

Process decomposition of expanded rural housing at the rural–urban fringe: evidence from 27,034 buildings in Pudong New Area, Shanghai, China

Expanded
rural housing
in China

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Abstract

Purpose – Faced with the challenges of rural population decline, combined with the widespread expansion of homesteads in rural areas, local Chinese governments hope to strictly control and minimize rural housing land. Accurately decomposing the process of rural housing expansion and revealing its driving factors will be helpful for land-use regulation by the government.

Design/methodology/approach – In this study, an unusually rich dataset of rural housing registration from Pudong New Area in Shanghai is employed. The study aimed to decompose the fragmented accumulation process and its expansion determinants on rural housing assets. The dataset covers all samples of rural households and housing plots at 72 surveyed villages in six towns.

Findings – Housing offers profitable capital and earning assets to villagers at the urban fringe, so they have a powerful incentive to build and expand more. The results of this analysis showed that the expansion of rural housing is largely due to the haphazard construction of auxiliary rooms by villagers, especially on plots of arable land that are adjacent to their houses that have been stealthily converted into auxiliary rooms and sheds. Low costs and weak penalties have led to an increase in rent-seeking expansions to rural houses. Houses with the smaller initial areas, families with more laborers and household heads, and the proximity of villages to downtown with convenient living services were the main driving factors for expanding houses. A concerted effort is needed to control the disorganized and unlicensed expansion of housing. This effort should include formulating areas for free use by villagers, high taxes on overused areas, serious penalties for unlicensed housing expansion and effective land-use planning.

Research limitations/implications – An understanding of the expansion status and control measures related to rural houses in Shanghai provides an important reference that can help to guide the formulation of

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rural housing policies, and the sustainable development of cities worldwide. Of course, this study cannot generalize about housing distribution and expansion status worldwide based on the study area in China, because China's land tenure policies are unique. But land registry data exists that makes research like this feasible. There is a need to carefully examine the detailed housing distribution in each country before it can be decided on how best to address the disorderly increase in rural housing stock, and promote the reduction of rural residential expansion.

Originality/value – First, the process of rural housing expansion by using an unique dataset which covers ten thousands of samples is revealed. Second, the results have policy implications for reducing the amount of idle and inefficiently rural homestead. The focus is on rural housing growth and its driving factors in Shanghai, and the villagers' motivations for housing expansion are explored.

Keywords Rural housing, Fragmented expansion, Driving factors, Rural-urban fringe, Pudong New Area
Paper type Research paper

1. Introduction

Puzzlingly, rural housing in China has increased despite the rapid outflow of the rural population. Facing this dilemma, the Chinese government devised a range of policies to control and minimize the area that comprises rural homesteads, with incentives such as compensation for villagers who withdraw from vacant homesteads. However, these efforts have had minimal success, and the government is still unable to control the housing construction craze and fragmented homestead expansion in the countryside.

Existed literature have highlighted the phenomenon of increased rural housing in China (Wang *et al.*, 2020; Deng *et al.*, 2020). Among these, several studies have devoted attention to the causes of expansion (e.g. rural allocation, institutional transfer, the informal market and special locations) (Wang *et al.*, 2020; Lyu *et al.*, 2020; Song, 2016). In particular, Fang and Tian (2018) found that marriage can explain the high homeownership rates and large housing sizes in rural China. These literature concluded that some families need more living space or just a stable and decent home, largely due to the increasing number of household members and next-generation household division brought by marriages. On the other hand, rural houses are a symbol of wealth and identity, and some farmers who already own a large number of rural homes will still work to accumulate capital for more housing investment. Even though some have migrated into cities, they still choose to spend money on expanding homes in their hometowns. As a result, rural residential land in China is on the rise, despite the out-migration of rural populations. This has severe consequences (Li *et al.*, 2016; Shan and Feng, 2018). Liu *et al.* (2010) firstly highlighted the issue of housing abandonment or 'village hollowing' in rural China. These issues also highlight the contradiction between inefficiently developed rural housing land and the high demand for urban construction land.

Despite the efforts mentioned above to explain the phenomenon of rural housing growth, empirical evidence supported by ample rural household data is unavailable. Several phenomena were essential to consider: How does rural housing accumulate from initial housing construction to its current status? Which types of buildings, households and villages are expanding? And what are the driving factors of the fragmented expansion of rural housings? In a word, there is little literature on housing expansion in villages, mainly it is difficult to obtain data on rural housing. In this, we employ an unique dataset of rural housing registration from Pudong New Area in Shanghai. The dataset covers all households samples and housing plots at 72 surveyed villages in six towns.

The contributions of this paper are as follows: First, we reveal the process of rural housing expansion by using an unique dataset which covers ten thousands of samples. Second, the results have policy implications for reducing the amount of idle and inefficiently rural homestead. We focus on rural housing growth and its driving factors in Shanghai, and explored the villagers' motivations for housing expansion.

The remainder of this paper is organized as follows. Section 2 presents the theoretical analysis and hypotheses of this study. Section 3 describes the research area and data.

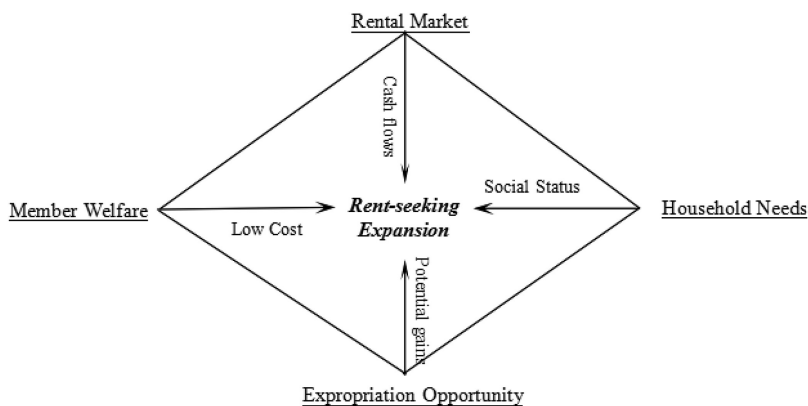
Section 4 details the methodology and explanatory variables. Section 5 describes the empirical results. Section 6 presents conclusions and implications.

2. Theoretical analysis and hypotheses

A conceptual framework was established to understand the process and driving forces of fragmented rural housing expansion, as shown in Figure 1.

First, homesteads were allocated to serve as basic membership welfare and living rights for rural villagers in China (Shi and Wang, 2021). As proposed by Abraham Maslow, housing is an effective means for solving basic needs and realizing a sense of belonging and security. Since the foundation of People’s Republic of China, the Chinese government has established an equitable homestead welfare system to benefit all rural households. Every rural family has the membership right to apply a plot of homestead with zero fees from the village collective (Ho, 2017). They build houses by themselves at low cost. Meanwhile, in order to control the number of homesteads, Chinese local governments have set quotas and area standards for homesteads according regional endowment. Chen *et al.* (2017) pointed out that rural homesteads were a product of the “one household, one homestead” policy that limited each rural household to a single rural homestead of a given size. But governments have rarely imposed use fees on excessive housing constructions due to low income levels in rural households.

Second, housing is not only a living place for human beings, but also as a signal of family wealth and social status. Scholars have done considerable work investigating the functional evolution of rural housing land (Su *et al.*, 2019). Big spaces and high floor–area ratios in houses always reflect family viability and social status in the locality. As a general rule, wealthier villagers have more expansive and larger houses. Villagers who own large, new houses demonstrate their wealth and social status, helping to attract marriage and business partners (Sargeson, 1999; Yang and Gan, 2020). Arguably, constructing self-owned housing is one of the most important investments and decisions for rural households (Zhang *et al.*, 2022). There are special property rights that are segmented between rural housing and homesteads in China. Rural land is owned by collectives, rather than the state, whereas houses are the private property of families (Sargeson, 2002). The use rights of housing and homesteads are indefinite: their offspring have the right to inherit the houses (Kong *et al.*, 2018).



