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Evaluation and Optimization of the Financial Sustainability of Public Rental Housing Projects: A Case Study in Nanjing, China

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Academic Editor: Thorsten Schuetze
Received: 28 October 2015; Accepted: 1 April 2016; Published: 5 April 2016

Abstract: In recent years, Chinese governments have launched ambitious plans in developing public rental housing (PRH), which are almost impossible to accomplish without the involvement of the private sector. Yet, very few quantitative studies have been carried out to evaluate the financial sustainability of PRH projects in China, especially from the perspective of the private sector. This knowledge gap is bridged through the evaluation of the financial sustainability of a hypothetical privately owned PRH project in Nanjing, China as a case study, utilizing data of a state-owned PRH project and the classic discounted cash flow method. The results indicate that the studied project is financially infeasible, which means that private companies would not be willing to participate in the provision of public rental housing, if they merely focus on profits. Then, the most cost-effective optimization measure of the studied case is quantitatively selected from four possible optimization scenarios, leading to a financial balance. This paper presents the current financial status of Chinese PRH projects, thereby providing policy makers with useful references to effectively accelerate the private sector's provision of PRH in China.

Keywords: public rental housing; affordable housing; private sector; financial sustainability; optimization scenario; China

1. Introduction

It is well known that Chinese governments abolished their welfare housing policies and initiated the market-oriented urban housing provision system reform in 1998. Since then, most urban households have been required to satisfy their accommodation needs through the commodity housing market, and are no longer able to rely on their working units (*Danwei* in Chinese). At the same time, China's traditional affordable housing system was created, consisting of the Economical and Comfortable Housing (ECH) program, the Housing Provident Fund (HPF) program, and the Cheap Rental Housing (CRH) program [1]. Among them, ECH was developed for urban lower-middle and middle-income families, and CRH was built for the poorest urban households. HPF is a compulsory housing savings program under which both employers and employees are required to contribute a certain percentage of the employees' wages to a fund for the latter's future house purchase [2]. The significance of this traditional affordable housing program is notable. For example, about 429 million m^2 of ECH had been sold nationwide between 1998 and 2010.

However, there are several shortcomings in China's traditional affordable housing system. First, the nationwide scale and effects of ECH are both limited, because the number of ECH units sold was

only about 6% of that of contemporary commodity housing units sold from 1998 to 2010. Second, some wealthier households can purchase and resell ECH illegally, pushing both construction standards and prices of ECH beyond the reach of lower-middle and middle income families [1]. Third, the availability of CRH is very low, and thus few people could benefit from it. Along with China's booming price in the commodity housing market in recent years, housing shortages have become pressing socio-economic issues, particularly for those who can neither afford commodity housing nor meet the eligibility requirements for traditional affordable housing [3].

To address the aforementioned housing problems and improve the Chinese traditional affordable housing system, as well as to stimulate economic growth, a new affordable housing program entitled Public Rental Housing (PRH) was proposed officially by then-Premier Wen Jiabao's "Report on the Work of the Government" at the Second Session of the Eleventh National People's Congress on 5 March 2009. Since Wen's announcement, PRH has been assigned as the very core of China's new affordable housing system in several official documents such as the National 12th Five-Year Plan (2011–2015). In December 2013, the Chinese central government officially announced the merging of CRH into PRH starting 2014. As a result, ambitious plans for the development of PRH have been rapidly devised by the central government and many local governments. For instance, the Henan provincial government promised to merge CRH into PRH and cover the indemnified targets of ECH by PRH since 2014, in order to house 20% of the urban population in the whole province with PRH. Similarly, in February 2015, the Beijing municipal government announced the abolishment of ECH and the development of PRH starting in 2016. In recent years, nationwide PRH projects have been carried out by local governments with subsidies from the central government, resulting in evitable and evident government failure (e.g., huge fiscal burden and low supply efficiency) [4]. In fact, Chinese governments are well aware of this situation, and have issued several preferential policies to accelerate the private sector's participation in the provision of PRH since 2009 [5].

Unfortunately, except a few private real estate developers that have participated in PRH projects as agents, most of the private sector in China is unwilling to develop and own PRH projects, with the main reason being the fear of the financial unsustainability of such projects [6,7]. Is this fear rational or not? If yes, what measures should be taken to optimize the financial status of PRH projects from the perspective of the private sector? Furthermore, which measure is the most cost-effective? These urgent topics are to be discussed in this paper through a case study of a PRH project in Nanjing city, the capital of Jiangsu province in eastern China. The rest of this paper is organized as follows. To begin, recent studies concerning the private sector's provision of affordable housing in both developed countries and developing countries (including China) are reviewed, followed by the section where basic information of the studied project is described. Then, its financial sustainability is evaluated with profitability and debt-repayment ability indices, from the perspective of the private sector. In the section that follows, four possible scenarios to optimize the financial sustainability of the studied project are proposed and compared, and the most cost-effective one is selected. The last section concludes this paper with policy suggestions and possible future works.

