \\
& w_{t+1} = b_{t+1} + (1-\tau)z_{t+1}G(a_{t+1})W_{d,t+1}, h_{t+1} = h_t,\; o_{t+1} = o_t,\; k_{t+1} = k_t,\; a_{t+1} = a_t + 1.
\end{aligned} \tag{28}
$$

D Quantitative Analysis

D.1 Calibration

D.1.1 Cluster of cities

We pool all the cities into five locations based on their house prices in 2015. Location 1 consists of the top three cities – Beijing, Shanghai and Shenzhen, whose house prices far exceed other cities. Location 2 consists of Tianjin and the capital cities of the four most developed coastal provinces (Jiangsu, Zhejiang, Fujian and Guangdong) plus Wenzhou and Xiamen whose house prices are comparable to that of the provincial capitals. Location 3 consists of the other cities in these four provinces. Location 4 and 5 consist of the capital and non-capital cities of other provinces, respectively.[27] Figure A.4 shows that this clustering largely preserves the geographic dispersion in house prices and, more importantly, captures the majority of household migration. Between 2016 and 2020, migration across these five locations accounts for 77% of all intercity migration.

[27]We exclude four autonomous regions and three most distant provinces (Hainan, Gansu and Qinghai). By 2015, migration to and from these regions and provinces account for only 10% of all intercity migration.

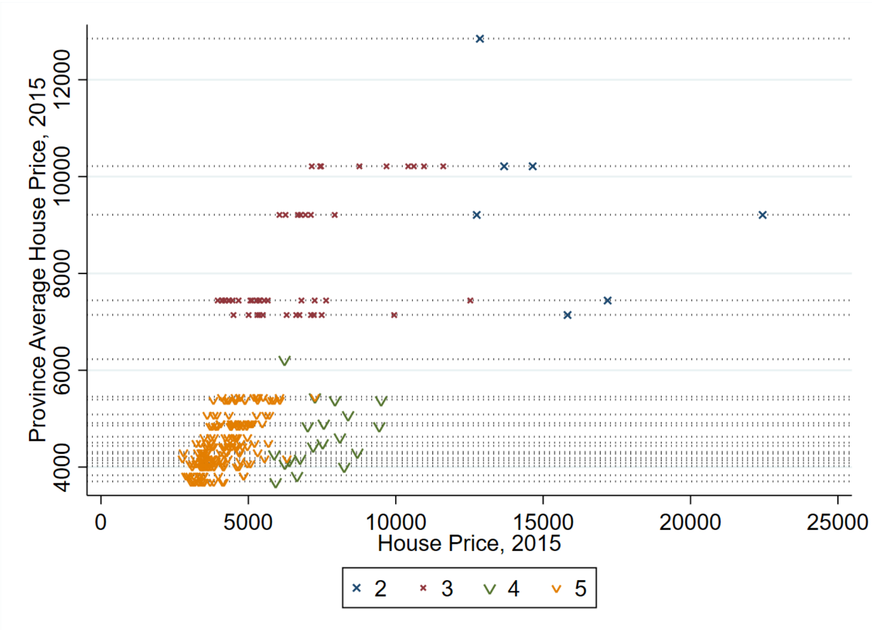


Figure A.4: Cluster of Cities

Note: This figure plots the province average house prices in 2015 against the city's house price scaled by the province average house prices.

D.1.2 Households

Preferences. We assume the following constant relative risk aversion (CRRA) utility:

$$e(a)u(c,h,\widetilde{A}) = e(a)\left(\widetilde{A} + \frac{\left((1-\alpha_h)c^\eta + \alpha_h h^\eta\right)^{\frac{1-\sigma}{\eta}}}{1-\sigma}\right).$$

e_a is an equivalence scale to capture deterministic changes in household size and composition over the life cycle. We set it following Giannone et al. (2023). We set the coefficient of relative risk aversion σ to 2. The parameter η governs the intratemporal elasticity of substitution between housing and non-housing consumption. The existing estimates of this elasticity varies a lot – for instance, Favilukis et al. (2023) uses a value of 2/3 while Li et al. (2016) estimates it to be 0.487. We use an intermediate value, which corresponds to an η of -0.7. Solving the renters optimization problem with respect to consumption and housing subject to the budget constraint, we derive the following expression for the expenditure ratio between housing rent and consumption, $\frac{Rh}{c} = R^{\frac{\eta}{\eta-1}}(\frac{1-\alpha_h}{\alpha_h})^{\frac{1}{\eta-1}}$. We calibrate the preference weight on housing α_h in order to match the average expenditure ratio observed in the CHFS data between 2017 and 2019, yielding the value of 0.05.