Source(s): Authors’ own work

Figure 1. Conceptual framework for understanding the driving factors of rural housing expansion

Third, village households have the right to reap the benefits or the rewards of their rural dwellings, such as rental or operating income. These cash flows are a source of livelihood for village households at the rural–urban fringe, an attractive incentive for rural housing expansion. When rural housings are located in a town or adjacent to downtown, their families benefit directly from public infrastructure investment (Ouyang *et al.*, 2022). Rural households have chance to share many of the benefits of urbanization (Shi and Wang, 2021). Rural housing at the urban–rural fringe has absorbed most migrants with its cheap rent, and it is a gathering space for informal economies such as unlicensed vendors, illegal clinics, small factories and so on (Alene, 2022). In this case, rural housing is not just a usable resource and living property, but also earning assets for villagers. When rural dwellings serve as indispensable capital for village households’ livelihoods, it is natural to expand and accumulate more housing assets for rent and profit. For village households, more housing areas and asset accumulations mean more extra revenue. Sargeson (2002) found that some villagers acknowledged that they built to reap economic benefits.

Further, households have some foreseeable opportunities to gain compensation payments or potential gains from urban village redevelopment or land expropriation. Qu *et al.* (2021) pointed out that the implementation of new community construction and homestead withdrawal policy are closely associated with the expansion or decrease of rural settlements. Driven by urban housing price “spillover”, villagers at the rural–urban fringe have more opportunities to participate in and share profits connected to urban redevelopment or land development (Liang *et al.*, 2018). Compensation for housing redevelopment or expropriation is gradually approaching the market price. Particularly, compensation is usually related to the areas of housings (Lai and Zhang, 2016). More housing area means more compensation, so villagers have strong incentives to expand their housings.

In conclusion, housing not only signals family wealth and social identity in rural areas; it also has the potential for earning capital. There is little or no cost to obtaining rural housing resources by village members, and illegal expansion is not risky. Moreover, when rural housing is seen as profitable assets or livelihood capital, it can earn cash income for villagers. So it is not surprising that residents are rebuilding or expanding their houses. All these phenomena are reflected in the capacity of village households for expansion, and act as a motivation to capture cash flows or potential gains from the informal and formal land and housing markets. The objective of this study is to decompose the process of and factors driving rural housing expansion, and to identify the housing areas, family households and villages that have undergone significant expansion in the Pudong New Area since 1978. We use the above theoretical analysis to propose the following hypotheses:

- H1.* The initial scale and floor ratio of rural houses influenced their probability and degree of expansion. Horizontal expansion and vertical growth are two types of housing expansion.
- H2.* The characteristics of rural households, such as housing needs, social status and economic conditions, reflect their capability in terms of the probability and degree of expansion. We thus assume that these relatively “capable” households, with a larger population or better economic conditions, are key groups in the context of the housing expansion. Identifying households at the center of housing expansion is the second aim of this study.
- H3.* Villages around which urbanization has been rapid have undergone more frequent and a larger scale of housing expansion. We propose that the expansion in rural housing starts from villages adjacent or close to the downtown, and gradually spreads to villages in the suburbs. The more mature the public infrastructure in the village is, the more active is its rental market for housing and the greater is the villagers’ motivation to expand housing for profits.

3. Study area, data and descriptive statistics

3.1 Study area

Shanghai is the largest international metropolis in China, which has jurisdiction over 16 districts, with a population of 24.89 million permanent residents. Pudong New Area is the second-largest administrative region in Shanghai, and covers an area of 1,210.41 km² that accounts for 19.09% of the total area of Shanghai. Settled in 1992, Pudong New Area is the first national new district in China, and serves as the “dragon’s head” to deepen and broaden the country’s reform and opening up. After 30 years of development, it has undergone significant changes, from a crisscrossing countryside to a modern urban district. It has emerged as a “miniature” version of urban construction in China and the integrated development of urban–rural regions. However, under the constraints of the urban–rural system and the idiosyncrasies of the development of the land market, Pudong New Area has undergone the “double growth” of land for urban and rural construction during rapid urbanization. This is in line with the characteristics of development of most cities in China. Construction on rural land has been dominated by homesteads, and exhibits the phenomenon of “increase instead of decrease.” This has affected the high-quality development of cities. Because of the lack of detailed and fragmented data on rural houses, few studies have provided a complete understanding of the piecemeal expansion of rural houses within rural–urban fringes from the perspectives of houses, families and villages. We thus use the detailed survey of rural housing to decompose the characteristics of expansion and diffusion of rural houses in Pudong New Area over the past 40 years, especially since the 1990s.

3.2 Data

Our major data source was the rural housing and updated cadastral survey, conducted by the Shanghai Institute of Land Resources between 2015 and 2017. The data covered six towns and 72 villages in Pudong New Area (Figure 2, Figure A1). The unique dataset included a complete sample of 35,341 rural housing units in Pudong New Area, and contained detailed information on homesteads, houses (such as building structures, building area, homestead area, floor–area ratio, building time, expansion frequency, expansion time and incremental area), and family demographics (such as household size, number of household heads, gender, age, marriage status and *Hukou* status). Surveyed villages adjacent to downtown or to a town, and radiated by urban development, have a network of convenient transportation and active informal economic operations. Of these houses, 5,729 rural houses were built in the 1950 and 1970s. These older houses are in an idle or protected status, and were not included in this analysis. Further, 2,598 rural houses were not included in the study, due to incomplete information regarding family members. Lastly, a total of 27,034 rural housings were included to analyze.

Additional data contained the information of roads, commercial and public service facilities and points of interest (POI), such as shopping, catering, medical, education and entertainment facilities. Based on these data, a road map was generated from remote sensing images at 15 m resolution provided by an environmental data cloud platform. The commercial POI data came from Baidu Maps, which provide spontaneous data from different sites.

3.3 Descriptive statistics

Table 1 presents descriptive statistics of the main characteristics of the houses, households and villages. Of the surveyed villages in Pudong New Area, the current mean homestead area and building area are 137.32 m² and 258.06 m², respectively. The average main room area, auxiliary room area and shed area are 203.63 m², 47.37 m² and 7.05 m². The main room was the core part of a rural house, and its average building area accounted for 65.92% of houses. Meanwhile, auxiliary rooms account for 18.36% of the

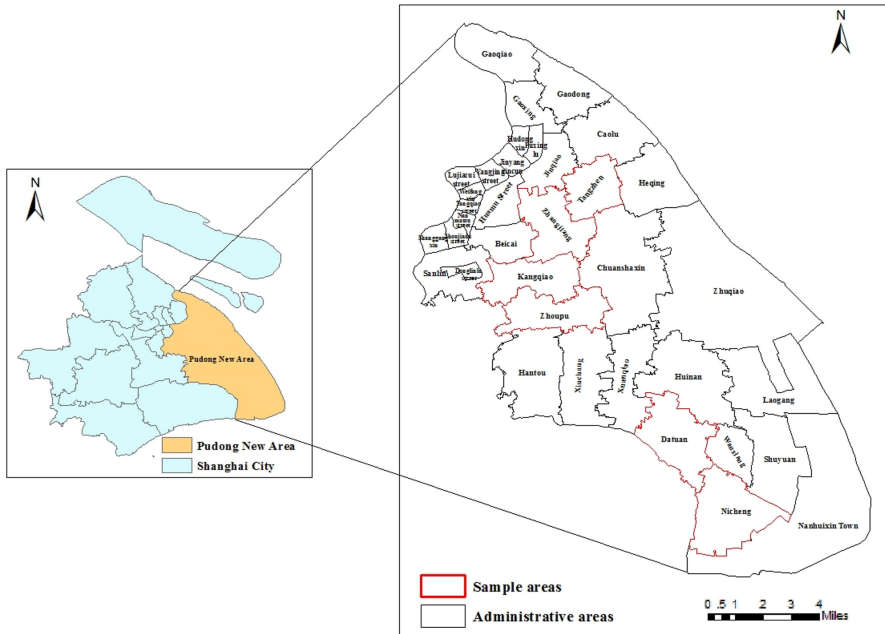


Figure 2.
Surveyed area in
Pudong New Area

Source(s): Authors' own work

average house building area, and their proportion of the homestead area is 28.94%. Of the sampled housings, the maximum building area of a single house was 2240.06 m², and the minimum was 4.36 m²; the maximum homestead area was 1191.79 m², which was 8.68 times the average area; the average floor area ratio of the sampled main rooms was 2.18, while the maximum sample was 5.08. This shows that there is an obvious gap in housing building areas, homesteads and floor ratios among rural households.