2. Literature Review

In recent years, many developed countries have reduced governments' direct provision of PRH while increasing the private sector's provision in this regard, such as the U.S., the U.K., the Netherlands, and Ireland. Many researchers have paid close attention to this trend and analyzed its reasons, effects and/or influences. For instance, one of American HOPE VI's objectives is promoting the mixed-finance partnerships between public, private and non-profit sectors, through a case study in Louisville, Kentucky [8]. Recent Irish experiences in increasing private sector provision of social housing with the aid of housing allowances are assessed [9]. The controversial use of the Private Finance Initiative (PFI) as part of the Labour Government's Decent Homes program in the U.K., namely the transformation of social housing from the "public housing model" of the welfare state era to the "social housing model" of today is addressed [10]. The factors which affect the market orientation of semi-public

service organizations in their transition from public to private are explained with a case study in Dutch housing associations [11]. Italian housing policies have shifted from central state provision towards a multi-level local governance organized into partnerships between regions, municipalities, third-sector and private investors since the turn of the new millennium [12]. The changing roles of private not-for-profit housing associations in English and Dutch housing provision are also explored, revealing that aspects of the work and identity of housing associations shift between public and private domains [13].

Several developing countries (such as India, Nigeria, and Malaysia) have also attempted to provide PRH for low-income populations through the private sector, which has been discussed ardently in recent years. For example, the contradictions in enabling private developers to provide affordable housing are examined through a case study in India [14]. The contribution of Public-Private Partnerships (PPP) in improving accessibility of low-income earners to housing in Nigeria is evaluated, suggesting that government provision of land to private developers at zero cost and lowering the high building standards will ensure better results [15]. A case study on the contribution and challenges of the private sector's participation in housing in Nigeria is undertaken, indicating that such participation has the potential for improving housing delivery [16]. The role of the private sector's participation in housing development for low-income households in both Malaysia and Nigeria is compared, revealing that the success of the private sector depends on the existence of a favorable socio-economic environment and of an effective institutional and regulatory framework [17]. Applying the multi-case approach and case studies, the control mechanisms used by public agencies in Malaysia under PPP arrangements to ensure private partner compliance are examined, identifying the governance archetypes which prevailed in previous PPP relationships [18]. Obtaining data through interviews and questionnaire surveys, as well as secondary data sources, a shift from a state-led public housing provision to an enabling approach did stimulate the activities of private house-builders and primary mortgage institutions in Jos, a city in north-central Nigeria [19].

In China, the necessity of accelerating the private sector's provision of PRH has also been widely recognized by a lot of scholars, though their suggested means vary. For example, a dual housing provision structure (namely PRH and commodity housing) is believed to be the future of the Chinese real estate industry, and private real estate developers should possess full property rights of PRH projects and run them [6]. Shortage in funds is declared as the biggest barrier to the development of PRH, and thus a Build-Operate-Transfer (BOT) model to promote the private sector's provision of PRH is designed [20]. A theoretical PPP financing model to attract the private sector's participation in the provision of PRH in China is proposed [21]. The applicability of three financing models, including Real Estate Investment Trusts (REITs), BOT, and Public Intermediary Private Partnerships (PIPPs) are qualitatively analyzed and compared, revealing that the private sector's provision with government subsidies is an important way to build new PRH projects [22]. A strength, weakness, opportunity, and threat (SWOT) analysis of public housing delivery by public-private partnerships in China from the perspective of the public sector is conducted, suggesting that one of the strongest hindrances is "low profits for the private sector to participate in PPP housing" [7]. Taking Beijing as a case study, the provision of PRH with the incremental upgrading of "villages in the city" are linked through the adoption of partnerships between multilevel governments, the collective organizations, villagers, migrants, the informal sector and other stakeholders [23].

From those studies, it is clear that many countries value the private sector's provision of PRH for low-income households. The necessity of promoting privately owned PRH projects in China has also been broadly identified, and a number of quantitative analyses have been carried out from the perspective of the public sector. However, the financial sustainability of PRH projects in China has rarely been evaluated from the perspective of the private sector, despite its importance amongst private developers. This knowledge gap is to be bridged through investigating the financial sustainability and optimization of a PRH project in the city of Nanjing, China.