We assume the following functional form to evaluate bequests when household dies,

$$\varphi(x) = \bar{\varphi} \log(x).$$

Following Kaplan et al. (2020) and Giannone et al. (2023), we calibrate $\bar{\varphi}$ to match the ratio of liquid wealth at age 56-60 to liquid wealth at age 41-45. This results in a value of 10.

Demographics. We model eight working-age groups ($\bar{a} = 8$), covering ages 21 to 60. We calibrate the five-year mortality rate $p(a)$ to match Census 2020 data.

Labor earning. The age-specific profile $G(a)$ is chosen to match the mean of labor earnings by age. Using household income data from the CHFS, we divide observed pre-tax wages by $W_{\ell,t}$ to obtain a measure of $G(a)z_{i,t}$, and then compute the average by age to calibrate G^a.

For idiosyncratic income risk $z_{i,t}$, we follow Favilukis et al. (2023) and model its evolution as a 4-state Markov chain. For the level of those 4 states, we assume they are age-specific. We normalize observed pre-tax wage by $W_{\ell,t} \cdot G^a$. For each age group a, we define four grid points corresponding to the average of the normalized pre-tax wage within the 0-25%, 25%-75%, 75%-87.5% and 87.5%-100% percentiles. Let $z_{a,j}, j \in \{1, 2, 3, 4\}$ denote these grid points. By construction, $E[z_{a,j}|a] = 1$. The transition matrix for $z_{i,t}$ is assumed to be age-invariant and is estimated directly from the data. Specifically, we observe the income percentile bin an individual belongs to in year t and then again in year $t + 2$. This allows us to calculate the transition probabilities for each CHFS wave, and then average across surveys. The resulting two-year transition matrix is used to back out a five-year transition matrix.

Discount factor. We calibrate β to match the ratio between the average liquid wealth and earning. This implies an annualized $\beta = 0.985$.

Amenities and migration. In our migration cost specification, the age-dependent component $\tau_1(a)$ is calibrated to match the average out-migration profile over the life cycle, resulting in an average value of 3.37 across age groups. The coefficient τ_3, which governs the sensitivity of migration to distance, is calibrated to match the empirical correlation between bilateral migration shares and bilateral distances, yielding $\tau_3 = 0.22$. When a household becomes a homeowner in a destination different from its current housing location, an additional migration cost τ_2 is incurred. We calibrate τ_2 to match the observed share of households that change housing locations, which implies a value of 1.15, comparable in magnitude to the average value of $\tau_1(a)$.

We calibrate the inverse migration elasticity $\nu = 0.4$, consistent with values found in the literature. Caliendo et al. (2019) estimate an annual cross-state migration elasticity of 0.5 for the U.S. economy. In contrast, Tombe and Zhu (2019) estimate a long-run migration elasticity of 2.54 in a static model of Chinas economy. Based on these estimates, we target a 5-year migration elasticity of 2.5, which implies an inverse elasticity of $\nu = 0.4$.

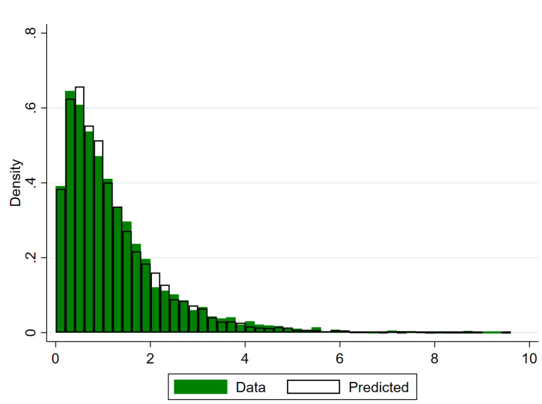
We calibrate the amenity values for each location, $\{A_\ell\}$, to match the observed population distribution between 2016 and 2020. Normalizing the amenity value of location 5 to zero, the calibrated amenity values for the remaining four locations are 0.29, 0.13, 0.04, and 0.04, respectively – indicating that the top three cities, Beijing, Shanghai, and Shenzhen, offer relatively higher amenities. For households who reside in location ℓ but own a house in a different location o, we assume they derive utility from the average amenity value of the two locations. That is, $\widetilde{A}_{\ell,o} = \frac{1}{2}(A_\ell + A_o)$.

