韓國開發硏究
제29권 제2호(통권 제100호)

Estimating the Benefits of the Korean Public Housing Program for Low-Income Families Under Non-Homothetic Preference

Joonhyuk Song
(Associate Research Fellow, Korea Development Institute)

비동조적 선호체계를 이용한 우리나라 공공임대주택의 편익 추정

송 준 혁
(한국개발연구원 부연구위원)

* (e-mail) jhsong@kdi.re.kr, (address) Korea Development Institute 207-41, Chongyangri-Dong, Dongdaemun-Gu P.O.Box 113, Chongyang Seoul, Korea

• Key Word: Non-homothetic Preference(비동도적 선호체계), Public Housing(공공임대주택), Benefit-Cost Ratio(비용편익비율)
• JEL code: D01, D31, D61, D63
• Received: 2007. 8. 14 • Referee Process Started: 2007. 8. 28
• Referee Reports Completed: 2007. 11. 14

ABSTRACT

It is widely accepted that public rental housing programs affect both the allocation of resources and the distribution of welfare. This paper explains institutional arrangements of public housing program in Korea and assesses the benefits of the program. In contrast to the previous studies which employed homothetic preferences, the benefits of the public housing were estimated based on non-homothetic preferences to allow for different income effects across households.

Empirical results suggest that average benefit-cost ratio of public housing program is 0.91, and hence, the deadweight loss seems to be well-contained in Korean public housing program compared to other countries. However, the distribution of the benefits reveals that the transmission of the benefits should be improved to achieve the desired goals of residential welfare for low income families.

일반적으로 공공임대주택은 자원의 배분 뿐만 아니라 복지의 분배에도 영향을 미친다. 본 연구에서는 우리나라의 공공임대주택에 대한 제도적 변화와 공공임대주택의 편익에 대해 설명해 보고자 한다. 기존의 많은 연구들은 동조적 선호체계를 고려하여 공공임대주택의 편익을 분석함으로써 공공임대주택에 따른 소득효과에 대해 명시적으로 고려하지 않았다. 이에 반해 본 연구는 비동조적 선호체계를 고려함으로써 공공임대주택에 따른 소득효과를 명시적으로 고려하였다. 이러한 선호체계를 바탕으로 시행한 분석 결과, 공공임대주택의 편익-비용 비율은 0.91을 기록하였으며, 이는 우리나라의 공공임대주택에 따른 사중손실(deadweight loss) 규모가 크지 않음을 반영한다고 볼 수 있다. 그러나 편익의 분포를 살펴보면 편익과 소득수준 간의 상관관계가 그리 높지 않아 공공임대주택의 궁극적인 목표계층인 저소득층에 대한 실질적인 혜택이 그리 크지 않은 것으로 나타났다.

Ⅰ. Introduction

Many in-kind government programs associate a price subsidy with a quantity restriction on the consumption of subsidized goods. These programs have strict rules on eligibility and quantities of subsidized goods, and are offered at the below the market price. Public housing programs have been regarded as an effective in-kind subsidy by providing an adequate living environment to those who cannot afford such housing services in open markets. Hence, most developed nations have established their own public housing programs based on their social and political backgrounds to enhance social bond and vertical equity.

Like most developed countries, the Korean government intervenes in the housing markets. Earlier, subsidizing the consumption of housing services was rooted in the idea that housing was a merit good having external effects on the health and ability to work of household members. However, as the Korean economy grows and social demands for sharing economic profits increase, these arguments seemed to be lost grounds to distributional considerations. Most of the government interventions are focused on stimulating the supply of housing in the form of subsidies on the construction of housing for low-income families.

The essential feature of Korean public housing is to present participants with an all-or-nothing option, i.e. to participate in the housing program, a candidate family must live in a housing unit specified by the government at a sub-market rent. Specifically, this type of subsidy is different from the pure price subsidy program where participant are permitted to choose their housing, but pay less than the market price. As public housing policy is not implemented through the market mechanism, many researchers are interested in the efficiency and the magnitude of deadweight loss of the program.

DeSalvo (1971) provided theoretical tools to evaluate the benefits of tenants employing Hicksian equivalent variations. Since then, many researchers have attempted to measure the benefits empirically. Murray (1975) evaluated the consumer surplus of public housing programs of 7 cities in the U.S. and investigated the distribution of these surpluses using two different specifications of utility function: Cobb-Douglas and generalized CES utility[1]. He found that the public housing program increased the real income of subsidized tenants by around 35%, and the size of benefits increased with family size and age of head. Olsen and Barton (1983) applied Stone-Geary utility function to compute the benefits in New York City, and found that the benefits were inversely related to income.