3. The Framework

To accelerate the construction process and enhance the supply efficiency of planned affordable housing, an agent-construction system has been adopted by the Nanjing municipal government since 2010. Agent companies are usually traditional real estate developers, with rich experience in developing commodity housing and commercial buildings. They can obtain 3% in profits and 1%~2% in agent fees on the basis of total costs, which are to be completely undertaken by the government [24]. As a result, agent companies have no initiative to reduce the cost of affordable housing, and the financial condition of Nanjing's municipal government worsens with the adoption of agent-construction system, which may end up crushing the local government financially and in turn halt the provision of affordable housing. To avoid such a predicament and achieve a sustainable provision of affordable housing, especially PRH, it is urgent to explore profitable approaches of PRH projects from the perspective of the private sector, and further promote the private sector's participation in these projects.

The studied case is a small PRH project in the Daishan affordable housing zone (hereafter Daishan Zone), which is one of the four largest affordable housing zones in Nanjing. It is located in the urban-rural fringe of Yuhuatai District in southern Nanjing, covering an area of 53,546.92 m^2, which is only about 4.28% of the total residential land area in Daishan Zone. Other residential areas are mainly used for ECH and CRH projects. The building structure of the studied case is frame-shear wall, and other indices are shown in Table 1. In order to conduct the following financial sustainability evaluation successfully, some assumptions have to be made as follows.

Table 1. Indices of the studied PRH project.

Index Name		Index Value	Index Name	Index Value
Aboveground building area (m^2)	PRH buildings	203,478	Floors of PRH building	12
	Commercial buildings	10,710	Floors of commercial building	1
Underground building area (m^2)	Civil air defense works	15,800	PRH suits	3960
	Equipment storage	20,012	Parking spaces	402

(1) Although the studied case is actually built by agent companies and owned by the Nanjing municipal government, it is assumed to be built, owned and operated by a private real estate developer called L Company, with the project enjoying all PRH-related policy incentives and satisfying all PRH-related regulations (e.g., design standard, tenant selection and rent price criteria). L Company is a real private real estate developer in Nanjing interested in participating in the provision of PRH.

(2) Considering its relatively small scale, for the sake of convenience, this PRH project is assumed to be built from January 2016 through December 2017. Thus, the studied project could be available to qualified PRH tenants by January 2018.

(3) In urban China, residential and commercial building owners can only have land use rights for 70 years and 40 years, respectively. However, to reduce long-term uncertainties and be consistent between the two building types, the operation period of PRH buildings and of commercial buildings are both assumed to be 40 years. In fact, the discounted income from PRH buildings in the final 30 years does not noticeably influence the financial sustainability evaluation.

(4) PRH buildings are well decorated and furnished to attract tenants, while commercial buildings only have basic decorations.

(5) The rent of PRH flats is 70% as much as that of surrounding private rental housing flats, as decreed in *Regulations of Public Rental Housing in Nanjing City*.

(6) The rent of commercial buildings in this PRH project is the same as that of surrounding market-oriented commercial buildings, which can be estimated by market surveys and interviews.

(7) To be conservative, 90% of PRH suites, accessory commercial buildings, and parking spaces are leased at average rents. Besides, considering the level of inflation and economic growth in Nanjing, their rents are assumed to increase by 10% after 5 years.

4. Financial Sustainability Evaluation

4.1. Estimated Costs

Prior to evaluating the financial sustainability of the studied case, its construction and operation costs must be estimated first. Based on relative laws and market conditions, the cost in the construction phase has been estimated and illustrated in Table 2. It is noteworthy that the feasibility report of a government investment project in China is necessary to obtain the official approval by authorities. The feasibility report must be presented by a qualified consulting company, which generally charges 0.2%~3.0% of the total cost or 0.12~2.50 million CNY. Based on a market inquiry, the estimated cost of the feasibility study is 0.20 million CNY.

Table 2. Cost items in the construction phase.