At the household level, the average size of surveyed household samples is 3.44; the average number of household heads, laborers and urban *Hukou* is 1.56, 2.54 and 2.00, respectively. The average age of the household head is 43 years old, and 74% are male. Meanwhile, the average distance of sample villages to the downtown of Pudong New Area is 20.61 km, and the average distance to the town is 2.85 km. These villages have relatively good road networks, with convenient and comfortable living environments.

4. Method and explanatory variables

4.1 Method

First, we analyzed some descriptive statistics, including comparisons of changes in the area of housing between expanded and unexpanded samples. We also summarized the key characteristics of housings, households and villages to identify the differences and spatial heterogeneities in the expansion of rural housing.

Second, we used a binary logit regression model to determine if there was a significant correlation between the characteristics of housings, family households and villages, and the likelihood of housing expansion. Binary logit is suitable for explaining the correlation between a binary dependent variable and multiple ordinal, nominal, interval-based and ratio-scale-independent variables (Saha *et al.*, 2020). In this study, the dependent variable had

Variables			Mean (S.D)	Max	Min
Housing characteristics (Obs. = 27,034)	Building area (m ²)	Main rooms	203.63 (101.10)	1,395.54	3.81
		Auxiliar rooms	47.37 (62.47)	1,127.70	0
		Shed	7.05 (27.46)	926.46	0
		Total	258.06 (127.50)	2,240.06	4.36
		Homestead area (m ²)	Main rooms	90.53 (32.83)	465.18
	Homestead area (m ²)	Auxiliar rooms	39.75 (48.22)	913.70	0
		Shed	7.03 (27.22)	926.46	0
		Total	137.32 (68.39)	1,191.79	4.36
	Floor area ratio (FAR)	Main rooms	2.18 (0.57)	5.08	1
		Auxiliar rooms	0.80 (0.61)	4.34	0
		Shed	0.18 (0.38)	2	0
		Total	1.89 (0.49)	5.08	1
Household characteristics (Obs. = 27,034)	Household size	3.45 (1.46)	15	1	
	Number of Household heads	1.56 (0.67)	7	1	
	Number of household labors	2.54 (1.24)	13	0	
	Number of urban household	2.00 (1.76)	14	0	
	<i>Hukou</i>				
	Age of household head	43.23 (10.53)	65	16	
Village characteristics (Obs. = 66)	Gender of household head (1 = male)	0.74 (0.44)	1	0	
	Road network density (km/km ²)	3.35 (0.83)	5.42	1.52	
	Convenience-of-living (number/km ²)	58.11 (76.85)	160.49	0.39	
	Proportion of cultivated land	0.21 (0.16)	0.57	0.0002	
	Distance to downtown (km)	20.61 (12.33)	46.92	8.05	
	Distance to town (km)	2.85 (1.28)	5.79	0.26	

Table 1. Descriptive statistics of rural housing, households and villages

Source(s): Authors' own work

only two possible outcomes: expanded (“1”) or non-expanded (“0”). The independent variables included the initial structure of the housing, household characteristics and heterogeneities among villages. By referring to work by Pontius and Schneider (2001), the logit model used in this work can be represented by Equations (1)–(4).

$$Y = \text{Logit}(P) = \text{Ln}\left(\frac{p}{1-p}\right) = \beta_0 + \sum_{j=1}^J \beta_j L_i + \varepsilon_i \quad (1)$$

$$Y = \text{Logit}(P) = \text{Ln}\left(\frac{p}{1-p}\right) = \beta_1 + \sum_{k=1}^K \beta_k H_i + \varepsilon_i \quad (2)$$

$$Y = \text{Logit}(P) = \text{Ln}\left(\frac{p}{1-p}\right) = \beta_2 + \sum_{m=1}^M \beta_m V_i + \delta_i \quad (3)$$

$$Y = \text{Logit}(P) = \text{Ln}\left(\frac{p}{1-p}\right) = \beta_3 + \sum_{j=1}^J \beta_j L_i + \sum_{k=1}^K \beta_k H_i + \sum_{m=1}^M \beta_m V_i + \mu_i \quad (4)$$

From Equations (1)–(3), this study provides insight into the effect of the initial housing state, household characteristics and village heterogeneities, respectively. Equation (4) adds all the

variables to estimate all drivers of rural housing expansion. Logit is the link function, P is the ratio of housing expansion and $p/1-p$ is the odds ratio of housing expansion. L_i is a set of variables that identify the initial housing state. H_i is a group of variables reflecting household characteristics. V_i is a group of variables that identify village heterogeneities. $\beta_0, \beta_1, \beta_2$ and β_3 are constant terms, and $\varepsilon_i, \epsilon_i, \delta_i$ and μ_i are error terms.

Finally, a series of OLS regressions were estimated to analyze the degree of housing expansion, where the area of increase or the frequency of expansion was used as the dependent variable. The general form is shown in Equation (5):

$$YAF_i = \beta_4 + \sum_{j=1}^J \beta_j L_i + \sum_{k=1}^K \beta_k H_i + \sum_{m=1}^M \beta_m V_i + \sigma_i \quad (5)$$

where YAF_i measures the area change of buildings or homesteads for each rural house (i), or the frequency of expanded houses. β_4 is a constant term, and σ_i is an error term. Other variables are defined the same as the logit model.

4.2 Explanatory variables

The variables listed in Table 2 were prepared to explain the process and driving factors of rural housing expansion. Rural housing expansion is always decided by its initial state of buildings or homesteads, household needs, economic capacity and the location advantage of villages. For the plot characteristic of rural houses, rural houses usually are divided into main rooms, auxiliary rooms and sheds in rural areas. To this end, we further distinguish according to these three types. Plot and household variables reflect a family's need for housing expansion and the social status of the household in the village. Direct gains of rural houses, such as rental or operating income, were key driving factors of housing expansion. These were related to its convenience-of-living environment, road accessibility and so on. So we collected several village-level variables. The above variables of the total sample, the expanded houses and unexpanded houses are further compared in Table 2.

5. Results

5.1 Plot state of expanded rural houses in Pudong New Area

Of the 27,034 rural housing samples, there were 8,972 expanded rural houses, and the frequency of housing expansion reached 12,174 times in total. The mean building area and homestead area increased by 28.67 m² and 22.33 m², respectively (Table 3). Comparing the area change of rooms, we found that villagers tended to redevelop and extend their auxiliary rooms and sheds. Over the past 40 years, the average building area of auxiliary rooms increased by 18.72 m² per house. The increased building area and land area of auxiliary rooms accounted for 69.29 and 69.68% of the total area, respectively. Auxiliary room expansion has become an assignable means for the fragmented accumulation of rural housing.