Among studies using the Korean data, Yoon (1997) investigated the efficiencies of the public housing programs and concluded that public housing was very poorly focused on redistribution policy. Jung (1999) studied public housing data in Seoul metropolitan city, and claimed that the distribution of benefits was positively related to tenants' income. He attributed his findings to a weak link between paid

[1] In his paper, he claimed that the Cobb-Douglas utility function is not an adequate utility function to gauge the benefits of public housing tenants.

rent and income. Kim et. al. (2004) have estimated the benefits with constraints on the unit size of public housing in Korea, and reported that the benefits decreased by 14~65% depending on housing types compared to the cases in which there were no unit size constraints. Aside from the data set they have used in their respective study, they all employed the same functional form of utility, which is Stone-Geary preference.

In this paper, I present and estimate the benefits of the Korean public housing programs employing non-homothetic preferences. Under homothetic preference, the income effects across households are treated to be the same, and, hence, only substitution effects are the major vehicle in explaining the behavior of households. This is hardly true in reality. Unlike homothetic preferences, non-homothetic preferences do not allow closed-form solutions in general. Therefore, the problem should be solved numerically using an iteration method. A computation algorithm to tackle the problem and estimate the benefit of public housing is also presented in this paper. The average benefit-cost ratio of Korean public housing is estimated to be 0.91. According to the result, the deadweight loss from the public housing seems pretty well-contained compared to other countries. I also investigate how benefits from housing programs are distributed among participants, and find the variation of the benefits is not correlated highly with household characteristics. Based on these findings, I can argue that the public housing program does not seem to be functioned as a target-oriented redistribution device. The administration needs to exert more effort to monitor and review the qualifications of the tenants at regular basis so that the public housing policy can achieve its desired goal.

The rest of the paper is organized as follows. Section 2 briefly introduces the public housing programs in Korea. The model used in estimating benefits of public tenants is presented in Section 3. Section 4 describes the data and delineates empirical models, and estimation results are reported in Section 5. Section 6 concludes.

Ⅱ. Public Housing Programs in Korea

The Korean residential assistance programs consist of two tiers[2]. The first tier is indirect subsidy programs, or demand side subsidy programs, composed of Chonsei[3] Loan Program and Housing Allowance Program. The second tier is direct subsidy programs, or supply side subsidy programs, through which the central or local government provide public rental housing for low income families at below the market rents. The eligibility for the residential assistance program and the amount of the subsidy are determined by household income, family composition, etc.

The Chonsei Loan Program, launched in 1990, is to lend some fraction of Chonsei deposit at below the market interest rate. This program is administered by National Housing Fund (NHF). The beneficiaries of this program are obtaining implicit rent

[2] Part of the following discussion is excerpted from Jung (2004).

[3] Chonsei is a unique rental system in Korea in which a tenant pays an upfront deposit upon contract, with no additional periodic payment. The tenant receives the nominal value of the deposit from the landlord upon expiration of the contract, which last typically two years.

subsidies which amount to the difference between market interest rates and paid interests. To qualify for this program, the applicant's Chonsei contract should meet criteria on size of dwelling and amount of Chonsei deposit[4]. When one becomes a successful applicant, he can borrow up to 70% of Chonsei deposit at the interest rate of 2%.

Housing Benefits Program has been operated as a part of national basic living allowance system established in 1999. The national basic living allowance system was introduced to provide basic livelihood conditions for all families in Korea. Housing benefits come from two channels: direct and indirect housing allowance. Direct housing allowance is paid out on the basis of income, family size, and the living allowance includes indirect housing allowance. The total housing benefits are 17.7% of minimum living costs which are relatively low considering the housing costs of low income families are 20~30% of their minimum living cost. The activity of this program is presented in Table 1.

The public rental housing program was commenced in 1988 when the government initiated "two million units of housing construction project." Public housings are referred to those units which are being financed in part by public funds from central or local government or the National Housing Fund (NHF), even though some of them are owned by private investors. These housing units are provided to low-income families at submarket rents.

There are a variety of public housing programs depending on the share of construction costs, size of housing, rental period, and qualification for prospective tenants. The Permanent Rental started in 1989 and terminated in 1993. This housing provided space up to 40 square meters, and current outstanding stock of this housing is 190,077 units. The 5-year Rental and 50-year Rental began in 1992, providing public rental housings for households with income higher than the extremely poor. The housing space is up to 60 square meters. The National Rental Program was introduced in 1998. At the beginning, two types of rental period, 10 years and 20 years, were provided, but consolidated into a single plan of 30 years in 2002. Other types of public housing programs include Workers' Rental and Private-supplied Rental.