No.	Cost Item	Amount (Million CNY)	Calculation Base
1	Land use rights	250.00	Unit price of similar land nearby
2	Pre-construction works	8.02	
2–1	Submission for approval	1.25	5 CNY per total building area
2–2	Survey and design service	5.50	22 CNY per total building area
2–3	Feasibility study	0.20	Regulations and market survey
2–4	Temporary facilities	1.07	20 CNY per land area
3	Construction and installation	375.00	
3–1	Construction works	250.00	1,000 CNY per total building area
3–2	Equipment and installation	125.00	500 CNY per total building area
4	Infrastructure facilities	48.42	
4–1	Road and sewage pipes	2.68	50 CNY per land area
4–2	Drinking water pipes	5.35	25 CNY per above ground building area
4–3	Electricity implement	25.00	100 CNY per total building area
4–4	Gas pipes	11.59	2,600 CNY per suite
4–5	Cable television system	2.14	10 CNY per above ground building area
4–6	Road lamp	0.32	6 CNY per land area
4–7	Landscape construction	1.34	25 CNY per land area
5	Expenses for other and unpredictable works	17.38	
5–1	Expenses for other works	3.75	15 CNY per building area
5–2	Expenses for unpredictable works	13.63	2% of the sum of cost item No. 1–4
6	Indirect and management expenses	20.96	
6–1	Indirect expenses	13.98	2% of the sum of cost item No. 1–5
6–2	Management expenses	6.99	1%of the sum of cost item No. 1–5
7	Financial expenses	31.53	
7–1	Loan interest	29.68	Annual interest rate (6.55%)
7–3	Other financial expense	4.60	1% of credit ceiling

From Table 2, it is clear that construction costs are estimated to be 751.32 million CNY. The costliest item is construction and installation, followed by land use rights, infrastructure facilities, and financial expenses. These four items amount to almost 94% of the total construction cost. Among them, construction and installation cost and infrastructure facilities cost are almost fixed, since they determine the quality of the studied PRH project. The cost of land use rights and that of financial expenses are about 1/3 and 4% of the total construction cost, which are significant yet changeable items. As a result, the cost of land use rights and that of financial expenses are two key items for future financial optimization.

After obtaining the estimated cost in the construction phase, the cost of this studied PRH project in its operation phase is then estimated. It comprises three components, namely running cost, loan interest, and depreciation. As regards the running cost, it mainly involves managements' wages and welfare, maintenance costs, and advertisements for accessory commercial buildings. In general terms, the annual running cost of a PRH project in China is about 3 CNY/m^2 [25]. Since the total building area of the studied PRH project is 250,000 m^2, the annual running cost of this PRH project is thus estimated at 0.75 million CNY.

To estimate the loan interests of the studied PRH project in its operation phase, the fundraising plan must be formulated beforehand. Similar to listed real estate companies in China, L Company plans to obtain a loan as much as 60% of the total investment, which is 453.28 million CNY. The equity capital, 302.18 million CNY, is mainly used to obtain land use rights and to pay pre-construction works, and the remainder is spent in the second half of the first construction year. Based on the construction schedule and other assumptions in Section 3, the investment and fundraising plan is formulated and illustrated in Table 3.

Table 3. Investment and fundraising plan (Unit: million CNY).

No.	Item	Sum	Year 2016		Year 2017	
			Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec
1	Total investment	751.32	366.14	112.25	112.25	160.68
1–1	Land use rights	250.00	250.00	0.00	0.00	0.00
1–2	Pre-construction works	8.02	8.02	0.00	0.00	0.00
1–3	Construction and installation	375.00	93.75	93.75	93.75	93.75
1–4	Infrastructure facilities	48.42	0.00	0.00	0.00	48.42
1–5	Miscellaneous and unpredictable works	17.38	4.34	4.34	4.34	4.34
1–6	Indirect and management expenses	20.96	5.24	5.24	5.24	5.24
1–7	Financial expenses	35.67	8.91	8.92	8.92	8.92
2	Raising fund	751.32	365.88	158.55	112.25	114.39
2–1	Equity capital	264.41	258.02	6.39	0.00	0.00
2–2	Loan fund	486.91	112.25	101.73	112.25	160.68

The last component of estimated cost in the operation phase is depreciation, which directly influences the payback period and profit. However, it is noteworthy that the depreciation would not be included as a negative cash flow in the Net Present Value (NPV) calculation. Since PRH buildings and accessory commercial buildings of the project are both for rental purposes, the depreciable asset equals the whole project and the depreciation base equals the original value of fixed assets, namely the estimated investment in Table 3. The minimum depreciation period of the project is 20 years, according to *Regulation on the Implementation of the Enterprise Income Tax Law of P. R. China*, effective since 1 January 2008. Since the operation periods of PRH buildings and accessory commercial buildings are both assumed to be 40 years, so should the assumed depreciation period of the studied case. The residual value rate is another compulsory parameter, which is determined as 5% in *Notice of the State Administration of Taxation on Strengthening Administration on the Repealed Items of Enterprise Income Tax Administrative Examination and Approval*, effective since 18 June 2003. In line with *Regulation on the Implementation of the Enterprise Income Tax Law of P. R. China*, a straight-line method is adopted to calculate the annual depreciation as 17.84 = (751.32 $\times$ (1 $-$ 5%)/40) million CNY.

