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Economic Valuation of Green Open Spaces: The Effects of Homeownership and Residential Types

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ABSTRACT : This paper aims to examine the effects of homeownership and residential types on the economic values of urban green spaces. Green open spaces as public goods provide positive externalities that are comprised of pecuniary and technological externalities. Seoul, South Korea, is used as a case study using choice experiments, with split-sample online respondents of 1,000. The study results evidenced that the differentiation between the two types of externalities is imperative for equitable provisions and efficient management of various urban open spaces. There is a positively significant and substantial impact of homeownership for apartment dwellers, ceteris paribus, but not for house dwellers. For apartments, the efficiency loss can be reduced by increasing green spaces up to the critical point where the marginal cost is at equilibrium with tenants' marginal values. For non-apartment houses, it is not homeownership but the monthly household income that has a significant impact on the amenity value. In general, public benefits from green spaces are equivalent to 16% to 33% of the current residential prices on average for a view or access. Different residential types do not cause a significant impact on the access values. Residential profiles for green spaces were developed, together with tailor-made policy suggestions.

Keywords : Urban green spaces, Homeownership, Residential types, Willingness to pay, Choice experiments

JEL Classifications : Q51, Q57

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도시녹지의 경제가치 평가: 소유 여부와 주택유형의 영향

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요 약 : 본 논문의 목적은 주택 소유 여부와 주택유형이 도시녹지공간의 경제가치에 주는 효과를 검증하는 것이다. 공공재로서 녹지공간은 양의 외부효과를 제공하는데, 화폐 외부효과와 기술 외부효과로 나누어진다. 서울을 사례연구 대상지로 하여 선택실험을 진행하였고, 1,000명으로 구성된 온라인 표본을 분석하였다. 분석 결과에 의하면 형평성과 효율성을 고려하여 다양한 유형의 도시녹지를 관리하기 위해서는 두 가지 형태의 외부효과를 차별화하는 것이 매우 중요하다. 모든 조건이 같은 경우에, 아파트 거주자들은 소유 여부가 녹지공간의 경제가치에 양의 유의함을 보여준 반면, 일반주택 거주자들은 그러한 영향이 없었다. 아파트의 경우 세입자들이 느끼는 한계가치와 한계비용이 일치하는 균형점까지 녹지공간을 확장하여 사중손실을 저감할 수 있다. 이와는 상반되게 일반주택의 경우에는 소유 여부가 아니라 가구소득이 어메니티 가치에 유의한 영향을 주었다. 녹지공간의 공적 편익(지불의사액)은 평균적으로 현재 거주지 가격의 16%에서 33% 정도까지 조망이나 접근성의 형태로 구체화되었다. 녹지 접근성의 가치에는 거주지유형의 차이가 유의한 영향을 주지 않았다. 녹지공간을 위한 거주자 프로파일과 정책제언을 제시하였다.

주제어 : 도시녹지공간, 소유 여부, 거주유형, 지불의사액, 선택실험

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I. Introduction

Healthy natural environments have influenced the growth of cities, but excessive urbanization and industrialization have reduced green open spaces in cities and produced pollution and noise, resulting in poor living conditions. Urban green spaces generally mean open areas with a vegetation component such as city squares, parks, forests, mountains, agricultural lands, rivers and lakes, and their surrounding green areas, which function to enhance human-nature relationships (MOE, 2012; Taylor and Hochuli, 2017). Urban green spaces offer various ecosystem services (for an extended list of studies and examples, see Jenks and Jones (2010)). These services (e.g., air and water quality regulation, climate regulation, tourism and recreation, aesthetic values, cultural heritage, and physical health and spiritual benefits (MA, 2005)) are also known as "amenities". An amenity is defined as the pleasant or attractive quality of a feature that increases one's wellbeing, pleasure or comfort (Merriam-Webster, 2017). With economic growth and higher household incomes, demands for amenities such as scenic beauty, leisure, and other human-nature interactions have increased in residential areas and surroundings. Recently, there has been an increasing interest in a positive relationship between urban green spaces and their effects on human wellbeing and the quality of life (e.g., Bertram and Rehdanz, 2015; Wendelboe-Nelson et al., 2019).