Initial distribution of individual household states. The economy starts with a distribution of households who are characterized by the residence location ℓ and individual state variables s_0, which is given by $(\ell, a, z_0, b_0, h_0, o_0, k_0)$. In the representative sample of the National 1% Population Survey Data of 2015, we can directly observe the (ℓ, a, h_0, o_0, k_0) for all urban households that live in their own houses. We define a house to be shanty if the house was constructed before 1990, or there is no formal kitchen and bathroom in the house. For those that are renting, we randomly assign them with k_0 based on the share of shanty and normal houses in their originating cities. Given k_0, we use the average shanty and normal house size for their h_0.

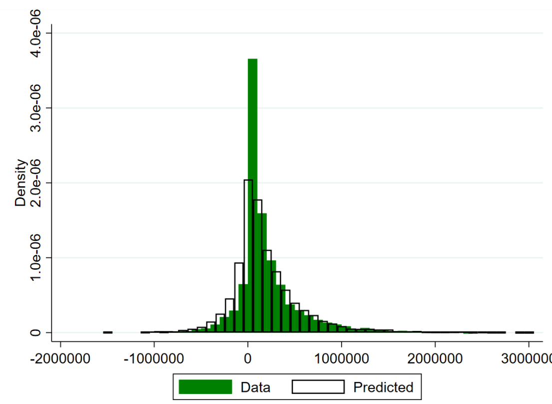
The Population Survey Data has no information regarding the income z and asset b. To take into account the dependence of (z, b) on (ℓ, a, h_0, o_0, k_0), we use the CHFS data of 2015 and 2017 to infer the distribution of (z, b) conditional on (ℓ, a, h_0, o_0, k_0). Specifically, using the CHFS data of 2015 and 2017, we first estimate the conditional mean of $\log(z)$ and b with the following regression:

$$y = \beta^1 \cdot k + \beta_2^k \cdot h + \alpha_{a,k} + \alpha_o + \alpha_\ell + \epsilon.$$

The regression also yields a distribution of the estimated residual term, ϵ^z and ϵ^b. We find no obvious dependence between the conditional mean of $\log(z)$ and ϵ^z. Thereby, we randomly draw ϵ^z from the estimated distribution and add it to the conditional mean, and then take exponential to recover our estimated value of z. For b, there appears to be some dependence between the conditional mean and ϵ^b. Therefore, we first sort households in the CHFS sample into ten groups based on the conditional mean of b, and get the estimated distribution of ϵ^b for each group. Then with the Population Survey sample, we calculate the conditional mean of b and randomly draw ϵ^b from the corresponding group and add it to the conditional mean. Figure A.5 plots the distribution of the actual z and b with the calibrated values based on the CHFS 2015 and 2017 sample. The distribution of the predicted value of z and b based on the procedure above matches the data fairly well.



(a) z



(b) b

Figure A.5: Comparing Actual and Calibrated z and b

Note: This figure plots the distribution of the actual z and b with the calibrated values based on the CHFS 2015 and 2017 sample.

D.1.3 Housing

We set collateral haircut $\bar{\omega}$ to 0.3 to match the Loan-to-Value ratio of the first home mortgage. We follow Kaplan et al. (2020) and Giannone et al. (2023) to set annualized $\delta^h = 1.5\%$. We set $\tau^{h,b} = 2.5\%$ to include deed tax and agency fee and set $\tau^{h,s} = 2\%$ to include capital income tax and agency fee. We set rental premium $v = 12.5\%$ to match the rent-to-house price ratio between 2011 and 2015. To calibrate the minimum size requirement, from the Population Census data of 2015, we use the 10% percentile of the house size distribution among households that own or rent houses. We set $\underline{h} = 50$ square meters and $\underline{h}_R = 40$ square meters.

Housing grids. Conditional on the dynamic consumption and savings decision, renters solve a static optimization problem to allocate resources between the consumption good (c) and housing services (h), which yields a closed-form solution for optimal consumption and housing expenditure. In contrast, for homeowners, the choice of housing services is dynamic. To proceed with the computation, we generate the following housing grid, starting from the minimum house size: $\{50, 65, 80, 95, 110, 140, 170\}$. The value of

170 square meters corresponds to the 95th percentile in the size distribution in the data.