4.2. Estimated Income

According to Section 3, the studied case has three sources of income, namely PRH buildings, accessory commercial buildings, and parking spaces. Since the building area and operation period of PRH buildings have been determined (see Table 1), the main task of estimating the income generated through PRH buildings is to forecast the unit rent, which is prohibited to exceed 70% of the market level, as indicated in Section 3. Thus, the rental level of the surrounding private housing flats is vital for estimating the income of the studied PRH buildings.

Few private rental housings are found next to the studied case, since it is built at the urban-rural fringe, as indicated in Section 3. By expanding the radius gradually, about 60 flats in private rental housing are found within a radius of 2 km. Among them, 28 flats are quite similar to PRH flats of the studied project in many aspects, such as building area per flat, decoration standard, and surrounding infrastructures. The average monthly rent of these 28 flats is 15.01 CNY per building area. As a result, the average monthly rent of the studied PRH is about 10.51 (=70% $\times$ 15.01) CNY per building area,

and the income of the studied PRH buildings in the first year can be estimated as approximately 23.10 million CNY. Considering the assumption in Section 3 that the rent of PRH buildings would increase by 10% after 5 years, the annual rent of the studied PRH buildings from 2021 to 2025 would become 25.41 million CNY. Likewise, the annual rent of the studied PRH building in the following 30 years could be estimated. The total revenue from rental income for the studied PRH buildings in 40 years would be about 1.32 billion CNY.

Similar to the estimation of the income from PRH buildings, the monthly rent per building area is the starting point to estimate the income from accessory commercial buildings. Since comparable commercial buildings next to the studied case cannot be found, the survey radius is expanded to the whole Yuhuatai District, in which the monthly rent per building area varies from 40 CNY to 136 CNY with an average of about 100 CNY. Therefore, the monthly rent per building area of those commercial buildings under study is assumed as 100 CNY. Then, incomes generated by those commercial buildings in the first year and in the whole 40 years are 9.29 million CNY and 531.08 million CNY, respectively.

Likewise, the monthly rent per parking space can be predicated as 400 CNY, based on the assumptions in Section 3 and market survey. Then, incomes generated by those parking spaces in the first year and the whole 40 years are 1.74 million CNY and 99.30 million CNY, respectively. The total income of the studied project in the first year and in the whole 40-year period, can therefore be estimated at 34.12 million CNY and 1.95 billion CNY, respectively.

4.3. Estimated Tax Deduction

Besides the estimated cost, three types of taxes are required to be paid in the operation phase of the studied PRH project, namely transaction tax, income tax, and value-added tax. Since all PRH buildings, commercial buildings and parking spaces of the studied project are only for rental purposes, there would be no payable value-added tax. All required tax forms and their tax amounts are presented in Table 4. With regard to tax deduction for PRH, they are calculated in light of *The Note of Preferential Tax Policies on Supporting Public Rental Housing's Construction and Operation*, issued by the Ministry of Finance and State Tax Administration of the P. R. China in September 2010. However, it should be noted that tax deduction policies are only applicable to PRH buildings but not to accessory commercial buildings and parking spaces.

In fact, many central government institutions have either individually or jointly promulgated other preferential policies in various areas, such as land acquisitions, bank loans, corporate bond issuances, and investment grants [5]. Nonetheless, these preferential policies are often too general and difficult to be implemented. Some provincial/city level governments have also issued their own preferential policies to promote private sector provision of PRH, such as the agent-construction system in Hangzhou, municipal-level tax reduction in Jinan, rental subsidies in Zhengzhou, free land supply in Chongqing *etc*. [5]. Since the studied PRH project is located in Nanjing, where agent-construction has recently been issued, only tax deduction policies of PRH buildings in the studied project are considered (other preferential policies are to be referred to as possible options for future optimization).

From Table 4, it is clear that total transaction tax in the operation phase significantly decreases from about 256.63 million CNY to about 117.71 million CNY, which constitutes a 54.13% reduction. Since the income tax is based on net income and thus is negatively correlated with transaction tax, it increases by about 26.84 million CNY (or 15.95%). As a whole, the amount of tax reduction is about 112.07 (=138.91 − 26.84) million CNY or about 550.79 CNY per PRH building area, which is over 1/3 of the unit cost of construction and installation (Table 2). That is to say, the total and unit tax reduction are both notable. The following question can then be asked: Is the studied case financially feasible with such a tax reduction? This is to be explored in the next section.