As of 2004, the public housing stock reached 1,150,054 units, which are 8.9% of total national housing stock (12,989,000 units). This ratio is smaller than U.K. (22%) and Germany (17%), but bigger than Japan (7%) and U.S. (1%)[5]. The composition of public rental housing stock is presented in Table 2. Specifically speaking, the 5-year Rental has the largest share in public housing, and the stock of workers' rental is lowest.

This government regards the National Public Housing as the most important housing program for low-income families and plans to supply one million units for the period between 2003 and 2012. Part of construction costs will be subsidized by the national government budget. Aside from this, 500 thousand units of the public housing with 10-year rental period have been under construction initiated by private sectors. These private constructors are given preferential treatments on purchase of

[4] The size of rental housing should be smaller than 60 square meters in principle. The rental contract deposit varies depending on cities. For example, the deposit cannot exceed 50,000 dollars in Seoul metropolitan city.

[5] These ratios are taken during 1999~2000.

<Table 1> Minimum Living and Housing Costs

# of members	1	2	3	4	5	6
Minimum living costs (A)	418.3	700.8	939.8	1,170.4	1,353.2	1,542.4
Other transfer (B)	60.4	101.2	135.7	168.0	195.4	222.7
Cash grant (C= A-B)	357.9	599.6	804.1	1,001.4	1,157.8	1,219.7
Direct housing allowance (D)	33.0		420.0		55.0	
Living allowance (E)	324.9	566.6	762.1	959.4	1,102.8	1,264.6
Indirect housing allowance (F)	40.9	90.8	124.1	164.8	184.1	217.5
Total housing benefit (D+F)	73.9	123.8	166.1	206.8	239.1	272.5

Notes: 1) Household with more than 6 members will receive 189 dollars per each additional member as a minimum living cost.
2) The exchange rate is 1,000 Korean won per U.S. dollar.
Source: Ministry of Health and Welfare, A Guide to National Basic Living Program, 2006.

<Table 2> Public Housing Stock by Type

Types	Permanent	50-year	5-year	National	Workers	Private--supplied	Total
Units	190,077	92,850	655,908	47,203	38,566	125,450	1,150,054
Share (%)	(16.5)	(8.1)	(57.0)	(4.1)	(3.4)	(10.9)	(100)

Source: Ministry of Construction and Transportation, *Handbook of Housing*, 2005.

land, financing and taxes. According to this plan public rental housing stock will reach 10% of total housing stock by year 2012.

Ⅲ. Model

There are typically two measures used in evaluating public housing programs: Marshallian and Hicksian measure. While the Marshallian measure is defined on demand curve, the Hicksian measure is associated with indifference curve. The Marshallian measure has been criticized due to its assumption of a constant marginal

utility of income (see DeSalvo [1971], Hammond [1987]). This paper adopts Hicksian equivalent variation, or price equivalent variation, to measure tenants' benefits. The basic idea of Hicksian measure is to find the equivalent income level leaving the consumer as well off as under in-kind subsidy. The standard procedures to estimate the benefits consist of 4 steps. The first step is to specify a direct utility function. The second and third step is to derive the demand function for each good and find its expenditure function from indirect utility function. The last step is to evaluate the equivalent variation of tenant's benefits.

Specifically, let $e(p_H, p_x, u_0)$ be an expenditure function when a consumer does not participate in public housing program, where p_H is the market price of housing service and p_x is the price of non-housing goods and u_0 is the initial level of utility without subsidy. Now, he joins the program, and attains a higher utility, u_s, due to increased housing services and consumption of other commodities. In general, however, the combination of this consumption under in-kind subsidy is not generated from optimality conditions, which require the marginal rates of substitution (MRS) equals to the ratio of prices.

When the MRS is different from the price ratio, there is a distortion in the consumption allocations, implying some resources are wasted. Then, one may ask how much income should be given to leave this consumer the same level of utility enjoyed under public housing program, i.e. u_s, without affecting market prices. The income compensation needed in this case will not be greater than the money spent to provide the in-kind subsidy as deadweight loss will disappear in the former case. The equivalent cash grant to obtain u_s is denoted by $e(p_H, p_x, u_s)$. Hence, our Hicksian income compensating measure, i.e. net benefit, can be expressed as:

$$B^H = e(p_H, p_x, u_s) - y_0 \tag{1}$$

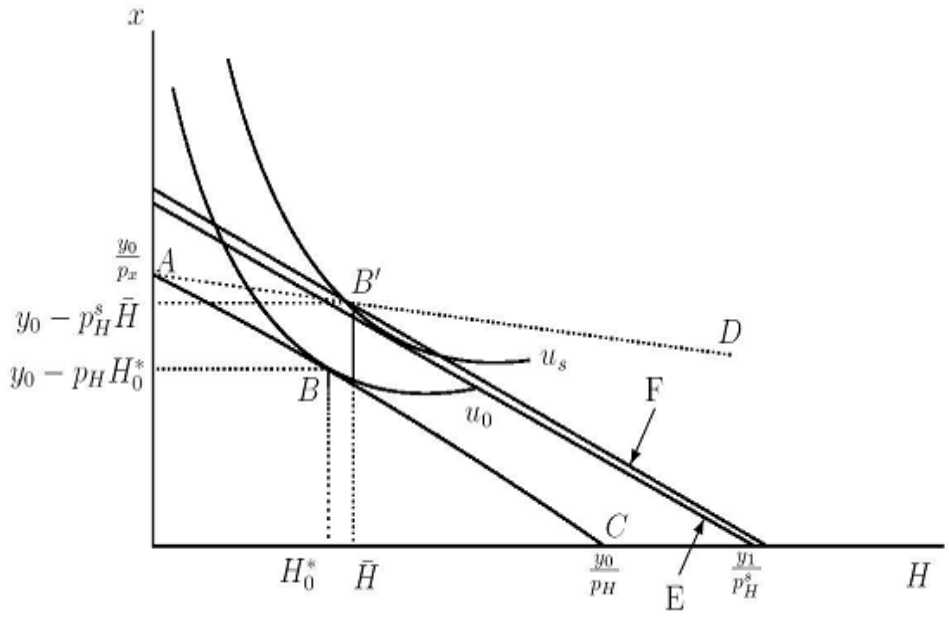
where y_0 is the individual's income. When utility function is homothetic, there exists an analytical form of the expenditure function and I can estimate the Hicksian compensation directly from eq. (1). Therefore, one can simply take some arbitrary forms of homothetic preference to make the computation of Hicksian measure simple. But, there is always a tradeoff in the choice of preferences. Homotheticity of preferences restricts the scope of income effect: constant income elasticity[6]. As there is no *a priori* reason to believe that income elasticities across households are the same, this restriction is too severe and inappropriate for empirical study. Recently, many works employ Stone-Geary utility to bypass the constant income elasticity problem. Easy in concept and empirical implementation, one needs to assume the minimum levels of consumption on housing services and other commodity *a priori*. This lowers the empirical robustness and the outcomes vary according to the specific assumptions one takes on the subsistence levels.

In this paper, I try to sidestep from this penchant. I consider a two commodity economy composed of housing services (H) and non-housing composite goods (x)[7]. The utility function of each household is defined as a variation of constant-

[6] Murray(1975) discussed these problems.

[7] Hicksian separability is assumed to make the relative prices of goods within the composite

[Figure 1] The Benefit of Public Rental Housing



elasticity-of-substitution (CES) of the form:

$$u(x,H) = (\omega H^{\rho} + (1-\omega)x^{\rho/\varepsilon})^{1/\rho} \tag{2}$$

which displays *non-homotheticity*. The budget constraints faced by a household is defined as:

$$p_H H + p_x x = y_0$$

Unlike the standard CES function, which displays unitary income elasticity, the intrinsic non-homotheticity allows us to escape the unitary income elasticity restrictions[8]. If $\varepsilon = 1$, then the utility function will be reduced to the standard CES function. I will test whether unitary income elasticity is maintained in the empirical section. Unless $\varepsilon = 1$, there are, in general, no closed form solutions to find B^H. Hence, I use an iterative method to approximate B^H to any desired level of

commodity to be constant. Hence, the utility function described in this paper is called Hicksian utility function.

[8] The income elasticity under this setup is:

$$\frac{y_0}{p_H H + \frac{\varepsilon(\rho-1)}{\rho-\varepsilon} p_x x}$$

Hence, if $\varepsilon = 1$, this equation reduces to unitary income elasticity.

convergence[9].

Figure 1 illustrates measurement of the Hicksian equivalence. $\overline{ABC}$ indicates the initial budget constraint before participating in a public housing program. The indifference curve tangents at the point B, denoted by u_0. When he joins the program, he is given a certain level of housing consumption, denoted by $\bar{H}$, at a subsidized price, p_{H}^{s}, and spends the remaining income on non-housing goods, denoted by $y_0 - p_H^s \bar{H}$. This is indicated by the point B' on the indifferent curve u_s. Of course, he enjoys a higher utility under the program compared to the situation where no public housing is provided. If not, he would not participate in the program at the first place. If he were to obtain the same level of utility as u_s, but required to pay market rental for housing level, he wound need an income y_1 represented by line E. This line is drawn parallel to the initial budget constraint to reflect that the prices of x and H are intact, while the level of income is shifted upwards. However, at B', the government needs to subsidize income represented by line F to make his level of felicity at u_s. The subsidy made by the government is $(p_H - p_H^s)\bar{H}$. The difference between F and E is called deadweight loss due to the nature of in-kind subsidy. The Hicksian equivalent variation is then decided by the difference between y_1 and y_0.