The area changes between 18,062 houses without expansion and 8,996 houses with expansion are presented in Figure 3. For houses that expanded, the mean of the initial building area and land area are both less than the related indicators of houses without any expansion. Of the two groups (expanded and unexpanded), there were minor 2 m² and 2.5 m² differences in the area of the main room or shed separately, while the land area or building area gap of the auxiliary room reached 15.89 m² and 17.14 m², respectively. Of course, after expanding one or several times, the building area and land area of housings that expanded were more than those without expansion. The average building area of the expanded houses was 63.82 m² bigger than unexpanded houses, of which the building area of auxiliary rooms was 39.28 m² bigger, and the area of main rooms and sheds were 14.20 m² and 10.34 m²

Explanatory variables	Whole (<i>N</i> = 27,034)	Expanded houses (<i>N</i> = 8,972)	No expansion houses (<i>N</i> = 18,062)
Whether or not expanded houses (yes = 1)	0.33 (0.47)	/	/
Increment building areas (m ²)	28.68 (64.99)	86.41 (87.97)	/
Times of housing expansion	0.45 (0.75)	1.36 (0.70)	/
Initial building area of main room (m ²)	198.09 (97.2)	196.42 (79.3)	198.92 (104.95)
Initial building area of auxiliary room (m ²)	28.65 (48.06)	17.2 (35.6)	34.34 (52.26)
Initial building area of shed (m ²)	2.64 (16.87)	0.68 (5.64)	3.62 (20.18)
Initial land area of main room (m ²)	88.16 (30.94)	86.79 (26.76)	88.84 (32.79)
Initial land area of auxiliary room (m ²)	24.19 (37.88)	13.57 (25.65)	29.46 (41.69)
Initial land area of shed (m ²)	2.64 (16.86)	0.67 (5.62)	3.62 (20.17)
Initial FAR of main room	2.18 (0.57)	2.24 (0.5)	2.15 (0.61)
Initial FAR of auxiliary room	0.59 (0.65)	0.44 (0.66)	0.67 (0.62)
Initial FAR of shed	0.08 (0.28)	0.03 (0.18)	0.11 (0.31)
Age of household head	43.23 (10.53)	44.23 (9.71)	42.73 (10.87)
Gender of household head (1 = male)	0.74 (0.44)	0.73 (0.44)	0.74 (0.44)
Household size	3.45 (1.46)	3.69 (1.45)	3.32 (1.45)
Number of household labors	2.54 (1.24)	2.75 (1.24)	2.44 (1.23)
Number of urban <i>Hukou</i>	2.00 (1.76)	2.21 (1.85)	1.90 (1.71)
Number of Household heads	1.56 (0.67)	1.64 (0.67)	1.51 (0.68)
Road network density (km/km ²)	3.33 (0.82)	3.56 (0.83)	3.21 (0.79)
Convenience-of-living (number/km ²)	27.11 (39.53)	34.16 (44.18)	23.60 (36.50)
Farmland abundance percentage (%)	0.28 (0.16)	0.27 (0.16)	0.28 (0.16)
Distance to downtown (km)	5.89 (4.05)	4.61 (3.74)	6.52 (4.05)
Distance to town (km)	2.99 (1.23)	3.06 (1.18)	2.96 (1.25)

Note(s): Standard deviations are in parentheses

Source(s): Authors' own work

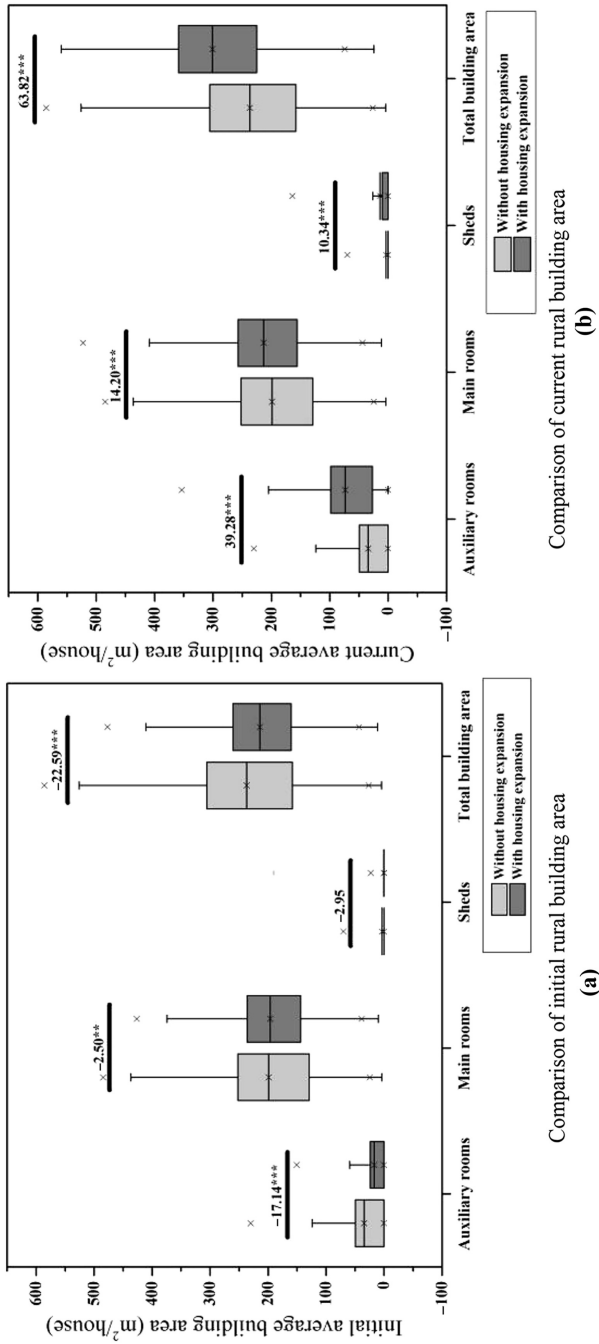
Table 2.
Explanatory variables and related comparisons

	Building Area (m ²)			Homestead/land Area (m ²)			Floor area ratio		
	Initial	Current	Change	Initial	Current	Change	Initial	Current	Change
Main rooms	198.09	203.63	5.54	88.16	90.53	2.37	2.18	2.18	/
Auxiliary rooms	28.65	47.37	18.72	24.19	39.75	15.56	0.59	0.8	0.21
Shed	2.64	7.05	4.41	2.64	7.03	4.39	0.08	0.18	0.1
Total	229.39	258.06	28.67	114.99	137.32	22.33	/	/	/

