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# Sustainable Supply Model Design of Public Rental Housing —Case Study of Chongqing

**Abstract** Public rental housing is an important governmental project. Within the next three years, Chongqing municipal government proposes building  $40 \times 10^6$  m<sup>2</sup> of public rental housing to solve the housing problem for 2 million people. Many problems of sustainability have happened in long-term large-scale construction, including gradually-slow renting progress, the shortage of funds, public rental housing community facilities are retrograde, and the selected sites are at the city's edge. This paper analyzes the Chongqing public rental housing situation from the perspective of sustainable public rental housing supply, putting forward a sustainable supply model that is suitable for Chongqing, and then calculates their portion.

**Keywords:** public rental housing, sustainability, supply model, filtering theory

## 1 Introduction

In 2013, China planned to start the construction of 6.3 million units of new affordable housing, including 4.7 million basic units. By the end of September this year, 6.2 million suites of the affordable housing had been launched nation-wide and 4.1 million basic units had been completed, reaching the annual goals of 98% and 87% respectively. The investment was 820 billion CNY. The current implementation throughout China of construction and promotion of affordable housing is still in the exploration stage. There are still some contradictions and problems, including project quality and supervision (Yang, 2012).

Chongqing has started over  $36 \times 10^6$  m<sup>2</sup> of public rental housing construction with the goal of 40 million, and 120,000 households have moved in. Through on-spot

investigation and literature research problems like huge funds lacking, remote site selection, poor quality, not full-finished equipment, and part-interruption of housing marketization have been found during the implementation of public rental housing.

As the center of West China and a target area for industrial relocation, construction of public rental housing in Chongqing is developing rapidly on a large scale. Problems arising in Chongqing are relatively typical in that, 40%–50% of the tenants are migrant workers, 15%–20% are new generation college students, and the other 30% to 35% are original residents. The “sandwich class,” which takes college graduates as mainstays, every year adds 127,000 new people to the employment group. College students and original residents are not happy at having to rent public rentals considering issues such as living safety, transportation, and facilities. College graduates have more choices when it comes to living: 26.6% turn to house agencies or rent privately; 26.6% live in staff dormitories; 14.1% lodge with relatives or friends; and, 30.4% purchase a new house or live in their own houses (Zeng, Qiu, & Li, 2012). Only 2.4% choose public rental housing. So it is necessary to explore and solve the sustainable supply model of public rental housing in Chongqing.

## 2 Sustainable supply of public rental housing

Sustainability is the ability to maintain a stable process or status and is often used to examine relationships between ecology, economy, and society. The non-declining consumption aspect of sustainable economic theory put forward by John Hartvik, and managing resources to maintain production opportunities put forward by Luthroll, fully embody that sustainability represents an acceptable status that human benefit can maintain in an infinite period. We public rental housing supply sustainability as: satisfying current high-unit supply, which means the sustainability supply of financial resources and physical housing,

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the sustainability of site selection, layout and healthy orderly life of district residents, the stability of the supplier and operation system, the sustainability of the whole housing market operation; and also building a supply system to manage resources so that the distribution of public rental housing between two generations could be achieved (Merliwot, 2013).

### 2.1 Public rental housing supply sustainability

The supply of public rental housing needs reasonable operation costs and maintenance costs, and also needs inflation-proof and reusability. It can achieve a better combination between the government and the market in public rental housing supply (Li, Hao, & Chen, 2012).

### 2.2 Public rental housing site selection sustainability optimization

Considering that the local government's control over land interest results in public rental housing sites that are reliable are at the edge of the city, which relates to high trip cost and slums. So it will make site selection more sustainable, if we make a full calculation of the tenants' traffic accessibility of the newly-built public rental housing site selection and government's income area, or purchase vacant housing (commodity houses that the estate developers fail to sell out) to supply public rental housing.

