A R T I C L E

The affordability of owner occupied housing in Beijing

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Abstract Facilitating home ownership and providing more affordable housing has received considerable attention in urban China. However, it remains a challenge to develop better measurements of affordability due to the income disparity and housing inequality in Beijing. In this study, a new measure of affordability is defined by residual income. Therefore, a minimum required budget for a family to purchase a "standard" unit is deduced by accounting for the basic necessities and financial loans. This paper also discusses the deficiencies of the implemented "Economic Housing Plan" on bridging the housing affordability gap.

Keywords Housing affordability · Low- to medium-income household · Residual income · Economic housing plan · Beijing · China

1 Introduction

China's housing policy, like that of most countries, has focused primarily on issues of affordability. In part, this emphasis is a product of the transformation from the old housing allocation system to a market-oriented system. But even more fundamentally, it results from the sustained inequities in housing quality along with the overt disparity in income in China. There is legitimate concern that disparities in the availability of adequate housing will intensify problems of urban poverty, and will widen the gaps of economic and social stratification (Wang 2003).

Housing affordability has long been an important part of the Chinese government's policy agenda. The government's "Economic Housing Plan" started in 1995. The objective of this program was to help medium- and low-income households to become homeowners

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by providing housing at reduced cost. As opposed to "commercial" housing, which is traded in the unsubsidized market, "economic" housing is subsidized by local government. Although the price of economic housing is lower than that of commercial housing, it is still too expensive for most medium- and low-income families (Wang 2000), and the rate of home ownership in these income groups is still very low.

Ineffectiveness of the government's affordability policies has a complex set of institutional and economic causes (See, for example, Rosen and Ross 2000; Wang 2000), but it has become increasingly clear that the affordability policy has not successfully brought house prices within reach of the targeted income groups (Sun 2004; Duda et al. 2005). A better understanding of the effective demand of medium- to low-income households should be a focal issue to further modify the affordability policy. This is the main objective of this study, which aims to measure the magnitude of housing affordability. The issue we focus on here is the household affordability of purchasing a new commercial apartment in Beijing. We research question is whether the medium- to low-income family in Beijing has sufficient income to afford an apartment defined by the minimum social standard according to their income, borrowing ability and current housing wealth. Furthermore, we highlight the deficiencies of the implemented "Economic Housing Plan" based on the new approach applied in this study.

Housing affordability is not a simple question of comparing house prices to family income. Affordability is a complicated concept that is difficult to define because it is influenced by the subjective values and differing social expectations of consumers. It is further challenged by the large disparities in family income and in housing quality in urban areas. In this context, the traditional measure of affordability, which is the ratio of aggregate income to house price, might lead to measurement errors that distort the targets of public policy and the evaluation of performance in an effort to achieve those targets. In this study, we develop the "residual income" concept of house affordability in Beijing. We identify a "standard" unit with minimum required attributes, whose value is calculated using a hedonic price equation. We then estimate the minimum budget requirement that will allow a household to afford this standard unit, considering the cost of non-housing necessities and the costs of financing. Comparing actual average family income to the minimum required budget, we estimate housing affordability for moderate- to low-income families. Therefore, in our proposed model, housing affordability is defined not only in terms of family income. It is defined by an analysis of the multiple determinants of demand: income; borrowing ability; non-housing costs; and current housing wealth.

In this study, our definition of affordability considers acquisition costs including down payment requirements and mortgage debt service. Therefore, our focus is restricted to owner-occupied housing. Households that have limited income or are unwilling to buy an apartment may view affordability as being determined by the terms of available rental contracts. The relationship between rents and income levels is crucial to capturing the full picture of housing affordability, since the sales market and rental market are both important segments of the housing market. Yet, the rental dimension of the market is usually disregarded in Chinese studies. One reason for this situation is that public policy is focused on encouraging home ownership (State Council 1998). In this paper as well, we focus on the sales market, since information on tenant performance is limited. However, the theory used in this study can be extended to the rental market.

This paper is organized as follows. Section 2 considers the background of housing reform in Beijing. In Sect. 3 we review conceptual issues associated with the definition of housing affordability and its measurement, and in Sect. 4, we describe the methodology used in this paper. Section 5 presents empirical results from the hedonic pricing model and

our estimates of house affordability in Beijing. Section 6 concludes the paper with some remarks on future research directions.

2 Background: housing reform in Beijing

Beijing, China's capital city, has one of the most important housing markets in China. This market has been highly active in public housing privatization, and it has provided an example to the rest of China through the national "Economic Housing Plan" started in 1998.

In the economic reforms in the 1990s in China, the acute conflict between the old housing welfare system and marketization was recognized as the most important problem of urban housing reform.[1] In order to strengthen the role of the real estate sector and make it an effective driving force for nationwide economic development, since 1979 the central government has vigorously promoted the sale of existing public-sector housing to existing tenants. Tenants in the public sector are encouraged to purchase housing through the "Housing Provident Fund", which accepts deposits directly from the tenant's employer for the purpose of buying, building, or improving the employee's home. Certain policies are designed to offer public housing to the tenant at reduced cost; the tenant can then either purchase the property at its direct construction cost or purchase it at a "standard price" determined in accordance with the buyer's income and years of employment. Local governments and particular work units are given the right to influence pricing. As a consequence, over 2.8 trillion RMB in housing equity was transferred from the state to the private sector (China Economic Insight 2004). Over 80% of allocated public housing was privatized by the end of 1998.