Source(s): Authors' own work

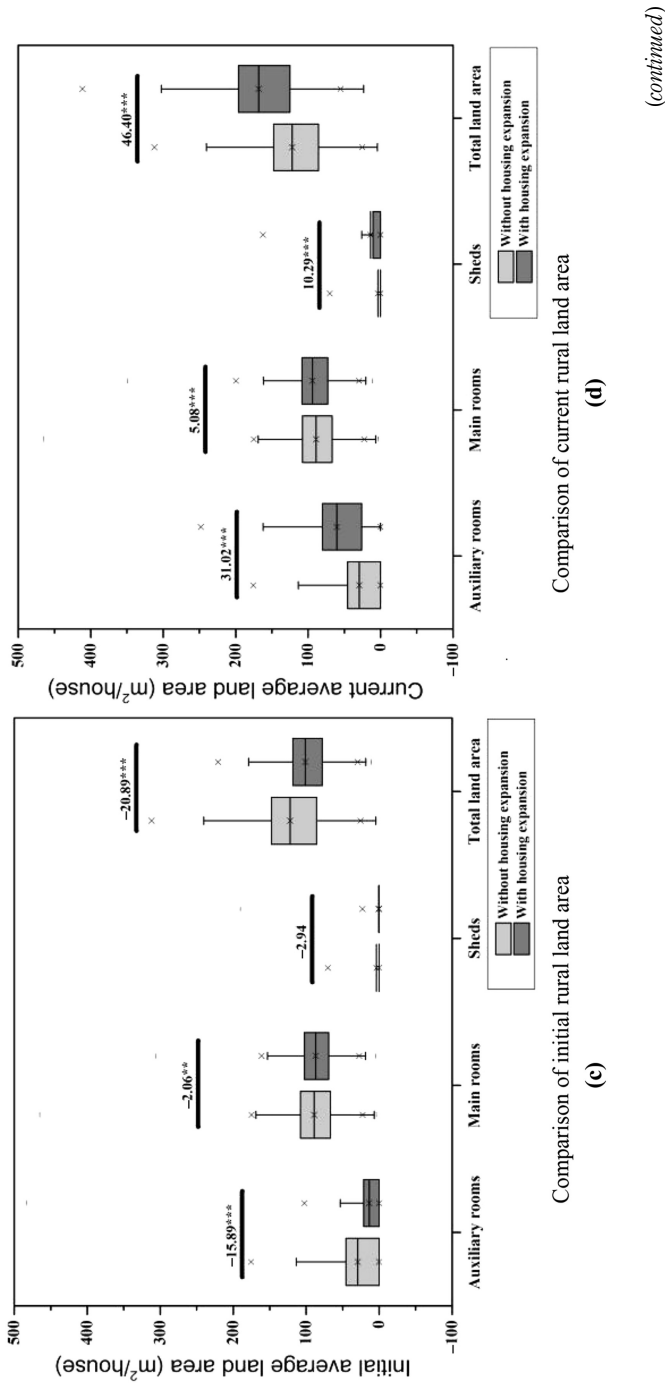
Table 3.
Average area change of the housing samples from 1978 to 2017

bigger, respectively. For some villagers, auxiliary room expansion seemed like a low cost and profitable way to accumulate their household wealth quickly. Arable land plots adjacent to their houses were stealthily converted into auxiliary rooms and sheds by villagers. According to the surveyed data, of the 8,972 expanded houses, 6,417 were one-story buildings (71.52%), 2,416 expanded houses were two-story buildings (26.93%) and 139 were three stories or more



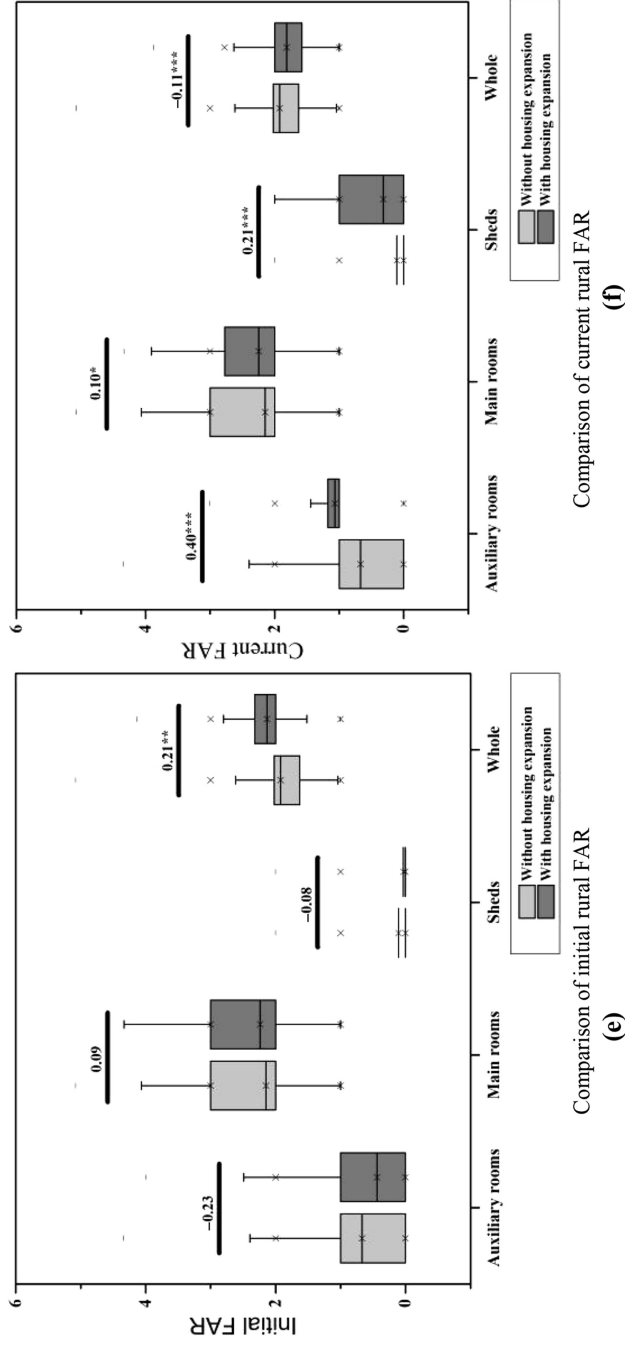
(continued)

Figure 3.
Comparison of rural housing status between groups with and without expansion (* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$)



(continued)

Figure 3.



Note(s): * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

Source(s): Authors' own work

Figure 3.

(1.55%). Thus we can see that the local government in Shanghai regulated the upward growth of rural housing. In particular, the expansion and rebuilding of main houses was strictly controlled.

Furthermore, we divided rural houses into four groups, with initial building areas of $<150\text{ m}^2$, $150\text{--}250\text{ m}^2$, $250\text{--}350\text{ m}^2$ and $\geq 350\text{ m}^2$. From Table 4 and Table A1, it is clear that the housing assets of villagers accumulated stealthily by the expansion of auxiliary rooms and sheds. The housing samples with an initial building area of $<150\text{ m}^2$ expanded the most on average, and the building area increased by 102.85 m^2 per house. Therefore, the proportion of rural housings with a building area less than 150 m^2 decreased from 21.11% initially to 6.74% currently. These results indicated that the housing samples with building areas of $<150\text{ m}^2$ obviously increased their housing area by expansion. This type of housing initially possessed smaller building areas, and had weak status in the village. Housing expansion was needed to improve the living conditions of households. We observed the largest ratio (40.65%) and the highest frequency (6,229 times) of housing expansion for houses with an initial area of $150\text{--}250\text{ m}^2$. After expansion, the mean building area of these houses increased by 83.04 m^2 . Seeking housing rent and property income, villagers took advantage of their household resources and social status to expand and accumulate housing assets. As a result, most rural houses distributed in this group carried out fragmented and small-scale housing expansions.

5.2 Household differences of expanded rural houses in Pudong New Area

The family demographic characteristics of the 8,972 expanded houses are compared as Tables A2–A7. The age of the household head, household size, number of household laborers, number of urban *Hukou* and number of household heads had a considerable effect on rural housing expansion, but the gender of the household head had no impact on their expansion behavior. Rural households with young and middle-aged heads (aged from 40 to 50 years) frequently expanded houses by using their economic advantage and social status. In general, the bigger the family and the more household laborers, the more their housing expanded. The need of living space for household members also motivated the expansion. This might also be due to the increased need for living space because of family division. As seen in Table A7, households with two or three household heads expanded more in terms of housing and homestead area. Multi-generational cohabitation led to more housing needs. In addition, for the group with the number of urban *Hukou* of ≥ 6 , the percentage of expanded houses was 43.84%. It seems that households with more urban *Hukou* members had a greater capability of expanding housing. In rural China, urban *Hukou* might increase the level of household non-agricultural income to some extent. The more urban *Hukou*, the sooner the laborers of the family are likely to stop farming, and the higher their non-agricultural income level.