Homeownership preferences. We calibrate the homeowner's housing preference ψ^h to match the observed average size ratio between owned and rented housing. This results in $\psi^h = 0.15$.[28] Finally, we calibrate $\zeta^h(a)$ to match the life-cycle profile of homeownership. The calibrated values are significantly lower for younger individuals (e.g., 0.11 for ages 21 - 25) compared to middle-aged groups (e.g., 0.21 for ages 41 - 45), reflecting the increasing propensity to own a home with age. The parameter ξ^h is calibrated to match the observed share of shantytown homeowners who purchase new formal housing in their current residence after receiving a cash settlement from the house location, resulting in $\xi^h = 0.9$.

Housing supply elasticity. We use *loan_dest* as a demand shifter to estimate the housing supply elasticity over five-year horizon. Specifically, we first estimate the treatment effect of *loan_dest* on the change of housing stock using the following specification:

$$\frac{H_{i,t}}{H_{i,t-1}} = \sum_{\tau \neq 2014} \mathbf{1}_{t=\tau} \cdot \left(\beta_\tau \cdot loan\_dest_i + \gamma_\tau \cdot loan\_orig_i\right) + \delta_i + \theta_{p(i),t} + \epsilon_{i,t},$$

With the coefficient estimates of $\{\hat{\beta}_\tau\}$, we can calculate the counterfactual housing stock in 2019 in the absence of the demand from cash-receiving immigrants as:

$$\hat{H}_{i,2019} = H_{i,2014} \cdot \Pi_{t=2015}^{2019}\left(\frac{H_{i,t}}{H_{i,t-1}} - \hat{\beta}_t \cdot loan\_dest_i\right).$$

The change in housing stock over five-year horizon as a result of *loan_dest* is $\frac{H_{i,2019}}{\hat{H}_{i,2019}}$. We then repeat the same procedure and calculate the change in house price over five-year horizon as a result of *loan_dest* as $\frac{P_{i,2019}}{\hat{P}_{i,2019}}$. The house supply elasticity, ρ^h, is the coefficient

[28] Our preference specification features complementarity between consumption c and housing services h, with $\eta < 0$. To ensure that homeowners purchase larger houses than renters, it is necessary that $\psi^h < 1$.

estimate of price growth instrumented by *loan_dest* using the following specification:

$$\log(\frac{H_{i,2019}}{\hat{H}_{i,2019}}) = \rho^h \cdot \log(\frac{P_{i,2019}}{\hat{P}_{i,2019}}) + \theta_{p(i)} + \log(\hat{H}_{i,2019}) + \varepsilon_i$$

We find the IV estimate of ρ^h to be 0.12.

Housing supply shifter. After solving the model under the observed path of wages and prices, we are able to compute the total housing stock demanded by households, which gives rise to the path of housing stock $\{H_{l,t}\}$. Then given the estimated housing elasticity, we could back out the supply shifter $\{B_{l,t}\}$ to ensure housing market clearing.

D.1.4 Other Parameters

We set R to be the five-year deposit rate in 2015, which gives $R = 1.145$. We set borrowing spread $\iota = 13.3\%$, which is the average spread between five-year time deposit and mortgage loan rates. We set $\tau = 10.3\%$, including pension of 8%, medical insurance of 2%, and unemployment insurance of 0.3%.