Table 4. Tax amount before and after reduction.

No.	Tax Denomination	Basis	Tax Rate	Tax Deduction for PRH Buildings	Tax amount (Million CNY)	
					Before Deduction	After Deduction
1	Transaction tax				256.63	117.71
1–1	Business tax	Turnover	5%	5%	97.55	31.52
1–2	City maintenance and construction tax	Business tax	7%	7%	6.83	2.21
1–3	Education surtax	Business tax	3%	3%	2.93	0.95
1–4	Land use tax	Land area	7 CNY/m^2	7 CNY/m^2	18.90	6.11
1–5	Building tax (for residence)	Building value	4%	4%	52.83	0.00
1–6	Building tax (for operation)	Rent income	12%	0	75.65	75.65
1–7	Stamp tax	Business income	0.05%	0.05%	0.98	0.32
1–8	Transaction service charges	Business income	0.05%	0	0.98	0.98
2	Income tax		25%	0	168.29	195.13

5. Evaluation Indices and Results

After estimating the cost and income of the studied PRH project, the corresponding financial feasibility evaluation indices, which mainly include profitability evaluation indices and debt-repayment ability evaluation indices, can then be calculated. Based on these indices, the financial feasibility of the project can thus be assessed.

The profitability evaluation indices of a construction project can be divided into two categories: (1) static evaluation indices; and (2) dynamic evaluation indices [26]. The latter is calculated on the basis of discounted cash flow, while the former is computed on the basis of undiscounted cash flow statement and income statement. Subsequently, some important parameters are obtained, such as total profit (369.34 million CNY) and after-tax profit (179.63 million CNY). The static profitability evaluation indices can then be calculated, which are shown in Table 5. Because the return on investment is very high, this studied PRH project seems rather attractive to the private sector. However, the annual return on total investment is smaller than the on-going risk-free rate of interest, e.g., the annual interest rate of a five-year period term deposit, which is 4.75% since 5 July 2012. In other words, the private sector will obtain less profit from investing in PRH than from depositing in banks. These results render private developers in a difficult situation as to whether they should be involved in the provision of PRH or not. In this case, when the time value and the discounted cash flow of this project are factored in, what will the profitability evaluation results look like?? Is this studied case attractive for private developers or not?

Table 5. Profitability evaluation indices.

Static Profitability Evaluation		Dynamic Profitability Evaluation	
Indices	**Value**	**Indices**	**Value**
Payback period of total investment (year)	34	Dynamic payback period of total investment (year)	NA
Return on total investment (%)	49.16	NPV of total investment (million CNY)	−371.04
Annual return on total investment (%)	1.23	IRR of total investment (%)	3.97

To obtain the dynamic indices of profitability evaluation of the project, the hurdle cut-off rate is needed. There are four recommended mainstream methods to predict the hurdle cut-off rate, including the Capital Asset Pricing Model (CAPM), the Weighted Average Cost of Capital (WACC), the Typical Projects Simulation Method (TPSM), and the Delphi method [26]. Since only a few PRH projects are developed by private developers in Nanjing, CAPM and WACC, as well as TPSM, they do not seem applicable here. Thus, the Delphi method is considered the most suitable. Based on interviews with five experts and two conductors from the private sector, 10% is determined as the hurdle cut-off rate of the project, taking into account the inflation level, opportunity cost, interest rate of term deposit,

and other factors. With this parameter, the dynamic profitability evaluation indices can be computed and also shown in Table 5. It is clear that the dynamic payback period of total investment is "NA (Not Available)". In other words, the total investment cannot be recovered in 40 years. In addition, the NPV of total investment is significantly negative, once again proving that this PRH project is not financially feasible. Finally, the Internal Rate of Return (IRR) of total investment is much lower than the hurdle cut-off rate. The dynamic profitability evaluation suggests that this studied PRH project is not financially feasible, and thus is not attractive to the private sector.

As regards to the debt-repayment ability, there are several evaluation indices, such as Interest Coverage Ratio (ICR), Debt Service Coverage Ratio (DSCR), Loan of Asset Ratio (LOAR), and Loan Repayment Period (LRP) [27]. Since all loans of this project are obtained from local commercial banks, no foreign investment is involved. Hence, only LRP is necessary [27], which can be calculated with the following equation:

$$\mathrm{I_d} = \sum_{t=1}^{LPR} R_t \quad (1)$$

where I_d is the sum of principal and interest, and R_t is the repayment capital at year t.