5.3 Spatial heterogeneities of expanded rural houses in Pudong New Area

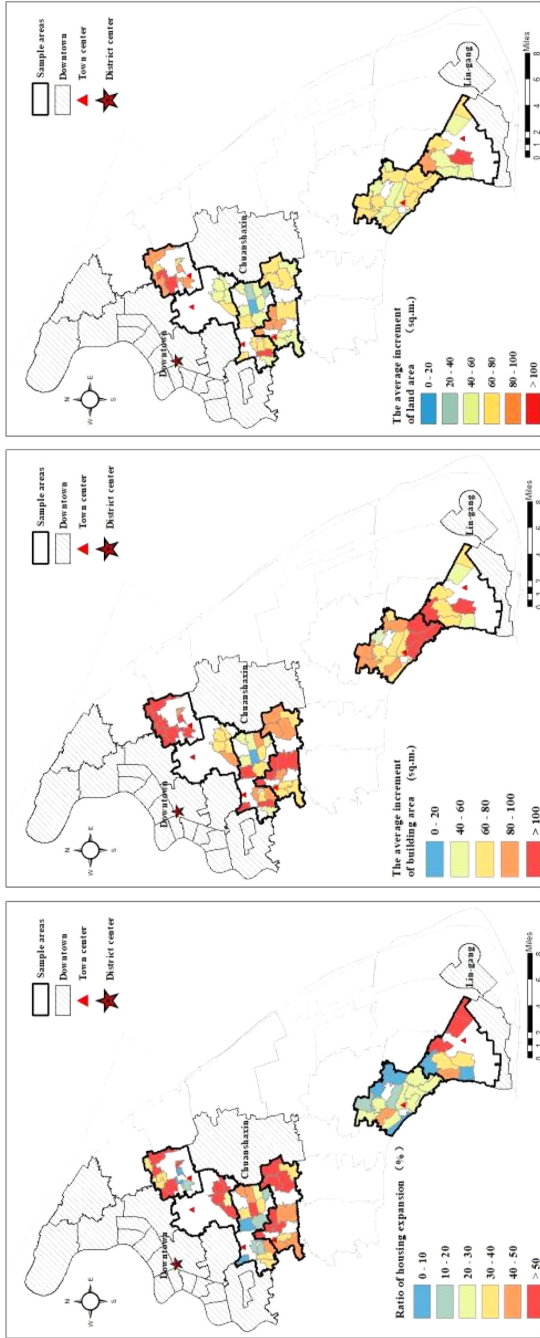
The spatial distribution of expanded houses in villages is shown in Figure 4. It seems that more expansion occurred in villages spatially adjacent to downtown or to a town, given the convenient living environment. Of these, there were 21 villages where expanded houses accumulated in half and more of the total rural houses in the past 40 years. Among the 8,972 rural expanded houses, 2,364 buildings were expanded twice or more. Rural houses are prohibited from being sold in China, but for rural housing at the rural–urban fringe, their location advantage from being adjacent to downtown or to a town and their low rent attract thousands of migrants. At the same time, urban renewal focused on rural houses situated at the urban fringe, further activating the property rights of rural housing in suburban areas.

The results of the area increment for expanded rural houses were also similar. They spatially increased with the decline of distance between villages and the downtown or a town.

Table 4.
Building area change
of expanded houses
based on area groups

Group	Expanded houses	Total of expanded houses	Proportion of expanded houses (%)	Frequency of expanded (times)	Initial building area (m ² /house)			Current building area (m ² /house)			Area change (m ² /house)					
					Main room	Auxiliary room	Shed	Subtotal	Main room	Auxiliary room	Shed	Subtotal	Main room	Auxiliary room	Shed	Subtotal
<150 m ²	1,894	6,123	30.93	2,549	103.36	5.56	0.17	109.09	145.29	58.70	7.95	211.94	41.93	53.15	7.78	102.85
150-250 m ²	4,523	11,128	40.65	6,229	186.15	12.37	0.43	198.95	197.87	71.07	13.05	281.98	11.72	58.70	12.62	83.04
250-350 m ²	1,974	6,231	31.68	2,643	260.60	28.76	1.14	290.50	267.11	83.79	18.39	369.29	6.51	55.03	17.25	78.79
>350 m ²	581	3,552	16.36	753	361.69	53.48	2.68	417.85	369.56	107.52	25.69	502.78	7.87	54.04	23.01	84.92
Overall	8,972	27,034	33.19	12,174	196.42	17.20	0.68	214.30	213.12	73.62	13.97	300.70	16.70	56.42	13.29	86.41

Source(s): Authors' own work



Percentage of expanded houses in surveyed villages (a)

Increase in the building area of expanded houses (b)

Increase in the household size of expanded homesteads (c)

Source(s): Authors' own work

Figure 4. Cumulative state of rural housing expansion for 66 villages from 1978 to 2017 in Pudong New Area

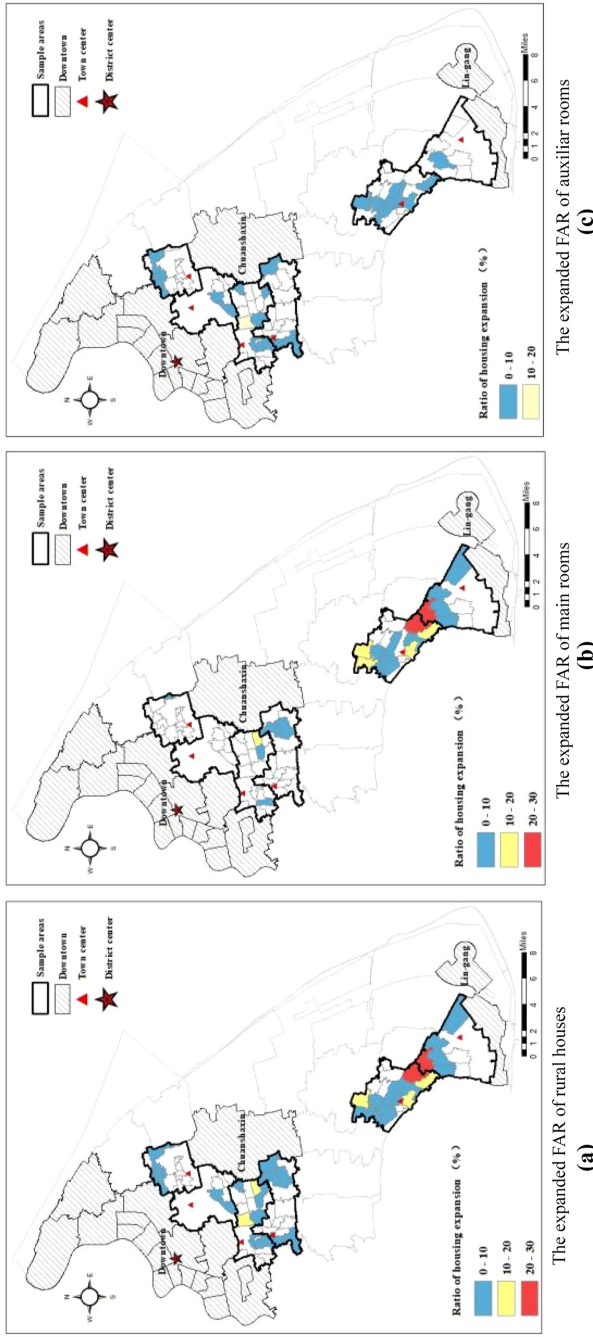
Table A8 shows that of 23 villages, expanded houses increased their building area by more than 100 m² per house on average. Several villages had only sporadically expanded houses, but the average expanded area was 100 m² or more. There were 14 villages with land area increments of expanded houses with 80 m² or more on average. In particular, the percentage of expanded houses was more than half of the total houses in seven villages: Dazhong, Xiaowan, Xinzhen, Yaoqiao, Yixin, Zhoudong and Zhounan. Interestingly, we observed that expanded houses over two stories high were generally located in villages far from the central downtown (Figure 5). This is due to the lax control of the floor–area ratio of housing construction in suburban areas.