The consumer's problem is to solve eq. (2). The optimality condition of this problem yields:

$$H = \left(\frac{(1-\omega)p_H}{\omega\varepsilon p_x}\right)^{\frac{1}{\rho-1}} x^{\frac{\rho-\varepsilon}{(\rho-1)\varepsilon}}$$
$$= \left(\frac{(1-\omega)p_H}{\omega\varepsilon p_x}\right)^{\frac{1}{\rho-1}} \left(\frac{y - p_H H}{p_x}\right)^{\frac{\rho-\varepsilon}{(\rho-1)\varepsilon}} \quad (3)$$

As discussed earlier, the housing choice is an implicit function of prices and non-housing consumption. The procedures of calculating Hicksian equivalent variations are iterative and the computation steps are as follows:

- Find the market prices of housing services (P_H) in the private rental sector. I measure the price by unit price per square meters from hedonic regression for the private rental market.
- Compute u_s.
- Apply P_H and eq. (3) and derive (H, x) to attain u_s for each household.
- Find $y_1 = P_H H + P_x x$, and $B^H = y_1 - y_0$.

[9] I use e^{-5} for convergence tolerance in out program. The results do not change perceptibly even if the tolerance level is tightened further.

Ⅳ. Data and Empirical Specification

1. Data

I use two survey data complied by Korea National Housing Corporation (KNHC) and the Korea Research Institute for Human Settlements (KRIHS) in 2004. The first survey is called National Public Housing Tenants Survey (Tenants Survey), and was carried out on a sample of families residing in 35 public housing complexes in 10 cities (or 8 provinces). The sample size of this survey is around 1,000. The second survey data is called National Housing Assessment Survey (Housing Survey), and is consist of a national sample of tenants in both public and private housing and homeowners save Cheju province. The sample size of this data is about 3,000. In this data set, I only include households residing in private apartment as most public rental housing is provided in the form of apartment. This restricts our data points, but I can find more reliable estimates by controlling the type of dwellings.

There are three types of rental contracts: Chonsei deposit, Chonsei deposit plus monthly rent, and monthly rent. For the first and second case, I need derive the equivalent monthly rent. To do this, I use the average stock market return during the last 10 years, which is 10.9%, as a relevant return for the deposit to convert Chonsei deposit into a rent-equivalent[10].

In Table 3, I compare selected statistics for both types of rental housing in Housing Survey: private and public. The mean-difference test indicates that there is a significant difference in housing space and rent between private rental and public rental housing. Housing space of public apartment is 6 square meters smaller than that of private apartment. Given a relatively small difference in housing space, there is a large difference in rent: 862,200 won versus 465,200 won. This speaks for itself how significant rental assistant program is. Apart from these two variables, other household characteristics, such as age, income, and number of family size are pretty similar between two groups. This fact hints that the actual beneficiaries of the program are dissociated with the target group of the program[11].

Table 4 reports descriptive statistics of Tenants Survey. Rents of public housing seem a little smaller than the counterparts in Housing survey. This is because their housing space is smaller than those living in public housing in Housing Survey. One pronounced fact is the income levels of public tenants in two survey data. Households residing in public rental in Housing Survey seem to earn 66% higher than those in Tenants Survey. One can deduce that the tenants in National Housing are poorer than those in other types of public housing, and National Housing is targeted more to low-income families than other housing programs based on these statistics.

---

[10] The benefit measure swings a lot depending on the choice of returns for housing deposit. Hence, readers are advised to focus more on the benefit-cost ratio rather than the absolute level of benefits.

[11] Yoon and Kim (1997) showed that 10~50% of public housing tenants were middle income households and unqualified for the programs.

<Table 3> Descriptive statistics of Housing Survey

	Private rental 894		Public rental 57		Mean diff. $\mu_1 = \mu_2$
	Mean	Std.Dev	Mean	Std.Dev	t-student
Housing space (m^2)	84.0	21.8	78.1	17.5	6.79 **
Rent [1)]	862.2	439.4	465.2	165.7	6.78 **
# HH member	3.67	1.52	3.63	0.95	0.22
Age of head	40.29	8.96	39.16	9.59	0.93
Sex of head (male= 1)	0.70	0.46	0.65	0.48	0.83
Income (monthly)	2,427.2	892.9	2,273.9	1,003.7	1.24

Notes: 1) Rents for Chonsei tenants are constructed using the average stock market return.
2) *, ** indicate significance at 5% and 1% level respectively.