### 2.3 Public rental housing sustainable supplier stability and operation

At present, public rental housing is in the solely supplied and managed by the government. There are problems such as low equipment efficiency of the government, and shortage of the funds. Property Right Theory insists that owners of property in private agencies take occupancy rights for surplus profit and have powerful incentives to increase enterprise profits. Therefore, it is necessary for us to introduce private agencies that are higher efficiency and have large amounts of private capital to form a sustainable supply and operating system for public rental housing (Yang, 2011).

## 3 The current supply of Chongqing's public rental housing

Chongqing's public rental housing capital is provided by the government. In the past ten years, Chongqing Land Group, which is responsible for the land reserve work, has created a reservation of over 100 thousand mu (1 mu  $\approx$  666.67 m<sup>2</sup>) (Zhang, 2011). This land for public rental housing construction is directly allocated by the government, while the public rental housing construction is

designated by the government to state-owned enterprises "City Investment Group" and "Real Estate Group" and other companies (Ma & Lai, 2012).

### 3.1 Renting progress and construction fund

In 2010, there were seven projects starting in the downtown area, which can provide 9.88 million square meters of public rentals and provide housing for 162,217 households. In 2011, there were nine projects starting in the downtown area providing 11.081 million square meters in public rentals and provide housing for 168,100 households. In 2012, there were 13 projects starting in the downtown area, which would provide 4.41 million square meters' public rentals and provide housing for 80,000 households.

Since the implementation of public rental housing in 2010, there have been seven times renting by lot-drawing. In 2011, there were 4 times with the renting rate of 59.69%. In 2012, there were 2 times with the renting rate of 64.88%. In 2013, there was only one time with the renting rate of 50.22%. From the renting process from 2011 to 2013, it can be found that 80,000 units of public rentals rented in 4 lots. The second year and the third year volume increase 50% over the former year. The general renting process is slows year to year.

The total investment of 40 million square meters of public rental housing in Chongqing is about 12 billion CNY. It consists of fiscal investment and financing loan with the ratio of 3 : 7. Fiscal investment is mainly collected on the 3,000 m<sup>2</sup> of stored national land and the central government's specialty fund, the local government fiscal budget, a reduction of or exemption from fees and taxes. Financing part is mainly collected by bank loans, non-bank financial agencies, housing accumulated fund loans, and marketing channels such as issue bonds (Chen, 2012). Table 1 is the investment of Chongqing's public rental housing. Table 2 is Chongqing public rental housing monthly income.

There is only about 1 million left every month provided by the two early public rental housing projects on the circumstance that it is saturated check and only interest is paid. Subsequent running costs and housing maintenance costs increase every year. Comparing each project's loan of over 2 billion, public rentals are only to rented not sold in the first five years. It is estimated that the payback period will be as long as 15.98 years with an internal rate of return of only 8.14%. This will be a huge financial pressure for the government without a doubt. The sustainable supply of public rental housing is hard to achieve.

### 3.2 Site selection and environment layout

The authors conducted a survey on 30 environmental factors present in public rental housing, and received 136 completed questionnaires from residents of public rental

**Table 1***The Investment of Chongqing's Public Rental Housing*

	Total investment				Costs		
	Fiscal investment	Accumulation fund	Loan from Commercial bank	In total	Financing cost	Housing management fees	In total
Min Xin Jia Yuan	960 million	800 million	1,440 million	3,200 million	10.86 million	90,000 per month	10.95 million
Beautiful Land	1,065 million	500 million	1,985 million	3,550 million	12.71 million	100,000 per month	12.81 million

**Table 2***Chongqing Public Rental Housing Monthly Income*

	Housing rents	Commercial rents	Garage rents	In total
Min Xin Jia Yuan	10.07 million	1.72 million	0.83 million	12.62 million
Beautiful Land	10.26 million	3.23 million	0.77 million	14.26 million

communities, residents of surrounding communities and government administrators. A list is obtained of five environment factors which drew the most attention. These five factors are precisely the problems as they exist in public rentals housing recently (Lv, 2013).

### 3.2.1 Transportation inconvenient and costly

Presently all public rental housing projects are at the edge of Chongqing downtown and relatively far from the main business centers. Most of 83 tenants in Minxin Jiayuan, which is the most mature community of public rental housing, work in the commercially developed area of Chongqing downtown area (shown in Table 3).