Among 3.5 million households living in Seoul in 2015, more than 66% lived in units or apartments ("apartments" hereafter) and 43% of them were tenants, whereas approximately 34% lived in single- or multi-family houses ("houses" hereafter) and about 77% of them were tenants (KOSIS, 2017). It is a unique aspect of South Korea that tenants normally pay their rents either as one-off deposits (called "Jeonse" in Korean) for the entire contract period (e.g., 26% of the apartment-based households and 30% of the house-based households in Seoul) or as monthly payments (e.g., 17% of the apartment-based and 47% of the house-based in Seoul) (KOSIS, 2017). Making the situation more complicated, only 12% of 221,683 transactions reported in the Seoul housing market in 2015 involved non-apartment dwellings (KAB, 2020). Consequently, studies based on transaction data using hedonic price methods might discriminate unnecessarily against those households living in the areas where transactions are limited (either apartments or houses) or tenants who cannot fully participate in the housing market, leading to a potentially biased or inaccurate welfare estimate and misdirected public policies. Thus, different residential types of households and their tenure types pose a methodological challenge in measuring the economic values of urban green spaces.

Nonetheless, the challenge is not exceptional for South Korea. For instance, it was about 64% of the households in the United States that were owner-occupied between 2015 and 2019 (The Census Bureau, 2020). For EU member countries on average, about 69% of the households were owner-occupied in 2016, and Germany showed the lowest rate of 52% (Eurostat, 2017). Therefore, the homeownership issue should be considered for equitable provisions of urban ecosystem services and amenities. In reality, however, the distribution and management of urban green spaces are inequitable in many parts of the world (Nesbitt et al., 2018), and the rich are more likely to have urban parks and forests than the poor (Poudyal et al., 2009). The situation regarding urban green spaces raises an important research question about the effects of the homeownership. The question remains scarcely examined, to our knowledge, and the effects might vary between residential types due to their divergent aspects.

Urban green spaces in highly concentrated residential areas, such as the Seoul metropolitan area of South Korea, might work as a major determinant of overall residential satisfaction (Bertram and Rehdanz, 2015), not to mention the quality of life (Jenks and Jones, 2010). Several studies in Korea investigated residential values of urban green spaces, either as the values associated with housing market prices using hedonic price methods (Yoon and Yu, 2001; Kim et al., 2007; Lee et al., 2013; Eom et al., 2019) or limitedly as the values in stated preferences using choice experiments (Kim and Choi, 2012; Lee and Kim, 2014; Choi and Eom, 2018). This paper contributes to the literature by employing household-level survey datasets that include previously ignored households (i.e., transaction-free owners and tenants), and by examining whether differing residential types (apartments vs. non-apartment houses) and homeownership types (owners vs. tenants) influence willingness to pay (WTP) values for green spaces. Conceptually, the extended approach is intended to identify technological externalities for the optimal and equitable provisions of green open spaces and their ecosystem services.

This paper aims to examine the effects of homeownership and residential types on the economic values of urban green spaces. Residential "views" and "accessibility" represent two major amenity values of urban greenspaces (Morancho, 2003; Kim et al., 2007; Lee and Kim, 2014; Mittal and Byahut, 2016). We considered them together with other major factors affecting property values. The random utility framework was extended to generalize household preferences across different homeownership residential types. Discrete choice experiments were framed to replicate respondents' current residential types, ownership and prices (i.e., a pivot design). The current residential prices were used as the payment vehicle so that the amenity values of owners and tenants can be realistically and effectively compared. The findings in this paper offer novel insights by showcasing a way to identify the minimum value estimate of pecuniary externalities and the maximum value estimate of technological externalities across diverse types of green spaces. The policy implication is related to an approximate quantity for optimal and equitable provisions of green spaces that can be tailored for differing residential types.

The structure of the current paper is as follows. The following section describes why differentiation between the two types of externalities is important for urban green spaces, selected research issues, and discrete choice models, together with research hypotheses to be tested. Section 3 is about the methodology, describing how choice experiments were implemented, including choice attributes, questionnaire designs. Sections 4 describes the estimation results of discrete choice models, welfare values for green spaces, testing results of the research hypotheses, and an extended explanation on externalities for efficient public policies. The final section provides brief conclusions.