<Table 4> Descriptive statistics of Tenants Survey

	Mean	Std.Dev	# obs.
Housing space (m^2)	64.5	9.0	790
Rent [1)]	334.9	80.5	790
# HH member	3.66	0.99	787
Age of head	44.1	11.2	744
Sex of head (male= 1)	0.69	0.46	790
Income (monthly)	1,366.3	533.1	790

Note: 1) Rents for Chonsei tenants are constructed using the average stock market return.

2. Empirical Specification

Before passing on to a discussion of our empirical results, the empirical specifications of the model need to be discussed. In order to compute the benefits of public housing tenants, I need to find structural parameters. As the housing and non-housing consumption basket after moving into public housing does not necessarily reflect the outcome of optimizing behavior, the use of data on public housing tenants prior to their participation in the programs should be employed to estimate the parameters. Tenants Survey has collected information on previous

housing before moving into public housing such as housing space, number of rooms, maintenance cost etc.

Take log on both sides of eq. (3) and rearrange terms:

$$\log H = \beta_0 + \beta_1 \log(\frac{p_H}{p_x}) + \beta_2 \log x + u \quad (4)$$

where u is measurement error, $\beta_0 = -\frac{1}{\rho-1}\log(\frac{\omega\varepsilon}{1-\omega}), \beta_1 = \frac{1}{\rho-1}$, and $\beta_2 = \frac{\rho-\varepsilon}{\varepsilon(\rho-1)}$. The identification is pretty straightforward. I can identify ρ from β_1. ρ and β_2 allow us to identify ε, and ω can be determined from β_0, ρ, and ε. To recover these deep parameters, I use classical minimum distance method. Eq. (4) is estimated using instrumental variables as the regressor, $\log x$, is endogenous. The instruments are $y, p_H, \frac{p_H}{p_x}$, heating system and a constant term[12]. If p_H and p_x are measure with errors, our estimates would be inconsistent. This will not affect our results significantly unless there are substantial inter-regional price differences.

One thing needs to be mentioned before discussing estimation results. In the model, current income is used instead of permanent income. Although permanent income is the right measure for income scale, the data set used in the empirical study is a single-year cross-section which makes it hard to find permanent income measures.

Ⅴ. Empirical Results

1. Benefit Estimates

Table 5 presents the estimation results of hedonic regression. The common practice is to regress market rent against a vector of housing characteristics, and the coefficients of the regressors may be viewed as market prices of housing traits. The covariates are housing space, number of dwellings in each housing project and its square, building age (VINT) and its square. The 8 regions are treated with 7 regional dummies, neglecting Seoul metropolitan area. As expected, housing space has a positive correlation with rents. As the number of dwelling increases, rents become higher but at a decreasing rate. Large dwelling complex tends to have a better public transportation, gardening within the complex, and large stores. These tend to raise the rents. But, as the dwelling units grow over some threshold level, it causes congestion, such as limited parking space, external noise, hence, affects negatively on rents. Building age has a positive sign, though insignificant. However, its square is significant at the conventional level. The signs of coefficients on regional dummies are negative. As the intercept represents the rent of households residing in Seoul, the negative coefficients imply the other cities pay less rents than Seoul, which is well

[12] Heating system does not affect directly to housing consumption expressed in square meters while it is related with non-housing consumption directly as heating expenditure is part of non-housing consumption. Housing consumption is influenced by heating system indirectly through income effects due to the changes in non-housing consumption

<Table 5> Estimation Results of Hedonic Equation

	Coefficients	t-value
Constant	3.4967	56.22
Housing space	0.0409	21.75
# dwellings	0.0002	8.88
# dwellings$^2/10^4$	-0.0006	-3.54
VINT	0.0007	0.41
VINT$^2/10^4$	-0.0374	-2.54
Incheon (dum= 2)	-0.6941	-19.10
Kyunggi (dum= 3)	-0.3717	-13.56
Busan (dum= 4)	-0.3236	-9.83
Deagu (dum= 5)	-0.5261	-13.73
Deajeon (dum= 6)	-0.7094	-15.49
Jeonju (dum= 7)	-0.9778	-16.20
Cheongju (dum= 8)	-0.9261	-24.98
Adj-R ^{2}	0.7028	

Note: VINT indicates the lapse of years since construction.

expected.

To estimate parameters, pre-program data on housing space, income and rents are used to infer the actual market behaviors of public renters. Recall that I cannot use post-program data as they do not reflect optimization behavior along with indifference curve. The data collects family income of 2005, not before the program. Besides, I do not have data on when they moved into their current public housing unit. Hence, I assume that all tenants moved in a year before the survey and discount income of 2005 with the annual growth rate of income during the years of 2004 and 2005. The structural parameters from the reduced-form regression are recovered by the classical minimum distance method. Housing demand for public housing tenants represented by housing space is estimated and reported in Table 6.