Table A.3: Parameter Values

Parameter	Interpretation	Internal	Value	Moment: model (data)	
Space					
L	No. of locations	N	5		
A_ℓ	Amenity	Y	0.295, 0.13, 0.04, 0.04, 0	Population distribution	Figure 7
$Z_{\ell,t}$	Productivity	N			
$B_{\ell,t}$	Housing supply shifter	N			
Demographics					
$\bar{a}$	No. of age groups	N	8		
$p(a)$	Mortality rate	N			
Preferences					
$e(a)$	Equivalence scale	N			
σ	Relative risk aversion	N	2		
η	Elasticity of substitution	N	-0.7		
α_h	Housing preference weight	N	0.05		
β	Discount factor	Y	0.985	Ave. liquid wealth / ave. income	0.25 (0.29)
$\overline{\varphi}$	Bequest	Y	10	Ave. liquid wealth 56-60 / 41-45	0.85 (0.86)
Earning					
$G(a)$	Age-specific profile	N			
$\{z_{a,j}\}$	Idiosyncratic income state	N			
π_z	Transition matrix of income state	N			
Housing					
ω	Collateral haircut	N	0.3		
δ^h	Housing maintenance cost	N	1.5%		
$\tau^{h,b}, \tau^{h,s}$	Deed tax, capital income tax	N	2.5%, 2%		
$\underline{h}, \underline{h}_R$	Minimum housing requirement	N	50, 40		
$\zeta^h(a)$	Age-specific profile	Y	-0.11, -0.01, 0.05, 0.1 0.205, 0.105, 0.04, 0.02	Homeownership over life-cycle	Figure 7
ξ^h	Utility loss of not owing a house	Y	0.9	% of the treated migrants purchasing new houses	56.8% (55%)
ψ^h	Relative house size	Y	0.15	Ave. size of owner- / renter-occupied house	2.05 (1.96)
ρ^h	Housing supply elasticity	N	0.12		
Migration					
$\tau_1(a)$	Age-specific profile	Y	0.27, 1.15, 2.15, 4 7.3, 6.4, 3.2, 2.5	Migration over life cycle	Figure 7
τ_2	Cost of changing house location	Y	1.15	% of households changing house location	4.31% (3.69%)
τ_3	Moving back to house location	Y	0.22	Bilateral migration patterns	Figure 7
ν	Migration elasticity	N	0.4		
Financial instrument					
R	5-year deposit rate	N	1.145		
ι	Borrowing spread	N	13.3%		
τ	Income tax	N	10.3%		