**Table 3***Min Xin Jia Yuan Tenant Working Areas*

Working areas	Percentage/%
Shapingba	10.84
Yuzhong	14.46
Jiangbei	36.14
Yubei	18.07
Jiulongpo	7.23
Dadukou	3.61
Nanan	7.23
Beibei	1.20

Only Metro Line 3 stops around the Min Xin Jia Yuan, and people relies mainly on busses for transportation. Over 49% of the residents spend more than an hour commuting. This decreases middle-and low-income groups living convenience and raises tenant living costs. Very few bus lines are linked to other commercial centers or districts in the public rental housing community. Many rail transit

lines are not open and intensive communities can led to crowded traffic and affecting traffic flow during commuting time (Li, Ye, & Su, 2011).

### 3.2.2 Isolation, non-comprehensive facilities and chaotic environments

These public rental housing projects sites were selected together and the site selection strategy easily results in segregating public rental housing communities from more mature communities. This increases the gap between social classes which works against long-terms public rental housing sustainability operations and creates significant hidden security dangers. Many breaking-door murder incidences have happened in Min Xin Jia Yuan (Zhang, 2010). Facilities in public rental housing can far more meet tenants' demand. A site investigation revealed a lack of important educational and medical facilities still persists in these four relatively mature public rental communities. The main reason is that the poor sites led to difficulties in attracting investment and the owner hadn't paid sufficient attention to commercial facility management.

Under these that residents are not so satisfied with the surrounding facilities. Many residents in public rental housing communities do not have steady jobs and live a hard life. Most of the groups start taking self-employment and pitching on the street, resulting in the rapid increasing number of illegal pitching, sewage flows around the community, and the environment deteriorates. Water leaks caused by the poor quality of the public rental housing further lower community satisfaction and problems arise such as property management fees cannot be collected punctually (Hu, 2013).

In conclusion, such problems of public rental housing supply in Chongqing are summarized in the following: slow rental progress, huge shortage of funds, unreasonable site selection and environment layout. Centralized con-

struction of large scale is a source of problems, and only multiple supply models can assist the sustainability of public rental housing.

#### 4 Design of public rental housing supply model

In mid-2012, the Chongqing municipal government proposed building 13.5 million square meters of public rental housing on the basis of over 28 million square meters of construction. Choosing a sustainable supply model to solve a series of problems is required. Different supply models should be adopted according to different situations. For workers in relatively centralized industrial park and industrial base, we can supply newly-built and intensively-built public rental housing. But for new graduates and the indigenous population, we can purchase vacant houses to meet their need using filtering theory as a basis.

##### 4.1 Necessity of the supply of public rental housing

Chongqing's development can be achieved without importing workers. Centralized construction of public rental housing can be constructed around the industrialization park and development zones. From the perspective of enterprises and the government, building public rental housing around work areas makes a difference. First, it can attract more workers and provide laborers which enterprises around industrial parks and development zones need. Second, it can benefit the labor stability and increase economic profits so that outer workers don't need to worry about housing if they have stable housing. Third, as more enterprises gather here the benefit pushes the city's economic development and urbanization process. From the perspective of outer workers, they are beyond the urban housing security system and do not have the right to enjoy housing security policies. Second, current policies for enterprise land use limit the construction of outer workers' apartments or dormitories. According to rules for urban planning management, constructing supporting facilities that are not for production are prohibited in industrial zones including residential sets, hotels, expert buildings, rest houses, training center and others. The land area for administration and office and living facilities cannot exceed 7% of the total land area for industrial projects in a national or provincial industrial park or development zones. In industrial parks and development zones at other levels, the rate cannot exceed 10%. The construction area cannot exceed 10% the total land area for industrial projects. Labor-intensive enterprises have large staffs and the 10% seriously limits the construction of enterprises apartments or dormitories. So it is necessary to conduct centralized construction of public rental housing in industrial parks, development zones and industrial bases (Wang, Hu, & Gu, 2011).