Because of its large number of state-owned enterprises, institutes, and government departments, Beijing experienced more public housing privatization than any other Chinese city. Besides, there are large staffs in Beijing working in central or ministry-level units and they often received better housing and more subsidies than did municipal or lower-level working units elsewhere (Huang 2004). From 1949 to 1998, more than half of the total fixed investment in Beijing was in state-owned enterprises and more than 63% of the housing stock was held by work units, especially central-level work units (NBSC 2000). As a consequence of public housing sales, the housing tenure structure in Beijing changed rapidly; by the year 2000 the ownership rate in Beijing had increased to 55.12% from 30% in 1992 (BSB 2005a).[2] Despite these sweeping changes, many observers (see Zhang 2000; Wang 2000) argue that those housing inequalities in Beijing continue and might even be more serious than before. This is because the households who were able to purchase publicly held housing at a discount are better off than those who were not able to buy public housing. They can use their public homes to protect themselves from rent increases or to obtain the financing needed to enter the more expensive commercial housing market.

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[1] More discussion on the motivation for the housing reform can be found in Wang 2000 and in Rosen and Ross 2000.

[2] According to Beijing Statistics Bureau, the ownership rate was 67.4 and 73.6%, respectively, in year 2003 and 2004.
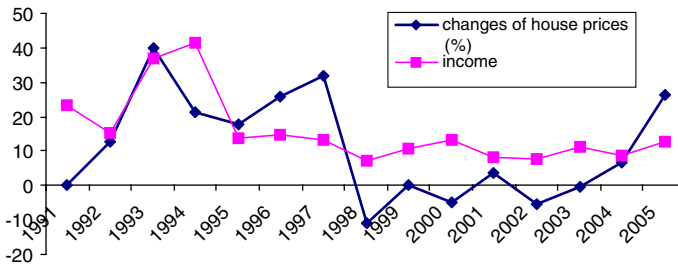
Fig. 1 1990–2005 house price and average income changes in Beijing. *Source*: Beijing Statistical Yearbook, 2005 and Chinese real estate Yearbook, 2005. Income is disposable income per household

Despite the relatively high rate of owner occupancy as the result of housing privatization in Beijing, the demand for housing is still growing rapidly. This situation results from an accelerated immigration from rural areas and from an accelerated level of renovation of old and dilapidated homes. Moreover, the government's objective of improving housing conditions and the living environment has a built-in tendency to increase market demand, even from those who purchased government housing. Most publicly owned housing was small in size and of relatively poor quality.

However, the persistent increases in housing prices in Beijing have always been the primary obstacle to meeting increases in housing demand, particularly for moderate- to low-income families. From 1998 to 2004, house prices in Beijing increased at an average rate of 25% per year, while average household disposable income increased at a rather stable annual rate of about 12% per year (see Fig. 1). After 1998, municipal governments terminated the traditional welfare system, and individual consumers rather than work units became the main source of purchasing power in the housing market. Therefore comparisons of income and price are a more reliable indicator of housing affordability post-1998. The gap between average home price and median household income widened after 2002, particular after 2004. The situation for low- and medium-income households is worse than that indicated by the averages. Earnings of medium-income households increased by less than 25% from 2001 to 2004. Increasing income inequality as measured by a GINI coefficient, which increased from 0.15 in year 1991 to 0.25 in year 2002, reflects the worsening situation of poorer households.

We should note that the Beijing municipal government's strategy began in 1993 with the "Kangju (healthy living) Project" before the national Economic Housing Project in 1998. The objective of that project was to improve living conditions for the medium- and low-income groups and encourage the establishment of an economical housing supply system (Meng and Feng 2005). The target group was limited to workers in state-owned enterprises, and priority was given to retired workers and teaching staff. The initial capital investment was very low but soon developed, accumulating 4.76 million square meters of new construction with 7.6 billion RMB of investment by 1998. This project led to the nationwide "Comfortable Housing Project" (*anju* project) involving 35 cities, which was further revised as the "Economic Housing Plan".

The development of "economic housing" is encouraged by polices such as free transfer of land, and reductions or exemptions from taxes and levies. This makes the average prices of "economic housing" 15% lower than the prices of similar quality commercial housing. These policies were intended to allow medium- to low-income households to enter the housing market by reducing the costs. In 2003, the total area of sold "economic" housing

was about 3.2 million square meters compared to 18.95 million square meters of sold commercial residences in Beijing. This ratio decreased to 12% in year 2004 (BSB 2004). The condition of purchasing "economic" housing is set differently by city and country governments. Nominally, it is restricted to the no-housing families and families with the income demarcation line standards set by local government, such as 60,000 RMB in Beijing. Generally, after owning the economic housing and land-use permits for a certain time (e.g. 5 years in Beijing), homeowners can sell their economic housing at the commercial market listing after paying to the government a certain proportion of revenue in accordance with the housing price post of commercial housing and economic housing of similar size and quality. "Economic" housing is only restricted in the sales market and it cannot be let on the rental market. . The rental market in China is quite small in size. In Beijing, the ratio of rental housing including public rental housing and private rental housing was about 31.8% in 2003 and 23.4% in 2004 (BSB 2005b). The Ministry of Construction reported that 70 cities had no social rental at all (http://house.people.com.cn/xinwen/060524/article_0900.html). In 2004, the cheap rental housing project was introduced to cities throughout China in an effort to secure the basic housing needs for the lowest-income families in the urban areas.[3]