From Table 3, it is clear that 179.93 million CNY and 270.86 million CNY will be borrowed from local commercial banks in year 2016 and in year 2017, respectively, with an annual interest rate at 6.55%, as shown in Table 2. The capital for repayment derives from undistributed profits and depreciation, and the method of maximum capacity in repaying principal and interest is adopted [27], since L Company wants to repay the loan (thus reducing the debt) as quickly as possible. Regarding the undistributed profit, it is the total after-tax profit subtracted by statutory surplus reserve and statutory welfare reserve. According to China's tax laws, both statutory surplus reserve and statutory welfare reserve are not payable unless the undistributed profit is positive, as they are 10% and 5% of the undistributed profit respectively. As for depreciation, its annual value is 17.84 million CNY (see Section 4.1). The statement of the repayment of both principal and interest can then be drawn, which shows that the LRP is 34.39 years. After an interview with two conductors of L Company, this LRP is unacceptable, because the operation phase is only assumed to be 40 years. Moreover, as illustrated in Table 5, the project is not profitable from the perspective of the private sector. It must therefore be optimized if it is to attract private sector participation.

6. Financial Sustainability Optimization of the Studied Case

6.1. Selecting Optimization Options

There are many factors affecting the evaluation of a project's financial sustainability, mainly involving its costs, incomes, and taxes. Because tax deduction has been considered and taxation is levied on the basis of current laws, rates of relative taxes are essentially fixed. Therefore, taxes are not the focal point in the optimization process. Furthermore, since the overall static evaluation indices of this project are quite attractive, as shown in Table 5, while all the dynamic evaluation indices are unsatisfactory, time value is found to be a key factor in determining the evaluation of its financial sustainability. As a result, cost reduction and income maximization as soon as possible should be the direction towards optimization.

As indicated in Section 4.2, the income of the project is derived from its PRH buildings, accessory commercial buildings, and parking spaces. As regards commercial buildings and parking spaces, their market prices are adopted and their amounts are restricted according to its planning control document. Concerning the PRH buildings, the total building area is also fixed by the planning control document. The only optimization measure is thus through the adjustment of the rent of PRH buildings to market level with local government's housing allowance to subsidize the difference between preferential rent and market rent.

To optimize the financial sustainability of the project through cost reduction, the cost in the construction phase should be emphasized, since they are spent earlier. Owing to the findings in

Section 4.1, the cost of land use rights and financial expenses in the construction phase are two key items for future financial optimization. As for the cost in the operation phase, only running cost, loan interest, and depreciation are taken into account. Among them, since the depreciation is essentially fixed under current laws and the running cost is too small, the financial expense (*i.e.*, loan interest) becomes another alternative for possible optimization.

In summary, there are three possible optimization measures, including (1) adjusting the rent of PRH buildings to market level with local government's housing allowance; (2) reducing the cost of land use rights; and (3) reducing the life-cycle financial expenses. In fact, these three optimization measures have been applied to a certain degree by some local governments of China, as mentioned in Section 4.3. Each measure leads to one scenario, while the fourth scenario is the combination of these three measures. The optimization effects of these four scenarios are to be examined and compared in the following section.

6.2. Assessing Optimization Results

(1) *Scenario I:* It allows L Company to increase the PRH rent to market level with the local government's subsidies to offset the difference. In this situation, the total amount of subsidies received in 40 years when pre-discounting is estimated to be 565.45 million CNY; post-discounting is estimated at 93.11 million CNY. The optimization results of Scenario I indicate that the NPV is −287.09 million CNY and thus the project is still financially infeasible from the viewpoint of dynamic profitability (Table 6). As a result, in order to make this project financially feasible, the local government should provide at least 380.20 (=93.11 + 287.09) million CNY in subsidies to L Company in the year 2016 (or equivalence in time value).

(2) *Scenario II:* In this situation, the cost of land use rights is reduced to zero and the necessary equity capital is spent equally in 2016. Hence, the received subsidy is equal to the cost of land use rights. The optimization results of Scenario II (Table 6) indicate that the studied project is still financially infeasible from the perspective of dynamic profitability. To make the NPV positive, at least 374.00 (=250.00 + 124.00) million CNY in subsidies should be provided by the local government in the year 2016(or equivalence in time value).

(3) *Scenario III:* The local government is to pay all the life-cycle finance expenses of this project on behalf of L Company. The overall finance expense pre-discounting is 751.32 million CNY and post-discounting is 251.01 million CNY. The optimization results of Scenario III show that the project, similar to Scenarios I and II, is financially infeasible (Table 6). Under these circumstances, in order to make this project financially feasible, the local government should provide at least 511.02 (=260.01 + 251.01) million CNY in subsidies to L Company in the year 2016 (or equivalence in time value).