Statistics from the Chongqing statistical bureau for 2012 indicate commercial housing vacancy in Chongqing downtown area reached 6.0736 million square meters which included  $3.0405 \times 10^6$  m<sup>2</sup> of commercial housing which had been vacant for 1–3 years and  $1.0709 \times 10^6$  m<sup>2</sup> of commercial housing which had been vacant for more than three years. If government can take in the housing stock, it would relieve the shortage of public rental housing and make resource configuration best by lowering the vacancy rate of commercial housing (Song, Huang, & Chen, 2000).

##### 4.2 Supply model selection based on the filtering theory

Housing values fall with time and depreciate, so there is housing stock of different grades. Filtering theory, in case the demands are unchanged, suggests that rents will rise with the decreasing supply of middle-and-low class housing. When rents rise to the level of upper-class housing, downward filtration of old housing of relevant grades accelerates. This leads to a small number of housing stocks for the upper class and an increase in the housing stock for middle-and-low class, which will provide abundant and available housing for government purchase of second-hand houses to supply public rental housing. Meanwhile, the decrease of upper-class housing stock is a direct incentive to developers to develop products for the upper class, which is in line with the government's policy that "market to upper-class housing, security for low-class housing". So the Chongqing government should use the supply model of purchasing second-hand houses to promote the sustainable supply of the public rental housing (Jian, 2005).

In the long-term, it is not consistent with filtering theory to construct a lot of new houses for middle and low income families. On one hand, the newly-built low-grade housing cannot keep the pace with social demands which will cause new waste. On the other hand, it will break the succession of supply chains of housing and lessen developer enthusiasm for developing housing for the middle and upper classes. The market will stagnate, and operating efficiency will be compromised as result. As small and medium-housing takes the majority of the rigid demand for housing in the Chongqing housing market, and the phenomenon still exists that demands for small and medium-housing exceeds supply. From the perspective of demand and supply, it seems obvious that we should increase the housing supply of middle-and-low class, but from the filtering effect of housing market, low-class housing can be supplied by the middle-class housing. So Chongqing government should consider lowering the limits for construction areas which will accumulate the downward filtering of middle-class housing and then make public rental housing more available. To speed filtering, the government should also control the development scale of public rental housing. All of these measures will contribute

to the whole housing market development (Wang, Sun, & Hao, 2012).

4.3 Proportion analysis of the supply model of public rental housing based on housing filtering theory

To achieve sustainable supply in public rental housing, there is a pressing need to focus on how to allocate the proportion between the supply model of new housing and the supply model of purchasing second-hand houses to realize welfare maximization for middle and-low income families. The same means as realizing the maximum number of the tenants. We discuss the topic on the basis of some consumption and Chongqing's supply plan of the public rental housing. By analyzing price changes of commercial housing and second-hand housing in recent years in Chongqing,  $R_1$  (the increased ratio of commercial housing's price) and  $R_2$  (the increased ratio of second-hand housing's price) can be calculated (shown in Table 4).

$$R_1 = (16.98\% + 19.8\% + 7.8\% + 39.1\% + 13.31\% - 0.23\%) / 6 = 16.12\%$$

$$R_2 = (2.97\% + 10.28\% + 3.1\% + 11.13\% + 46.16\% - 1.28\%) / 6 = 12.06\%$$

By December 2012, the scale of Chongqing's public rental housing reached 36.6162 million square meters, 580,700 units in total. Among that, the construction that have been finished reached  $6.5954 \times 10^6$  m<sup>2</sup>, 112,900 units in total. Take the construction which has not start for example, the number of units to be constructed will reach 49,700 in proportion to the area of  $3.3838 \times 10^6$  m<sup>2</sup>. Comparing with the Min Xin Jia Yuan whose total investment is 3.2 billion, with the scale of  $1.08 \times 10^6$  m<sup>2</sup>, the government have to finance 10.026 billion for the public rental housing to be constructed at the same market price, and it have to inject 6.016 billion after taking away the land cost and tax which take up 40% totally. Table 5 is calculating table of proportion of multiple supply model of Chongqing's public rental housing.