We further observed the change in expanded rural houses from the plot level, and the spatial distributions of houses expanded two or more times are shown in Figure 6. The period from 1988 to 2007 was the most frequent period of rural housing expansion in Pudong New Area. During this period, there was rapid economic opening and urban development in Pudong New Area. The development of urban areas and industry activated the informal market of rural housing at the fringe, thus stimulating villagers to expand their rural houses frequently. From 1988 to 1997 and 1998 to 2007, there were 3,948 and 4,554 respective occurrences of rural housing expansion in the surveyed region, accounting respectively for 31.05 and 35.82% of the cumulative expansion frequency. As seen in Figure 6, there was no hot spot of rural housing expansion in the period from 1978 to 1987, and the percentage of housing expansion was below 15% in all 66 villages. From 1988 to 1997, two hot spots of rural housing expansion formed in the surveyed area, and the percentage of expanded houses exceeded 30% in 12 villages. Both hot spots are adjacent to the downtown of Pudong New Area. From 1998 to 2007, hot spots of rural housing expansion moved into Tangzhen Town and Zhangjiang Town. At that stage, China has just opened the urban land and housing market, and the rapidly rising prices of urban land and urban apartments led to an informal market for rural houses and housing rental, which provoked frequent expansion to rural housings. After 2007, there was only one hot spot of rural housing expansion in the surveyed area: Zhangjiang Town.

5.4 Driving factors of expanded rural houses in Pudong New Area

Based on the above analysis, there were distinct features and differences for rural housing expansion at the housing, household and village levels in Pudong New Area. We further examined the factors driving rural expansion by using binary logit regression, the results were shown in Table 5, its multi-collinearity test as showed in Table A9. In terms of the characteristics of rural houses, the initial building area of houses and the initial floor–area ratio of auxiliary rooms and sheds were negatively correlated with the incidence of rural house expansion. In general, the smaller the initial area of the houses, the more incentive there was to expand, especially for auxiliary rooms and sheds. This is consistent with the above analysis showing that relatively smaller rural houses were more likely to expand auxiliary rooms and sheds stealthily. Household characteristics like the age of the household head, household size, household laborers, number of urban *Hukou* and number of household heads positively led to rural housing expansion, which significantly increased the likelihood of expanding houses. The characteristics of household size, household laborers and number of household heads reflected the need for living space as a result of family splitting. Moreover, the convenience of public services and infrastructure such as road network density and convenience of living had a positive effect on expanding houses. Those villages adjacent to the downtown areas were more likely to expand.

We obtained very similar results as above from the regression analysis of the driving factors for the increment number of rural house expansions (seen in Table A10). Their robust test were shown in Table A11. It is not surprising that the increment of expanded houses also



Source(s): Authors' own work

Figure 5. The distribution of expanded houses over two stories for 66 villages in Pudong New Area from 1978 to 2017



Figure 6. Spatial distributions of expanded houses (two or more times) from 1978 to 2017 in Pudong New Area

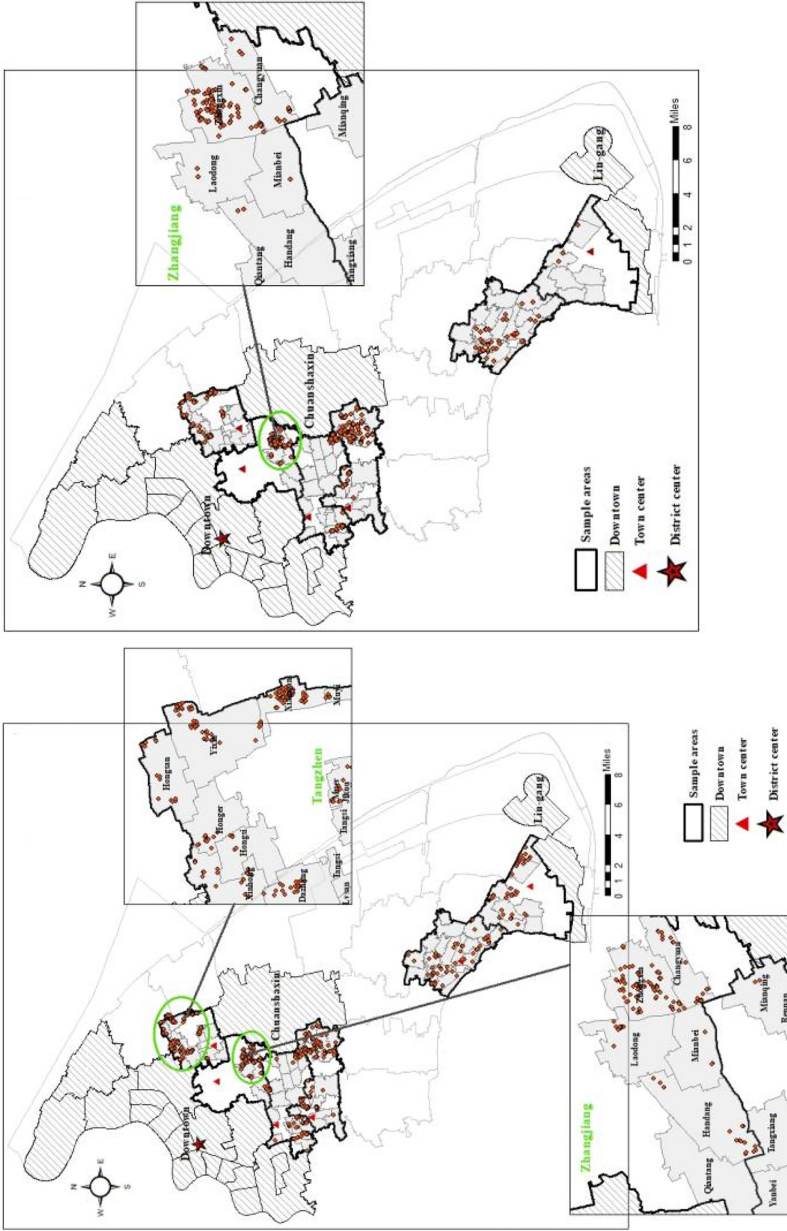
Spatial distribution of expanded houses from 1978-1987

(a)

Spatial distribution of expanded houses from 1988-1997

(b)

(continued)



Spatial distribution of expanded houses from 2008–2017 (d)

Spatial distribution of expanded houses from 1998–2007 (c)

Source(s): Authors' own work

Figure 6.

Table 5.
Logit regression model
of rural house
expansion in Pudong
New Area

Model statistics		Values	
Chi-square	1656.856 ^{***}	459.169 ^{***}	1,713.338 ^{***}
-2 log likelihood	32292.329	33896.393	32525.661
Nagelkerke's R-square	0.102	0.024	0.091
Predictive efficiency	66.9%	58.2%	64.7%
Hosmer-Lemeshow test significance	0.671	0.588	0.660
			3634.518 ^{***}
			29587.145
			0.252
			74.8%
			0.749