D.2 Additional Quantitative Results

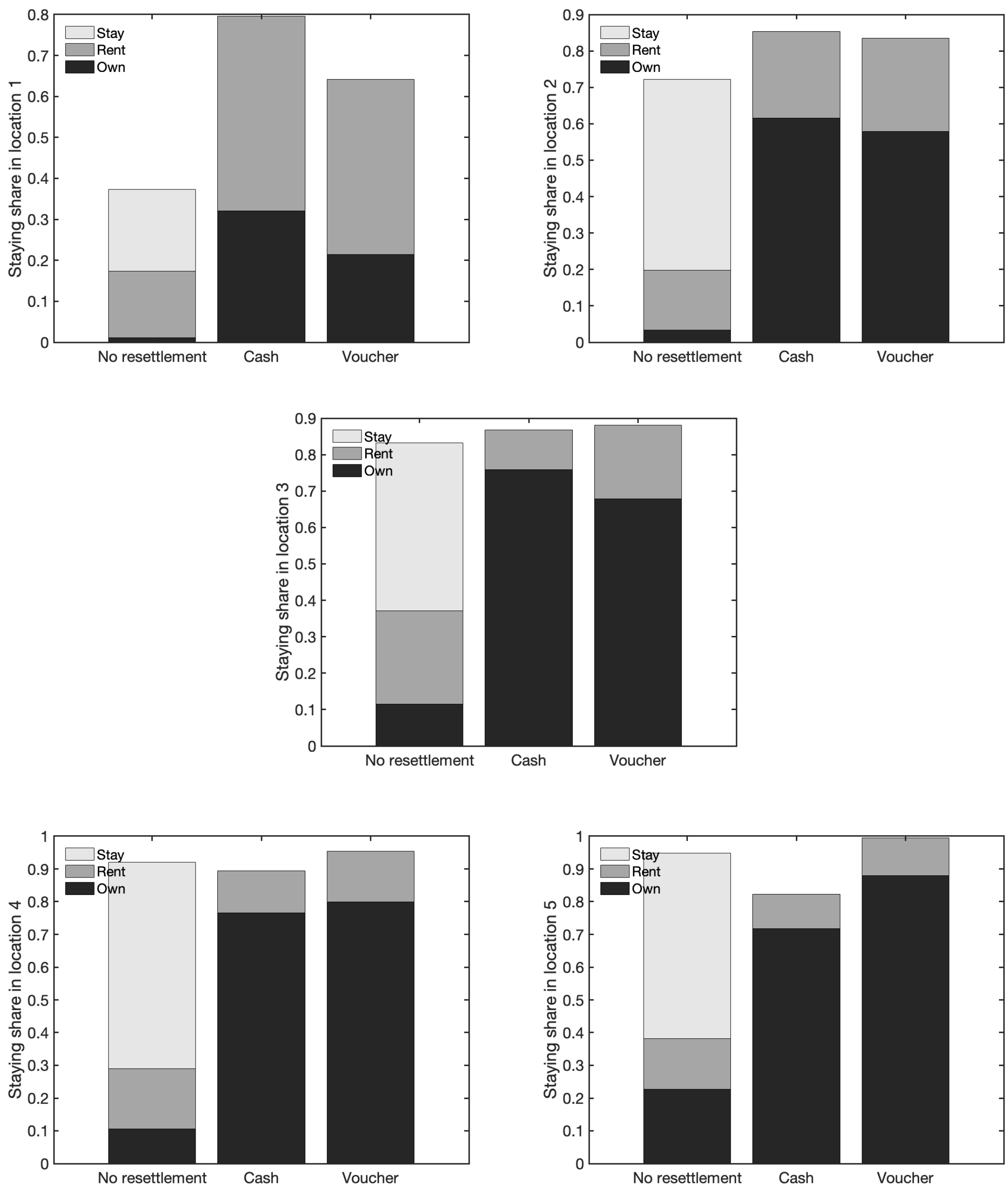
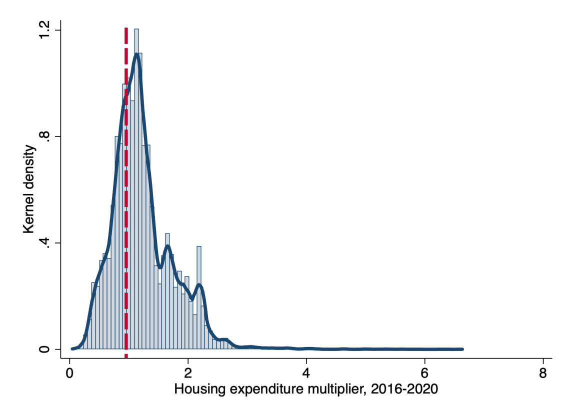
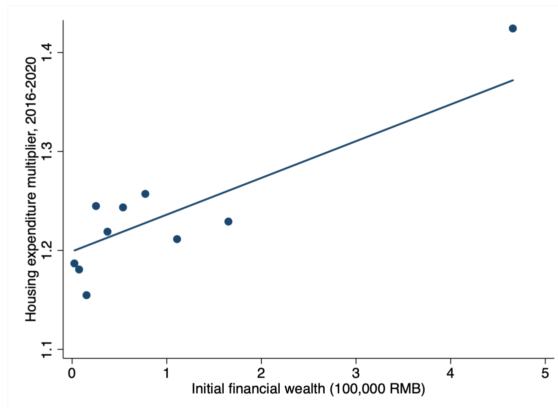


Figure A.6: House Tenure Choice of Stayers: Cash versus Voucher

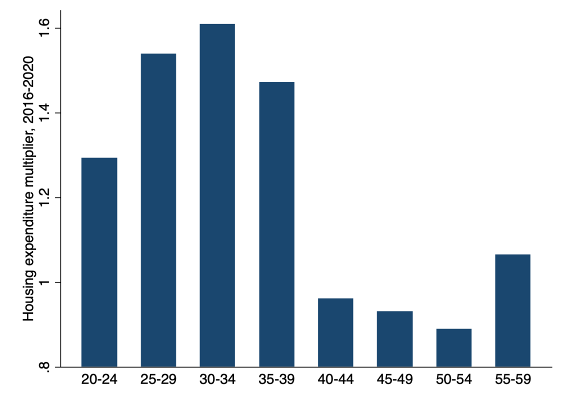
Note: This figure plots the housing tenure choices for households that do not out-migrate under cash versus voucher resettlement.