List the equation set:

**Table 4**

*Calculating Table of the Increase Rate of the New Commercial Housing and Second-Hand Housing's Price in Chongqing Downtown Area*

Year	Average price of new commercial housing (yuan per square meter) gross floor area	$R_1$	Average price of second-hand housing (yuan per square meter) gross floor area	$R_2$
2006	2,697		3,976	
2007	3,155	16.98%	4,094	2.97%
2008	3,998	19.80%	4,515	10.28%
2009	4,310	7.80%	4,655	3.10%
2010	5,994	39.10%	5,173	11.13%
2011	6,792	13.31%	7,561	46.16%
2012	6,775	-0.25%	7,464	-1.28%

**Table 5**

*Calculating Table of Proportion of Multiple Supply Model of Chongqing's Public Rental Housing*

	Formula	The meanings of functions	Values
Funds planned to be injected by the government	$I = I_1 + I_2$		6.016 billion
Funds need to be injected under supply model of constructing public rental housing	$I_1 = P_1(1 - K)(1 + R_1) \times S \times N \times X_1$	$P_1$ Average price of newly-built public rental housing per gross floor area	3,150
		$K$ Ratio of land cost and tax to housing price	40%
		$R_1$ Ratio of incremental price of newly-built commercial housing	16.12%
		$S$ Average rental area (of public rental housing)	40
		$X_1$ Ratio of the supply model of constructing new public rental housing to total supply	$X_1$
		$N$ Number of tenants of public rental housing	49.7 thousand
Be injected under supply model of purchasing housing	$I_2 = P_2(1 + R_2) \times S \times N \times X_2$	$P_2$ Average price of purchased second-hand housing per gross floor area	7,464
		$R_2$ Ratio of incremental price of second-hand housing	12.06%
		$X_2$ Ratio of supply model of purchasing second-hand housing to total supply	$X_2$

**Table 6**

Calculating Table of Distribution Proportion of Multiple Supply Model of Chongqing's Public Rental Housing

	Distribution proportion of extremes		Judgment for $I$	Evaluation
Supposing 1	$X_1 = 0$	$X_2 = 1$	$I = 1937139 > 601600$	Coincident with filtering theory; Welfare level comes to maximization but limited by funds; Not practical
Supposing 2	$X_2 = 0$	$X_1 = 1$	$I = 508285 < 601600$	Not coincident with filtering theory; Welfare level is relatively high but limited by funds; Not practical
Solutions	$X_1 = 93.47\%$	$X_2 = 6.53\%$	601600	Coincident with filtering theory; Integrated welfare level comes to maximization

$$508285X_1 + 1937139X_2 \leq 601600$$

$$X_1 + X_2 = 1$$

Solutions to the equation set are as Table 6.

Considering the development of the entire real estate market based on the filtering model, and focusing on maximizing the welfare level of public rental housing, the optimal proportion distribution is: the supply model of constricting new public rental housing provide 93.47% for the housing market, while the supply model of purchasing housing provide 6.53%. The two models then provide the rest public rental housing of 3.3838 million square meters together.

## 5 Conclusions

This paper is from the perspective of economics, makes a selection of supply model based on housing filtering theory and the current situation of Chongqing public rental housing and housing market, further it works out the proportions for different models, and concludes as follows. Problems arise frequently in the public rental housing projects supplied by Chongqing government, which brings great danger to the sustainable supply of public rental housing. Meanwhile, combined with the supply failing to meet the demands in current housing market in Chongqing and an unbalanced supply and demand structure, contradictions between supply and demand are sharpening with the accelerated urbanization and increasing housing price. However, the vacancy rate is high, and second-hand housing markets are undeveloped. So taking effective supply model of public housing can accelerate the filtering of the housing market, and help the implementation of the public rental housing. By calculating the proportion of the supply model, we make it sure that the optimal proportion distribution combination, the supply model of constructing new public rental housing make up the model of market housing 93.47%, and the supply model of purchasing housing provide 6.53%.

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