3 Assessment of housing affordability

Housing affordability is not a characteristic of housing but a characteristic of a housing service as it relates to the ability and the desire of consumers to pay for it. Housing affordability is a relationship between housing and people (Stone 2006). Housing affordability is a function of decisions that households choose to make between housing expenditures and expenditures for non-housing goods. That is, households make decisions reflecting trade-offs between different forms of expenditures that reflect their relative cost and attractiveness (Malpass 1993). These decisions involve an important element of subjectivity. Some households might choose to reduce their housing consumption in order to enjoy more consumption of other goods and services, while other households might prefer to do the reverse of that. This subjective choice is not only dependent upon individual preferences but is also influenced by the cost and availability of loans (Malpass 1993). Therefore, in our view housing affordability is a subjective and complex concept that cannot be neatly or simply assessed by a single ratio of house price to income.[4]

In this view, there are three critical dimensions of housing affordability: income, non-housing demand and housing demand. Affordability is then conditioned by the opportunity cost of housing consumption as opposed to non-housing consumption (Hancock 1993). Accordingly, housing affordability should be measured as a household's ability to pay housing costs without imposing constraints on living conditions. In other words, a household can be considered having a housing affordability problem if disposable income after subtracting non-housing costs is too small to pay for adequate housing. Therefore, the appropriate indicator of housing affordability should be the difference between housing cost and the residual income remaining after paying for required non-housing goods (Stone

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[3] The cheap rental housing project was started earlier in August 2001 in Beijing, but by 2004 there were only a few families that had been allocated their residences by this project.

[4] The discussion on the deficiencies of a ratio indicator as a measure of affordability can be found elsewhere, e.g. in Hancock 1993; Hulchanski 1995 and Thalmann 2003.

2006). The residual income concept of housing affordability has been investigated by Lerman and Reeder (1987), Thalmann (1999), Stone (1990, 1993, 2006) and Kutty (2005). Such a concept highlights the relationship among incomes, housing costs and expenditures on non-housing necessities. The residual income approach presents a competing position to the traditional paradigm of housing affordability, which uses a simple ratio between house price and household income (Stone 2006). The residual income approach allows us to directly address the question of "Affordable to whom?", and to specifically address the physical standard of housing that we are applying (Stone 2006). It gives us a flexible theoretical framework within which we can model the distribution of affordability (e.g. Stone 1993, 2006), subjective household choice (e.g. Thalmann 1999) and financial constraints faced by low-income households (e.g. Stone 2006). It also accommodates the quantitative evaluation of political implications of mortgage underwriting and the eligibility requirements for housing subsidies (Stone 2006). Freeman et al. (1997) provide an international review on the study of housing affordability and comprehensively discuss the residual income approach.

One challenge in operationalizing this method is the specification of minimum standards of adequacy for housing and for non-housing items. Stone (2006) discusses these issues but does not attempt to develop specifications for housing standards, which is important in a heterogeneous housing market. Theoretically, the "social minimum" refers to the bundle of resources that households need in order to lead healthy and productive lives in their society. However, the social minimum is a complicated concept to define and specify (White 2004). For the adequate housing standard, Lerman and Reeder (1987) and Thalmann (1999, 2003) use a quality-based measure.

Studies of housing affordability in China are very limited in scope and focus primarily on policy-oriented discussions of the marketization of the housing market. Rosen and Ross (2000) address problems related to the *Anju* project, while Wang (2000) identifies two major groups of urban poor in China and considers the impact of current housing reform on their accessibility to housing. Mostafa and Wong (2006) present a systemic study on housing affordability in Shanghai between 1995 and 2000. However, the concept of residual income has not been introduced in the Chinese study.

There are significant differences between the Chinese housing market and the highly developed housing markets where the residual income method has previously been used, such as the USA and the UK. However, the Beijing housing market has recently evolved substantially, changing from a government-owned welfare system to a system that is primarily market driven. Therefore households in Beijing and in other cities in China must now make market-based decisions about housing consumption. As in developed countries, people in China are also required to make free-market decisions regarding the distribution of income to housing and non-housing consumption. Their ability to afford housing will depend on how much purchasing power they have left after buying essential non-housing goods and services. Therefore, we believe that the residual income approach is now both valuable and appropriate in China, especially in major urban centers where most of the housing supply is privately owned.

The use of the residual income approach in China offers many important advantages for policy-makers and analysts. First, the measure helps us to accurately measure the size of the affordability gap, informing policy targets, and enabling us to more accurately measure the effectiveness of public policy. Second, our model can incorporate current housing wealth into the affordability equation, an advantage that is very important in the case of Beijing, because it incorporates the effects of large-scale recent privatizations of public housing. Third, our measure is flexible in that it allows us to measure affordability

for different socio-economic groups. We further discuss the last two issues in the conclusion. Income inequity between urban residents has been a persistent problem in China and growing income disparities are posing a series of challenges for development in China.