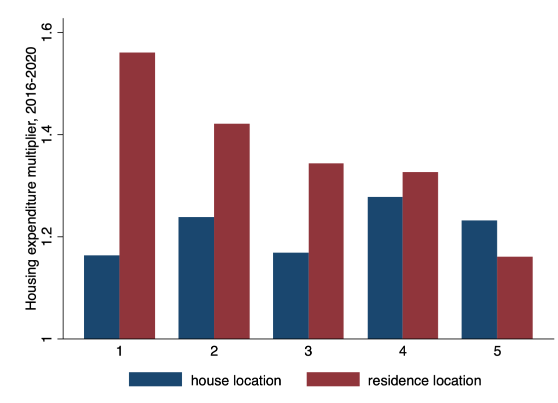
(a) Distribution



(b) Wealth



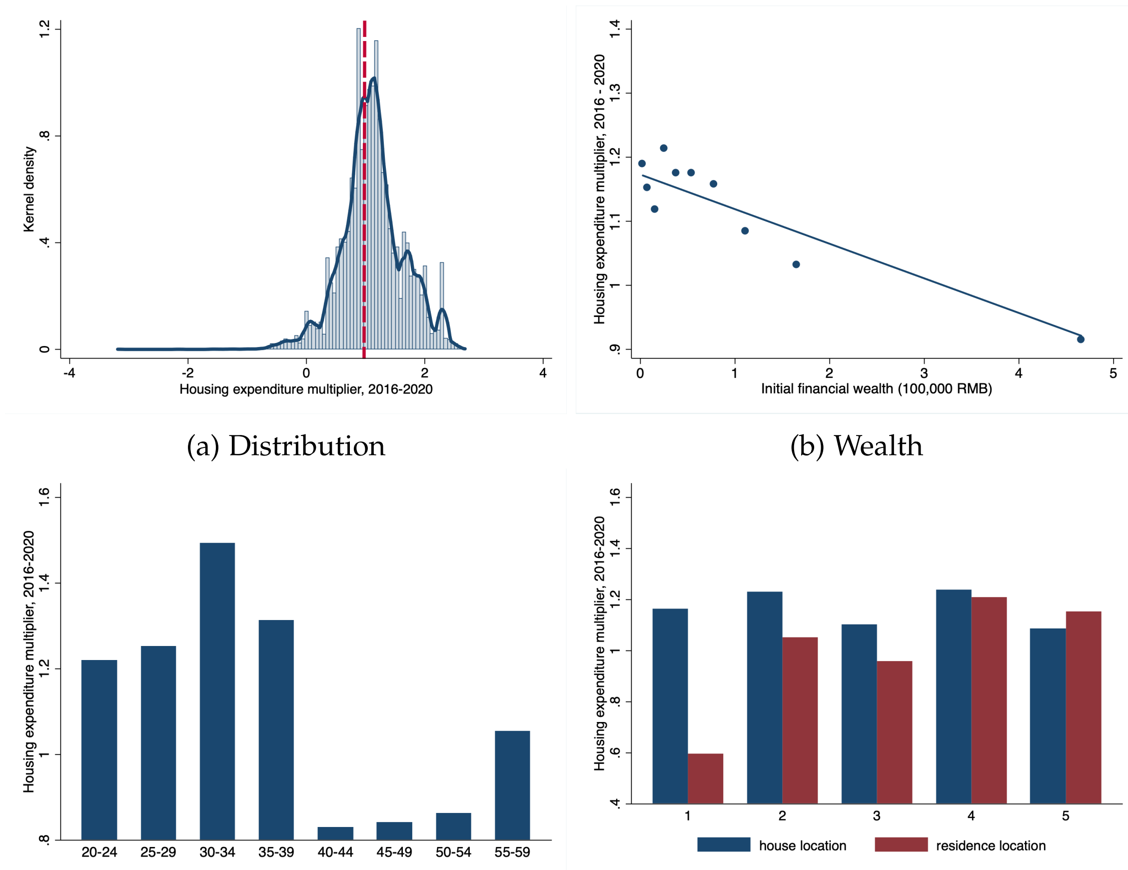
(c) Age



(d) Location

Figure A.7: Housing Expenditure Multiplier, Cash Settlement, 2016-2020

Note: This figure plots the distribution of the housing expenditure multiplier across all treated households, and the average housing expenditure multiplier for different household wealth, age, and house/residence location under cash resettlement.



(a) Distribution (b) Wealth

(c) Age (d) Location

Figure A.8: Housing Expenditure Multiplier, Voucher Settlement, 2016-2020

Note: This figure plots the distribution of the housing expenditure multiplier across all treated households, and the average housing expenditure multiplier for different household wealth, age, and house/residence location under voucher resettlement.