Table 7 presents the benefit measures of public housing. Estimated rent implies the implied rent of public housing if it were traded in a competitive housing market. Paid-rent is the actual payment made by renters, and implicit subsidy is the difference between estimated rent and paid rent. Overall the benefit-cost ratio ($\frac{\text{E.V}}{\text{Implied Subsidy}}$) is 0.91, which seems pretty high. The highest benefit-cost ratio is 0.96 in Daegu, and the lowest is 0.66 in Cheongju. Based on these results, the deadweight loss seems to be pretty well contained in Korean public housing program.

Table 8 illustrates the previous estimates for benefit ratios employing Stone-Geary preferences as a workhorse of the analysis. The benefit ratios vary depending

<Table 6> Regression Results of Housing Demand Equation

	Coefficients	t-value
Constant	2.425	17.60
β_1	-0.382	-12.40
β_2	0.138	4.58
Adj-R^2	0.223	
ω	0.986	448.96
ρ	-1.617	-7.75
ε	-2.535	-4.47

Note: Other regressors include household size, location dummies.

<Table 7> Benefit Measures of Public Housing

	Estimated Rent	Paid Rent	Implicit Subsidy	E.V.	$\frac{\text{E.V.}}{\text{Implicit Subsidy}}$
All	546.9 (133.8)	334.9 (80.5)	212.0 (119.0)	194.5 (108.9)	0.91
Seoul	656.5 (50.0)	380.6 (48.7)	275.9 (23.8)	259.5 (26.8)	0.94
Incheon	474.0 (21.5)	408.0 (40.6)	65.9 (34.3)	56.7 (33.0)	0.86
Kyunggi	611.0 (72.5)	333.2 (73.0)	277.8 (92.3)	254.1 (82.1)	0.91
Busan	742.8 (45.9)	409.3 (82.4)	333.6 (75.6)	274.1 (80.3)	0.82
Daegu	534.6 (43.8)	256.7 (45.5)	277.9 (37.9)	268.3 (36.3)	0.96
Daejeon	481.5 (37.2)	361.4 (68.4)	120.1 (52.9)	112.5 (55.3)	0.93
Jeonju	335.6 (0.0)[1)]	255.1 (31.3)	80.5 (31.3)	77.2 (31.7)	0.96
Cheongju	324.5 (32.2)	273.1 (39.7)	51.4 (18.2)	34.2 (26.4)	0.66

Note: 1) Only 1 type of public housing provided.

<Table 8> Benefit Distribution on Household Characteristics

	Coefficients	t-values	Coefficients	t-values
Constant	187.64	7.38	305.38	17.22
income	-0.39	-4.32	-0.10	-1.78
hsize	0.33	0.08	-1.95	-0.84
age	1.33	3.39	0.51	2.15
Age^2	-0.01	-0.53	0.00	0.31
Region dummy	No		Yes	
Adj-R^2	0.25		0.69	

on the minimal levels of housing and non-housing consumption used in the estimation processes. The benefit ratio reported in this paper does not seem to be widely different from the previous works. This doesn't mean that the approach taken in this paper has very limited impact on the estimating housing benefits. Rather, this implies that the needs for public housing have been an urging issue for low income families such that the changes in the shape of preference do not change the benefits of public housing tremendously. But, still the differences in benefit ratios are not negligible, and income effect should be given fair amount of attention in evaluating public housing programs as they have nontrivial impact on the income level of the poor families.

2. Distribution of the Benefits

Policy makers are interested in how benefits from a program are distributed among participants as well as the average magnitude of benefits. Table 9 shows the results of regressing benefits against income, size of household, age of head and its square. Columns 2-3 report results without regional dummies and Columns 4-5 present results with regional dummies. Among the included regressors, benefits are negatively correlated with income, yet insignificant, and positively correlated with age. This might be that old people are more likely to become public housing tenants as the eligibility for the program is more favorable to the aged. The economic significance of coefficients is limited except constants and regional dummies. Households with head age of 50 are receiving 5,100 won more benefits than those with head age of 40. This is pretty small magnitude. Housing policies need to deliberately consider age and income profile of tenants to enhance the effectiveness of the policy.

Ⅵ. Conclusion

Public rental housing has been regarded as the most important housing program for low-income families in Korea for the last 18 years and will be operated as a major vehicle for the distribution of welfare in the near future as well. This paper has attempted to estimate the benefits of Korean public housing programs using a non-homothetic preference. Empirical results show the average benefit-cost ratio is 0.91. According to this, the public housing program has been managed relatively well, compared to other countries in the average sense.[13] This might reflect the chronic high demand for affordable housing for low income families in Korea. However, the distribution of benefits among participants seems quite problematic. The estimated results show that benefits vary most by regions and tenants' characteristics have not been given much attention to the distribution of benefits. This problem seems to arise due to the lack of supervision and a poor review process to verify the eligibility of the prospective tenants. Policy makers should recall that the target group of public housing is those who cannot afford to buy a minimal housing service on their own. So, continuous supervision on the eligibility of tenants for public housing should be implemented so that the benefits of public housing can be transmitted well into the target population.