4 Methodology in the paper

In this paper, we apply the residual income approach to affordability assessment in the city of Beijing. We consider housing to be affordable for the household if residual income after subtracting the minimum cost of necessary non-housing goods and services is adequate to cover the cost of a new dwelling, including the down payment and periodic debt service. We construct a theoretical unit of housing representing a minimal socially acceptable standard, calling this the "standard" unit. We then derive a minimum required budget that a household would need in order to be able to purchase such a "standard" unit. In this calculation, we take into account the minimum required non-housing consumption and the household's ability to cover mortgage costs.

There are two major steps in this empirical specification. In the initial stage, we assess the market value of a "standard" apartment located in Beijing for a typical three-person family by determining the minimum socially accepted attributes. We estimate the implicit values of housing attributes for the "standard" unit using a hedonic model, connecting house prices to the value of a bundle of attributes. The advantage of the "average price" or "medium price" hedonic price model regards the heterogeneity of the housing stock. It shows that housing units commanding similar prices can be quite different in essential attributes such as size, location, and surrounding environment. Therefore, this model is flexible, incorporating subjective differences in consumer preferences. In an affordability study, this approach also facilitates a sensitivity analysis, allowing us to measure affordability using different concepts for the standard unit. It also provides a theoretical basis for making inter- and intra-city comparisons, since it allows us to define the standard unit using different attribute packages according to the regionally different development levels. Numerous studies have utilized this technique to assess the price of properties connected with attribute preference (e.g. Gillard 1981; Sirpal 1994; Walden 1990; Thalmann 1999, 2003), while empirical research on the urban housing market on the Chinese mainland has been very scant (e.g. Yang 2001; Wen et al. 2005; Tian 2006).

The second step involves measuring the minimum required budget of a family who might wish to purchase the standard unit. Using official statistics on expenditures for non-housing goods and services as a reference, and after taking financing costs into account, we derive a minimum required budget that would allow a family to purchase the standard unit. By comparing the difference between the family's actual income and the minimum required budget, we are able to measure the extent to which housing is accessible for families with different income levels.

We focus our analysis on first-time buyers in this paper. However, we can extend our discussion to include existing owners by incorporating the value of their current housing wealth in the analysis. We can estimate the potential average selling price for the purchased public housing and compare it with the "standard" housing price to indicate the degree to which housing wealth can contribute to increase household affordability.

5 Empirical results

5.1 The "standard" housing unit

We use real transacted prices and related attributes of new commercial residences in the hedonic price analysis. Data is collected from nine urban districts[5] in the city area of Beijing during the year 2003 from Beijing's central registry of housing transactions. There, all the transacted properties are registered and kept on record for the local real-estate administration. The data used in the paper thus can be deemed reliable for their accuracy and completeness. Luxury residential communities, in which the surface area of the apartment is more than 150 square meters, are excluded from our hedonic model.

The total number of new construction projects in 2003 in Beijing was 239, more than 50% of them in three districts (Tongzhou, Chaoyang and Haidian). In this study, we select house prices and related attributes randomly from each of the nine districts controlling for the ratio of new apartments to the total number of projects (see Appendix 1 for further information).[6]

Typically, in the hedonic study, the housing attributes are classified into structural attributes, location attributes, and neighborhood attributes (see the literature review by Palmquist 1984; Williams 1991; Goodman 1998; Chin and Chau 2003). These attributes encompass both quantitative and qualitative attributes. For the structural attributes, nominally studies reveal that the number of bathrooms and the number of bedrooms, floor area, and lot size are positive relative to housing price (Fletcher et al. 2000; Garrod and Willis 1992; Carroll et al. 1996). They also found that building age negatively relates to property price (Clark and Herrin 2000; Clapp and Giaccotto 1998) and the existence of a basement or garage increases the dwelling price (Garrod and Willis 1992; Michaels and Smith 1990). Among these variables, only the number of bathrooms and the number of bedrooms, and the floor area are relevant for this study because all of our studied apartments were built in the same year, and no lot, basement or garage was provided for any individual unit. Besides, luxury residential communities are excluded in our study, this implies that the number of bedrooms and bathrooms tend to be linear with the size of apartment. We thus omit the number of bedrooms and bathrooms from the model to avoid colinearity of the variables in the model. Only the size of the apartment captured by its total square area is thus included in the structural attributes.

For the location attributes, two variables—namely, distance to CBD and public transportation—have been empirically found to be the most important factors in housing price (McMillan et al. 1992; Palmquist 1992; Adair et al. 2000; Yang 2001). Specifically in this study, "Annular" is used to indicate the location of the apartment since it is one of the features of the urban development pattern in Beijing. Housing prices can be expected to decrease with the ring road number because the distance from the CBD of Beijing increases as the ring number increases.

In neighborhood attributes, public services, e.g. schools (Clauretie and Neill 2000; Jud and Watts 1981), hospitals (Huh and Kwak 1997) and supermarkets (Yang 2001) that were found to be significant factors in previous studies are included in this study. That is because they are considered by the consumers to be important characteristics, particularly for the low- to medium-income households who are our focus in the study. Information on

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[5] There are in total 11 urban districts classified by authority in Beijing. In this paper only two districts, Changpin and Daxing, which are in suburban areas, are excluded in the data.

[6] We are grateful to Xin He at Tsinghua University in Beijing for helping with the data collection.

environmental externalities such as noise, criminality and air pollution are not available in the Chinese study.