Variables	Estimates	Odds ratio	Estimates	Odds ratio	Estimates	Odds ratio
Initial building area of main room ^a	-0.004 (0.001)	0.996 ^{***}	0.007 (0.001)	1.007 ^{***}	-0.004 (0.001)	0.996 ^{***}
Initial building area of auxiliary room ^a	-0.007 (0.001)	0.993 ^{***}	-0.016 (0.031)	0.985 ^{**}	-0.010 (0.001)	0.990 ^{***}
Initial building area of shed ^a	-0.012 (0.003)	0.988 ^{***}	0.046 (0.017)	1.047 ^{**}	-0.012 (0.003)	0.989 ^{***}
Initial FAR of main room ^a	0.891 (0.036)	2.438 ^{***}	0.116 (0.017)	1.123 ^{***}	1.011 (0.039)	2.749 ^{***}
Initial FAR of auxiliary room ^a	-0.347 (0.032)	0.707 ^{***}	0.027 (0.009)	1.027 ^{**}	-0.294 (0.034)	0.745 ^{***}
Initial FAR of shed ^a	-0.773 (0.095)	0.462 ^{***}	0.039 (0.025)	1.040 ^{***}	-0.780 (0.098)	0.458 ^{***}
Age of household head ^b					0.013 (0.002)	1.013 ^{***}
Gender of household head ^b					-0.021 (0.033)	0.979 ^{**}
Household size ^b					0.154 (0.019)	1.166 ^{***}
Number of household labors ^b					0.131 (0.019)	1.140 ^{***}
Number of urban <i>hukou</i> ^b					-0.153 (0.012)	0.858 ^{***}
Number of Household heads ^b					0.244 (0.028)	1.276 ^{***}
Road network density ^c					0.335 (0.021)	1.398 ^{***}
Convenience-of-living ^c					0.005 (0.001)	1.005 ^{***}
Ratio of cultivation land ^c					-0.033 (0.123)	0.967 ^{**}
Distance to downtown ^c					-0.102 (0.006)	0.903 ^{***}
Distance to town ^c					0.068 (0.013)	1.071 ^{***}
Constant	-1.457 (0.055)	0.233 ^{***}	-1.590 (0.067)	0.204 ^{***}	-3.931 (0.156)	0.020 ^{***}

Note(s): ^a Plot characteristics. ^b Household characteristics. ^c Village characteristics
* $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$
Source(s): Authors' own work

correlated with the above characteristics of houses, households and villages. The key factors and their driving factors were nearly same as the above logit regression. The initial building area of the main room and auxiliary rooms and the initial FAR of auxiliary rooms were negatively correlated with the increment and the frequency of expanding houses. The smaller the initial area of rural houses, the higher the increment and the higher the frequency of expanding houses. This result is also consistent with the household demographic characteristics of rural house expansion. Rural families with more family members, laborers and household heads always had a bigger increment area of their expanded houses. Those villages adjacent to downtown or to a town with convenient living infrastructure had a bigger increment area and expanded their houses more often. The difference is that the increment and frequency of expanding houses were not significantly related to the initial area of sheds. That is because sheds were only concentrated in a few villages, whereas rural housing expansion was common throughout Pudong New Area. The age of the household head had no significant effect on the expansion area of the house. This finding is in contrast to the results of the logit regression of expansion and non-expansion. Moreover, road density was negatively correlated with the increment of housing expansion. This is because villages with denser road networks have stricter governmental supervision and relatively little land for rural housing expansion.

6. Conclusions and implications

The housing expansion craze has become one of the fundamental challenges in rural China. Rural homesteads have not decreased, but rather increased synchronously with urban land expansion, despite the rapid decline of the rural population. In this study, we explored the process of piecemeal expansion in rural buildings and housing assets over the past 40 years in Pudong New Area, and examined the correlation between the expansion in rural housing, and the characteristics of houses, families and villages. To our knowledge, this is the first attempt to decompose the expansion of housing in rural Chinese villages based on a large dataset of surveyed samples from the rural–urban fringe. This work can serve as a reference for the government to understand the process and driving forces of rural housing expansion, and to adopt efficient policies and measures to regulate it.

Our analysis included 27,034 rural houses in Pudong New Area from 1978 to 2017. It found that 33% of rural houses had expanded building areas over these 40 years. Of these, 8,972 rural houses were expanded a total of 12,174 times, and the average building area accumulated with an increase of 86.41 m², mainly by enlarging the homestead. The increment of the average land area for an expanded house was 73.88 m², and 89.39% of this increment occurred on plots of arable land adjacent to the houses that were stealthily converted into auxiliary rooms and sheds. This was the result of the welfare system of collectively distributed homesteads, and emerging capital gains and wealth from rural houses due to rapid urbanization. In addition, weak or limited regulations regarding auxiliary rooms in dwellings provided substantial scope for villagers to expand their rural housing. Furthermore, due to advancing urban renewal and land markets, unorganized and unapproved rural houses entered the rental market or the expropriation market. In a word, the emergence of rural housing in informal or formal markets motivated the expansion of rural houses. Beyond Shanghai, rural houses and homestead expansion have emerged throughout the whole of China, especially at the urban–rural fringe (Zhang *et al.*, 2022; Zhao *et al.*, 2019; Wu *et al.*, 2019). This is a dangerous phenomenon with adverse effects, even for the villagers engaged in this expansion.

It is critical that policymakers control the expansion of rural housing. The Chinese government has set up an approval system for rural housing construction, and several measures have been implemented to control disorganized housing expansion. However, some villagers continue to expand rural buildings illegally, motivated in some cases by the

increased need for living space, but also stimulated by the gains from the rental market for rural houses. Housing expansion has been quite active in these six towns of Pudong New Area over the last 40 years. The study further showed that families in houses with the less initial areas had more family members, laborers and household heads were more likely to expand houses. Labor capital (the number of household laborers) and family splitting (the number of household heads) were significant indicators for housing expansion. These factors reflect the need for more family living space. Moreover, households with more urban *Hukou* members had a greater capability of expanding and accumulating housing. It means that relatively “capable” households with better economic conditions were the key groups to expand house. In addition, location advantage was more sensitive to expansion. Proximity to downtown offered more opportunities to manifest the property value of housing assets. Rural houses in villages that were close to downtown, with convenient living services and transportation conditions expanded more often and had a bigger increment area. Those rural dwellings that were adjacent to downtown or to a town had a strong motivation to expand houses and pursue the informal surplus associated with housing expansion.

We agree with the nationalization of land development rights, but under the current situation described above, in order to control the expansion of rural housing, the government should pay careful attention to land development rights with rural collectives and villagers. We suggest that policy should consider appropriate economic tools, such as taxes and penalties, to control the unapproved and unorganized expansion of housing. Rural inhabitants with more housing stock expand their initial housing wealth to accumulate more negotiation capital (Cai *et al.*, 2020). This behavior not only leads to unequal housing assets among rural residents but also damages the fair distribution of social welfare, government credibility and the effectiveness of policies for regulating rural homesteads. Thus, governments should strictly clarify their right to control the land and housing development. For instance, they can impose a tax on excess housing areas in order to prevent farmers with more housing stock from pursuing rural housing investments without restrictions. Furthermore, our results revealed that this type of increased rural housing stock usually emerged near the rural–urban fringe. If this informal housing land can be converted into urban construction land in an orderly way, it will mitigate the lack of urban development space. As such, we suggest establishing a market to facilitate the conversion of rural development rights.

Shanghai has a total area of 289,499.59 hectares of land for residential, industrial and mining use, of which rural residential land comprises 67,384.05 hectares [1]. As empirical analyzed in this paper, the average building area and homestead area of rural houses are large on the rural–urban fringe in Shanghai. Because of the proximity to downtown, convenient transport networks and cheap housing rent, these urban villages are the most attractive sites for migrations in the city. Meanwhile, this low-density residential land is an attractive site for local governments and real estate developers to promote urban redevelopment. Our results suggest that it is necessary to impose a series of measures to control disorganized and unapproved rural housing expansion at the rural–urban fringe. This does imply that strict area standards for free homestead use by villagers are necessary. The distribution system of residential land in rural villages should be gradually reformed or abolished, given the rapid decline of the rural population. Furthermore, high fees for overused areas in rural houses, land increment taxes for rental houses, and serious penalties for illegal or improper housing expansion are recommended. Finally, effective land-use planning will benefit villages. Feasible land-use planning, extensive public participation and supervision are effective ways to stop the illegal expansion of rural houses.

Note

1. http://www.cnr.cn/shanghai/shzx/zq/20211123/t20211123_525669180.shtml

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Supplementary materials

The supplementary material for this article can be found online.

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