For the past years, most of residential assistance programs have been carried out through supplying houses initiated by public sectors in Korea. Considering the insufficient stock of public rental housing, housing policy for low income families should be geared at the provision of housing units for the time being. Even though the deadweight loss of public housing programs is small relative to other advanced countries, still the loss of 10% cannot be simply dismissed. As the Korean government supplies more public houses, the deadweight loss will become bigger due to the diminishing marginal returns. This will urge policy makers to switch their stance from the current public-provided housing programs. To find answers for the new tools on residential welfare, Korea needs to pay attention to the experiences of advanced countries many of which, including the U.S. and Britain, have converted or in the way of converting their public housing programs towards demand-oriented policies from supply-oriented policies. A large volume of research discusses the benefits of demand-oriented policies over supply-centered ones, and Korea needs to consider changing its policy stance to enhance the effectiveness of public housing programs.

[13] Olsen and Barton (1983) and Hammond (1987) estimate the ratio to be 75.5 and 60.5 in the U.S., respectively. Borger (1985) estimates that of Belgium to be 83.0.

References

Blomquist, G. and L. Worley, "Hedonic Prices, Demands for Urban Housing Amenities, and Benefit Estimates," *Journal of Urban Economics*, 9, 1981, pp.212~221.

Borger, B. D., "Estimating the Welfare Implications of In-kind Government Programs: A General Numerical Approach," *Journal Public Economics*, 38, 1989, pp.215~226.

DeSalvo, J. S., "A Methodology for Evaluating Housing Programs," *Journal of Regional Science*, 11(2), 1971, pp.173~185.

Gibb, K., "Trends and Change in Social Housing Finance and Provision within the European Union," *Housing Studies*, 17(2), 2002, pp.325~336.

Hammond, C. H., *The Benefits of Subsidized Housing Programs: An Inter-temporal Approach*, Cambridge University Press, 1987.

Hausman, J. A. and D. A. Wise, "Discontinuous Budget Constraints and Estimation: The Demand for Housing," *Review of Economic Studies*, 47(1), 1980, pp.75~96.

Heim, B. T. and B. D. Meyer, "Structural Labor Supply Models when Budget Constraints are Nonlinear," *Working Paper*, Northwestern University, 2003.

Jung E., "Distributional Effect of Public Housing Programs in Korea," *Fiscal Studies,* 13(2), 1999, pp.353~374.

Jung E., "Low Income Housing Policies in Korea: Evaluations and Suggestions," *KDI Research Paper*, 2004, pp.345~373.

Jung E., "Measures to Facilitate the Supply of Public Housing," *KDI Research Paper,* 2005, pp.197~229.

Koning, R. H. and G. Ridder, "Rent Assistance and Housing Demand," *Journal of Public Economics,* 66, 1997, pp.1~31.

Kim, I. J., Kim, G. Y. and J. H. Yoon, "Estimation of the Tenants' Benefits Residing in Public Rental Housing with Unit Size Constraint in Korea," *Urban Studies,* 41(8), 2004, pp.1521~1536.

Mayo, S. K., "Theory and Estimation in the Economics of Housing Demand," *Journal of Urban Economics,* 10, 1981, pp.95~116.

Murray, M. P., "The Distribution of Tenant Benefits in Public Housing," *Econometrica*, 43(4), 1975, pp.771~788.

Olsen, E. O., "An Econometric Analysis of Rent Control," Journal of Political Economy, 80(6), 1972, pp.1081~1100.

Olsen, E. O. and D. M. Barton, "The Benefits and Costs of Public Housing in New York City," *Journal of Public Economics,* 20, 1983, pp.229~332.

Oh, D. H., "A Study on Estimating Benefits of Public Housing Tenants in Korea," *Korea Policy Review,* 9(3), 2000, pp.237~257.

Stewart, J., "A Review of UK Housing Policy: Ideology and Public Health," *Public Health,* 119, 2000, pp.525~534.

The Ministry of Construction and Transportation, *Handbook of Housing,* 2005.

The Ministry of Health and Welfare, *A Guide to National Basic Living Program,* 2006.

Yoon, J. H. and H. S. Kim, "Estimating Income Equivalent Benefits of Tenants in Public Housing," *Housing Finance*, 210, 1997, pp.1~22.