In general, the challenge of the hedonic approach is to properly identify the functional form and then to select the design matrix in a way that will minimize the missing variable problem. However, in this case the objective of applying the hedonic model is not to identify the specific prices of the explanatory variables; instead, we want to estimate the market value of a standard housing unit as we define it. Therefore, a coefficient bias that might be caused by mis-specifying the functional form or by omitting significant causal variables is not a serious problem (Malpezzi 2002), as long as we include the most important causal variables, and the fit of the model is good.

The variables used in this study are defined in Table 1.

We do test several different function forms: linear, log-linear and semi-log-linear. The signs of the variables and the t-statistics are consistent (with the exception of "Transport" being less significant in the first two functions). We choose to estimate house price using the semi-log-linear equation. This functional form has advantages over some of the other, in that it allows the value added to vary proportionally with the size and quality of the home, and it often mitigates the common statistical problem of heteroskedasticity, or changing variance of the error term (Malpezzi 2002).

We present the nine-variable hedonic model in Table 2. It shows that 86% of the observed variation in unit price is explained by the model. All coefficients are significant at the 99% level, with satisfactory values of tolerance. As expected, location, transportation and public facilities are important determinants of apartment prices. Units located within the second or third ring have higher values *ceteris paribus* because they are closer to the CBD of Beijing. The negative coefficient of "Grocery" and "School" might be unexpected. However, Yang (2001) argues that the costs of some public facilities are included in the prime cost by sellers, who attempt to recoup it by increasing the housing price paid by the buyer. However, in theory, the external costs for public facilities such as the grocery store should be recouped from service charges in later years.

Table 1 Definition of variables in the hedonic price model

Variable	Definition
Price	Sale price of the apartment (unit: RMB)
Area	Total construction area of the apartment (unit: square meter)
Ring3	Ring3 = 1 if apartment is located within the second or third ring road
Ring4	Ring4 = 1 if apartment is located within the fourth ring road
Ring5	Ring5 = 1 if apartment is located within the fifth ring road
Transport	Transport = 1 if the apartment is located in a very good transportation environment (subway within 1.5 km and more than 9–11 bus lines pass), and minimal traffic problems (according to "1039 Beijing transportation service manual")
School	School = 1 if the apartment is located in a district (within 1.5 km) with more than 5 primary and elementary schools
Hospital	Hospital = 1 if the apartment is located in a district (within 1.5 km) with a second- or third-grade comprehensive hospital
Supermarket	Super = 1 if the apartment is located in a district (within 1.5 km) with at least one comprehensive supermarket
Grocery	Grocery = 1 if the apartment is located in a district (within 1.5 km) with more than five grocery stores

Table 2 Hedonic regression results	Coefficient	SE	t-value	Tolerance
Intercept	11.49	0.024	474.012	
Area	0.012	0	59.162	0.93
Ring3	0.51	0.023	21.847	0.384
Ring4	0.362	0.016	22.547	0.691
Ring5	0.322	0.015	21.048	0.752
Transport	0.013	0.023	1.818	0.863
School	−0.032	0.013	−1.735	0.675
Hospital	0.072	0.017	4.116	0.527
Supermarket	0.143	0.013	11.254	0.812
Grocery	−0.063	0.02	−3.212	0.854

Note: R^2: 0.913; Adjusted R^2: 0.856; SE: 0.17162; $F = 636.364$; Sing = 0.000

The next step in our analysis is to define the "standard" housing unit in terms of the attributes measured in the hedonic model. We need to define a unit representing the minimum socially acceptable living standards in Beijing. However, minimum housing standards are not defined for China. The only point of reference we have available is the tenth 5-year plan of China's government, which indicates that in 2005, the living area per person should reach 22 square meters in Beijing. For a family of three persons, this standard implies that the living area should be at least 70 square meters, and the construction area should be around 90 square meters. Therefore, we set Area* = 90 square meters for the "standard" unit.

This leaves us with the task of defining minimum standards for other hedonic variables. In the effort, we have no authoritative sources to draw upon. In the absence of any clear official guidance, we need to use more subjective measures for minimum standards appropriate for moderate income families. We do so making reasonable inferences regarding the basic needs of families with modest incomes.

We set Transportation* = 1 in our equation because most of the low and middle-income households depend heavily on public transportation. We believe that commuting capabilities is a fundamental determinant of housing consumption for these families. Hence, the "standard" housing is assumed to be located in peripheral locations with adequate transportation access to jobs.

For the location of the "standard" dwelling, we can assume that medium and low-income households can move out of the city center and live within the fourth ring of Beijing, where prices are more moderate. Because we have assumed that public transportation is good for these families, their need for nearby services is reduced. Therefore, for the "standard" apartment, we set Ring4* = 1 and Facility*(school, hospital, supermarket, grocery) = 0.

It is necessary to note that the "standard" apartment provides a benchmark for the measure of affordability but is not in itself a price-setting formula. It only provides a framework for identifying the socially desirable minimum housing consumption for households by specifying reasonable hedonic conditions.