(4) *Scenario IV:* It is the combination of the above three scenarios. Therefore, the total amount of pre-discounting subsidy is 1,566.77 million CNY and that of post-discounting subsidy is 594.12 million CNY. Comparing the different optimization results shown in Table 6, it is obvious that Scenario IV is the best among all four scenarios, and static profitability evaluation indices seem rather attractive. However, this studied PRH project is still not financially feasible from the perspective of dynamic profitability. To make the studied project financially feasible, at least 618.28 (=594.12 + 24.16) million CNY in subsidies should be provided in the year 2016 (or equivalence in time value).

Comparing the amount of subsidies involved in each scenario, it is obvious that Scenario II is the most cost-effective. Indeed, it is also the simplest and most operational scenario, since the other three scenarios are comparatively more time-consuming and ineffective. As a result, the measures optimizing the financial status in Scenario II are advised to eliminate the fear of the financial unsustainability for the private sector. In other words, it is recommended that the Nanjing municipal government provide

free land use rights and 374.00 million CNY in subsidies to L Company in the year 2016, in exchange for L Company's involvement in the development and operations of the studied PRH project.

Table 6. Optimization results of four scenarios.

	Indices	Scenario I	Scenario II	Scenario III	Scenario IV
Static profitability indices	Payback period of total investment (year)	20.42	25.68	25.47	20.02
	Return on investment (%)	423.51	253.35	156.13	424.35
	Annual return on total investment (%)	10.59	6.33	3.90	10.61
Dynamic profitability indices	Dynamic payback period of total investment (year)	NA	NA	NA	NA
	NPV of total investment (million CNY)	−287.09	−124.00	−260.01	−24.16
	IRR of total investment (%)	5.45	6.87	4.06	9.40

7. Conclusions

This paper has evaluated the financial sustainability of a Public Rental Housing (PRH) project in Nanjing from the perspective of the private sector, based on the estimation of its costs, incomes, and tax deduction. The results obtained from the dynamic profitability evaluation indices show that the project is financially infeasible, although the results from the static profitability evaluation and the debt-repayment ability evaluation seem rather attractive to the private sector. Through analyzing the significant influencing factors of costs and incomes, three optimization options and corresponding four optimization scenarios have been proposed. From the perspective of cost-effectiveness, the optimization scenario with free land use rights and a subsidy of 374 million CNY in the first year (or equivalence in time value) is strongly recommended.

The evaluation results of this studied PRH project represent actual financial situations and corresponding development predicaments of countless PRH projects in China. First, the widely adopted agent-construction system has proved ineffective in controlling the costs of PRH projects, although this system can attract the private sector's involvement. The privately owned mode is suggested, because the private sector is interested in controlling the total cost of PRH projects now. In addition, this mode will tap into the expertise of the private sector (especially private real estate developers) in building and operating residential communities. Second, common PRH projects are financially infeasible under the present preferential policies, and thus cannot effectively attract the for-profit private sector. To improve this situation and accelerate the development of privately owned PRH projects in China, more preferential policies and greater efforts are required. Since the static profitability indices are attractive and problems exist in dynamic profitability indices, time value proves to be the key influencing factor. The effects of preferential policies will therefore be greater when they are implemented earlier. The most cost-effective optimization measure of the studied case is to provide free land use rights with additional subsidies at the beginning. A comprehensive concession contract is the prerequisite that guarantees the involvement of the private sector in the development of the PRH project (as a privately owned one), enjoying all PRH-related preferential policies and observing whole PRH-related regulations. Third, new valuation methods should be constructed for privately owned PRH projects, since the private sector may obtain option premiums from uncertainties and corresponding management flexibility, which cannot be taken into account in traditional financial feasibility evaluation methods on the basis of discounted cash flows. Therefore, constructing a real option-based valuation model for privately owned PRH projects is a possible direction for future research.

Acknowledgments: This research is jointly supported by National Natural Science Foundation of China (No. 71301024), Ministry of Education of the People's Republic of China (No. 20120092120019 & No. 15YJC790067), Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD) and the Fundamental Research Funds for the Central Universities. Authors would like to thank Mr. Cao Yi, a bachelor's student of Southeast University, for his help in data collection and primary analysis.

Author Contributions: Author Dezhi Li contributed the largest part to this work, including the methodology and writing; Author Yanchao Chen contributed to case study; Author Hongxia Chen contributed to literature

review; Author Eddie Chi Man Hui contributed to linguistic check and modification; Author Kai Guo contributed to data collection.

Conflicts of Interest: The authors declare no conflict of interest.

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