Using the specifications presented in Table 2, we estimate the total price for a standard housing unit at 418,000 RMB.[7] Given this information, we can now consider the terms of

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[7] The result from the cluster method indicates that the average value for 95 square meters is 45,000 RMB.

the loan used to purchase the standard unit. A standard repayment loan, which has been the dominant credit contract for house purchase in China, is one in which the down payment is less than 30% of total value and the loan maturity is a maximum of 20 years. Applying the annual interest rate of 5.51%,[8] we can estimate the down payment at 125,400 RMB and the annual debt service payment at 24,530 RMB.[9]

To test the sensitivity of the location of the "standard" housing, we can estimate the price for the alternative "standard" units by simply adjusting the attributes associated with the units. In doing so, we can compare the value of a unit located in the Fifth Ring with the other consistent attributes, and a unit located in the Fifth Ring but without the desirable transport situation. These dwellings would have estimated values of 402,318 RMB and 397,122 RMB, respectively. This does not change our conclusion in fact.

To further test our definition of "standard" housing in the analysis, we present cluster analyses to classify housing units according to their mean area. We study the housing attributes in the market for a cluster whose mean area is maximally close to the "standard" area of 90 square meters. We can reverse the distribution of housing attributes in the market and use it as a guideline to define the "standard" attribute for the unit. However, this could be problematic as it relies on the distribution of the sample studied. In fact, in such a method, market availability determines the "standard" consumption for the household, which could deviate from the household's actual financial capability. Nevertheless, performing the cluster analysis here can help us to justify our choice of attributes for the standard unit. More important, it can confirm the reliability of our price estimate for the standard unit by allowing us to compare it with the price distribution in the actual market. The cluster analysis is shown in Appendix 2, and it supports our price estimate for the "standard" unit.

5.2 Assessment of housing affordability

In order to determine the minimum required budget necessary for a family to afford a "standard" unit as defined above, we need to assess the minimum required expenditures for non-housing consumption for a medium- to low-income family. To estimate these expenses, we use data from the Beijing Municipal Statistical Bureau, as shown in Table 3. The report divides the entire sample into five income groups of equal size, based on personal income. Thus, the top 20% is the high-income group and the bottom 20% is the low-income group.

Non-housing consumption data from Beijing Municipal Statistical Bureau were collected from the survey by the system of the state statistical bureau. The sample size is 1,000 urban households and the survey aims to understand the household's socio-economic conditions. Although the sample size is limited, no more formally gathered data are currently available in China. In this context, we use average household expenditure as a proxy measure of "minimum standards of non-housing consumption", since expenditure has been seen by many as the preferred measure of living standards. Several studies derive absolute poverty from expenditure data (e.g. Bradshaw et al. 1987; Saunders et al. 2000). However, to represent this information as a basket of goods and services faces the difficulty of defining categorical needs which must be met in order for human beings to function

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[8] Interest rate for housing accumulation found is 4.41%.

[9] A loan for housing is 70% of 418,000, which is 292,600. For a loan with an interest rate of 5.51% and 20 years maturity, the annual repayment will be $\frac{292600}{AF}$, where AF is defined as *annual factor* in finance, and $AF = \frac{1}{0.0551} - \frac{1}{0.0551 \times (1.0551)^{20}}$.

Table 3 Beijing urban household living expenditure in 2003 (annual per person)

Item	Average	Low	Medium–low	Medium	Medium–high	High
Living expenditure						
Food	3522.7	3053.9	3221.3	3728.3	3885.6	3867.7
Clothing	906.2	554.6	720.9	959.8	1108.3	1130.4
Household facilities	704.2	481.9	457.3	637.6	794.7	1258.5
Medical services	994	838.6	790.5	879.2	1084.5	1545.9
Transportation, communication	1688.1	714.1	1133.5	1234.6	1896.6	4258.2
Education, culture, recreation	1964.2	1281.7	1510.4	1918.0	2454.1	2278.3
Miscellaneous, service	388.7	225.9	263.2	344.3	441.7	551.9
Total	10168.1	7150.7	8097.1	9701.8	11665.5	14890.9

Source: Beijing Statistics Bureau, 2004. The survey includes responses from 1,000 households

(Bradshaw and Finch 2001). Besides, Sen (1983) and Doyal and Gough (1991) have also argued that basic human needs cannot be understood purely in physical terms. The definition has to take account of capabilities including the capacity to participate. Other measures such as the budget standard approach (Bradshaw 1993; Citro and Michael 1995), minimum income standards (Heikkila and McCausland 1997; Bradshaw and Finch 2001), social indicators (Townsend 1979; Gordon 2000) that have been used to determine the poverty threshold can be considered as the improved measure in affordability. Both conceptual and empirical standards for poverty levels in China have not been much discussed and need further study.

In our data, food is the largest consumption item for the moderate-income groups, followed by education and transportation. It is obvious that living expenditure on food is the highest consumption for all income-level households, followed by education and transportation on average. In 2003, per capita expenditures for non-housing essentials were 8,097 RMB for low- to medium-income households, which was 80% of the national average and 54% of the high-income level.

We simply add the minimum non-housing expenditure to the credit requirement (down payment and repayment) to get the minimum annual required budget for a family to be able to afford a "standard" unit. We conclude that a housing unit with a total value of 418,000 RMB requires a down payment of 125,400 RMB and an annual minimum family income of around 48,416 RMB (23,886 RMB per family[10] for non-housing consumption and 24,530 RMB for the housing loan payment).

By simply comparing the minimum required budget to the actual income of a family, we can directly assess the accessibility of a family to the standard unit. Here, we do not consider the housing wealth of current owners of housing. This will be discussed in the following section.

Before continuing with our analysis, we should discuss an important weakness in Chinese income statistics. It is generally argued that official income information does not reflect all sources of household earnings, and that therefore one must proceed with caution in Chinese studies. We believe, however, that this type of data will not pose a great problem in our measures. The main weakness of the official income statistics is that they do not report information on unregulated income such as bonuses or earnings from second

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[10] Average of 2.95 persons for each family.

Table 4 Annual family income and difference in income (disposable income and minimum required income) in 2004, Beijing

Group	Family income (RMB/year)	Difference between the disposable income and minimum required income (no down payment included)
Lowest-income family	21,833	−23791.565
Medium-to low-income family	32,334	−16082.445
Medium-income family	42,023	−11127.3
Medium high-income family	54,441	−4502.225
High-income family	87,422	18963.85
Average	46,132	−8393.9

Sources: Beijing Statistics Bureau, 2004 and author's calculations. Average persons per household is 2.95

jobs. For our targeted family, defined as a low- to medium-income household, it is reasonable to believe that unregulated income is limited and is in most cases not sufficient to significantly change their economic status.

Table 4 presents the average income levels for different income groups, as reported by the Beijing Statistics Bureau. It indicates a considerable income disparity among the different groups, such that the average income of a low- to medium-income family was only 36% of the high-income level. Comparing the actual income with the minimum required budget for the medium- to low-income household shows that these households confront a serious housing affordability problem. By adjusting the expenditure on non-housing consumption for each income group (from Table 3), we can measure housing affordability for other groups (second column in Table 4). The statistics for the higher income groups should be interpreted with caution because of the statistical problem discussed above. The affordability gap does not reflect any change in the definition of the appropriate "standard" unit.

For purposes of our study, the important conclusion from these statistics is that the incomes of low- and medium-income families fall far short of the level required to provide access to standard housing. To make standard housing available to moderate-income households, either household income would have to increase by 50%, or housing prices would have to decrease by 33%. We would expect that housing affordability is decreased with the increase of household size in the current China. This test however depends on further information to be derived from an individual family survey.

The gap between the persistently increasing housing price and the affordability to moderate- and low-income households indicates that housing price is not determined by the effective demands of households, particularly low- to medium-income households. Speculative purchasing by domestic investors, combined with torrents of overseas capital flow into China's residential sector due to speculation on a revaluation of the yuan to higher levels, led to a volatile and rapid price appreciation. In contrast to the low affordability of low- to medium-income households, homeowners who have purchased commercial housing have robust financial capacities (F. L. Wu, 2005, unpublished). The average mortgage payment accounts for 35% of a buyer's income, and more than 35% of the buyers paid back their loan ahead of the term (according to a survey conducted by China Central Bank in 2006). These homeowners benefit from the housing inflation and they tend to follow suit in speculative trading as property prices escalated. The market has been manipulated by some higher-income players (F. L. Wu, 2005, unpublished).

On the other hand, a report by China's foreign exchange administration bureau in 2005 pointed out that the real estate sector has been listed as one of the most important foreign investment sectors. It is estimated that foreign investment agencies bought 2.2% of the normal commercial residences and 13% of the high-end residences in 2005, spending 3.4 billion USD on property purchases (Miao et al. 2006). The influx of international capital into the real estate market opens up space for price inflation (F. L. Wu, 2005, unpublished).

So far, household savings and the down payment requirement have not been included in the analysis. They can easily be accommodated in the measure of affordability. We are focusing on the medium- to low-income household in the analysis. It is reasonable to assume that their savings are nominal and thus not sufficient to cover the estimated down payment requirement of 125,400 RMB on average. Even as the savings continue to accumulate in the bank in China, it is estimated that 66% of all saving deposits are controlled by only 10% of domestic depositors (*Asia Times*, Aug. 17, 2005). If we compare the estimated down payment requirement of 125,400 RMB with the annual family income of 32,334 RMB, we see that the down payment requirement is about three times as large as the household's annual income. It takes more than 15 years for a low- to medium-income household to save all the disposable income excluding the minimum living expenditure in order to be able to pay for the down payment. Therefore, the down payment requirement represents a significant additional barrier to home ownership for these households.

Regarding the assessment of the "Economy Housing Plan", we can simply recalculate the above result. Thus, we find that for a household to be able to afford a "standard" apartment, the price must be decreased by about 33%. This suggests that explicit government policies intended to reduce housing costs either through tax reductions or construction subsidies should target this price level. However, if we look at the price difference between economic housing and commercial housing, we realize that we are far from achieving this objective. On average, as we mentioned, the price of economic housing is only about 15% lower than that of commercial housing of similar quality. This statistic indicates that the medium- to low-income household still has difficulty affording an economic house at the current price level, and that the supply of economic housing has not successfully made home ownership accessible for the medium-income family.

6 Concluding remarks

Housing affordability is a complex topic. The mixed issues of income distribution and housing inequality also raise basic difficulties in measuring housing affordability in China. In this study, we have developed an alternative approach to the estimation of house affordability. We do not use the simple ratio of average housing price to household income. Rather, we have defined a "standard" housing unit determined by the minimum socially desirable living standards, and have estimated a minimum required budget for a family to be able to purchase such a unit. The minimum required budget is compared with actual household income to determine whether or not standard housing is affordable at a designated level of income, given reasonable assumptions with regard to financing costs and required expenditures for non-housing consumption.

For most first-time buyers, particularly for low- and medium-income households, the gap between the family income and minimum required income is huge. According to our calculations, to make standard housing available to the medium- and low-income household, family income would have to increase by 50%, or housing prices would have to

decrease by 33%. However, if we consider the housing wealth for the households who have bought public housing at a discount during the housing privatization in China, affordability can be expected to improve significantly if they can transfer their dwellings in the market. A second-hand housing market is required for a healthy development and government political support. Our results further indicate that, although housing affordability has been targeted as a major policy objective in China, as under the "economic housing" program, so far the policies have not been successful. In this context, the method developed in this study provides an informed quantitative method to measure the effectiveness of housing policy; it should be applied to assess future changes in policy.

The results presented in this paper suggest a need for multi-faceted policy responses that consider not only the owner-occupied housing market but also the comprehensive development in the entire real-estate market, including the rental and secondary markets as well as the financial markets. The correlation among these markets and their contributions to facilitating household affordability would require further research.

One more important study with the method developed here would be to capture the socio-economic characteristics of household affordability in Beijing. We can further classify our targeted families into different groups according to their employment, education and economic status and estimate affordability for each group. Currently there are two difficulties limiting such research. First, the primary targets of current government policy are medium- and low-income households. However, this is problematic due to the ambiguous definition of this target group in Beijing. Presently there is no definite, official definition of "middle class" in China. Some economists suggest that households with an annual income anywhere from 60,000 to 500,000 RMB (from 7,250 to 60,400 USD) should be categorized as medium-income earners. Accordingly, in Beijing, people with an annual income less than 60,000 RMB are generally regarded as belonging to the medium-income group. There is, however, no academic research or official statistical reports that have analyzed the family patterns and occupational characteristics for this medium-income group. Second, there are no statistics that directly connect employees' incomes to their careers in China. Such research would help us to study the characteristics and distributions of household affordability, and would enable us to estimate household affordability by type of employment, education status and family type. In addition, stratifying the family by career and economic characteristics could help overcome the data problems by limiting the disparities of income level within each group.

Appendix 1: New construction projects in Beijing in 2003 and number of projects selected for the study

District	Number of new projects (%)[a]	Number of selected projects in database (%)	Number of selected new apartments in database (%)
Tongzhou	53 (20.2)	21 (22.58)	232 (24.04)
Caoyang	50 (19.0)	26 (27.96)	228 (23.63)
Haidian	38 (14.4)	22 (23.66)	237 (24.56)
Daxin	29 (11.0)	0	0
Fengtai	25 (9.5)	10 (10.75)	120 (12.44)

Appendix 1 continued

District	Number of new projects (%)[a]	Number of selected projects in database (%)	Number of selected new apartments in database (%)
Changpin	15 (5.7)	0	0
Shijinshan	10 (3.8)	5 (5.38)	53 (5.49)
Xuanwu	8 (3.0)	3 (3.23)	32 (3.32)
Chongwen	6 (2.3)	3 (3.23)	34 (3.52)
Xicheng	3 (1.1)	2 (2.15)	23 (2.38)
Dongcheng	2 (0.8)	1 (1.08)	6 (0.62)

[a] *Source*: "Research report of Beijing residential market in 2003" by the Institute for Real Estate Studies, Tsighua University, Beijing

Appendix 2: Cluster analysis

In principle, the cluster's purpose is to identify the homogeneous subgroups to minimize within-group variation and maximize between-group variation on the housing market. There are a large number of methods that can be used for clustering procedures, and there is no consistent method found to determine the number of clusters. Nevertheless, in this study, the number of clusters is not our concern, as we are interested only in the clusters whose average area is close to 90. In this study, we achieved the cluster using K-means cluster analysis with the Euclidean distance method. As a result, three clusters were determined. Our target group is the one whose mean area of the unit is 95.

In examining the descriptive statistics for this cluster (see table), we notice that more than 70% of the units in the cluster are provided with good transportation conditions. Fewer units are located close to public facilities including school, grocery, hospital and supermarket. This evidence is consistent with our assumption of the "standard" housing unit. However, only 19% of the units in the group are located within the fifth ring and more than 40% are located outside the fifth ring. This is in fact due to the distribution of the new construction projects in 2003, as shown in Table 2. Concerning the fact that the sixth ring is newly constructed and is still under development, we still set our "standard" location in the fifth ring. The average value of this cluster is 453,461, which is a bit higher than the value we estimated for our assumed "standard" housing; this is due to the larger area and higher number of public facilities involved in the cluster. This suggests, however, that our estimated value is reasonable for the study.

Descriptive statistics for Cluster 2

	Minimum	Maximum	Mean	SD
Area	77.4	111.06	95.4388	8.8259
Price	203,046	820,398	453,461	147688.773
Ring3	0	1	0.1089	0.395
Ring4	0	1	0.14	0.398
Ring5	0	1	0.19	0.458
Transport	0	1	0.7060	0.490
School	0	1	0.14	0.500

Appendix 2 continued

	Minimum	Maximum	Mean	SD
Supermarket	0	1	0.37	0.476
Grocery	0	1	0.09	0.294
Hospital	0	1	0.24	0.447
Observations: 316				

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