Ⅱ. Urban green spaces as public goods

1. Technological externalities

It is not true that all positive externalities justify policy interventions because there are two types of externalities that are commonly ignored by the political dialogues (Holcombe and Sobel, 2001): pecuniary and technological externalities. Pecuniary externalities influence relative prices or property values of a good held by a third party in the market (e.g., Crompton, 2001), while technological externalities do not. Pecuniary externalities are just “pecuniary” without economic inefficiency (Holcombe and Sobel, 2001). Existing or new green spaces might increase the market prices of neighbouring residences, which can be examined using hedonic price methods (Crompton, 2001; Morancho, 2003; Kong et al., 2007; Melichar and Kaprová, 2013; Eom et al., 2019; Łaszkiewicz et al., 2019). Such externalities should not defend any corrective policies, in contrast to our experience (e.g., Crompton, 2001). On the other hand, technological externalities cause a market failure with inefficient distributions of resources (e.g., shortage of green open spaces), so to require public policies for optimal provisions.

Although, direct market prices do not exist for the entire amenity value that urban residents enjoy from green open spaces, the real estate markets or hedonic price methods might “partially” reflect the full scale of the economic benefits: pecuniary externalities. These indicate “capitalization” of externalities (Crompton, 2001). However, there must be remaining technological externalities that are not mirrored to the property values. Diverse amenities from green spaces go beyond those residents living closely or having a view, such as avoiding the urban heat-island effect, the green image of the city, habitats for biodiversity, and reduced emissions of greenhouse gases. As a result, the overall economic benefits (*AMENITY*) are comprised of pecuniary externalities (E_p) and technological externalities (E_t) that are difficult to disentangle in nonmarket valuation. With the homeownership effects, it might be possible to compare amenity values between homeowners and tenants, and between apartments and houses. The difference in economic values due to homeownership, ceteris paribus, might work as a proxy value for pecuniary externalities from green open spaces, and the remainder technological externalities.

$$\mathrm{AMENTIY} = \mathrm{E}_{p+}\mathrm{E}_{t} \tag{1}$$

Green open spaces (or their amenities) with positive externalities are normally defined as public goods because they are basically non-excludable and non-rival (Kotchen and Powers, 2006), and their provisions are not cost-free. There are management budgets and conservation funds to transfer privately-owned to publicly owned areas (Anderson and West, 2006; Netusil, 2013). In particular, urban green spaces are likely to compete with other demanding uses such as housing, roads, industrial sites, and retail businesses closer to residential areas. The benefits provided by these alternatives are the opportunity costs of keeping or altering the land for green spaces. Since most ecosystem services of green spaces are not directly traded in the market, their amenity values are not commonly known to decision makers in contrast with the opportunity costs, leading to market failure. However, once an open space is converted to one of these alternatives, restoring it is typically difficult and costly. Therefore, public policies requiring the maintenance of healthy urban ecosystems and green open spaces are vital for a good quality of life (Jenks and Jones, 2010) and equitable provisions (Nesbitt et al., 2018), if necessary with market interventions.

2. Research issues of urban greenspaces

Urban green amenities have been predominantly examined in the literature through the hedonic price method (Morancho, 2003; Kong et al., 2007; Melichar and Kaprová, 2013; Mittal and Byahut, 2016; Eom et al., 2019; Łaszkiewicz et al., 2019). Access to urban parks was the first factor evaluated using the hedonic price model. Access to other types of urban greenspaces was subsequently scrutinized in many cities (Vrooman, 1978; More et al., 1988; Pearson et al., 2002; del Saz Salazar and Menendez, 2007; Łaszkiewicz et al., 2019). Several studies differentiated among types of urban greenspaces and measured them more accurately, partly due to easier access to geographic information systems (GIS) and GIS databases (Powe et al., 1997; Chen et al., 1998; Sohn et al., 2020). For example, urban greenspaces were separated into many classes, such as parks, natural areas, lakes, sport fields, agricultural fields, and green buffers (Panduro and Veie, 2013), and measured in different ways, including Euclidian, walking, and driving distances from houses to urban greenspaces (Mok et al., 1995; Powe et al., 1997; Lu et al., 2014). Alternatively, the areas of a variety of urban greenspaces within different buffer distances from houses, up to a plausible maximum distance, were included in the model (Yoo et al., 2012; Wang et al., 2015). In addition to accessibility, the visibility of particular urban greenspaces was evaluated (Wu and Plantinga, 2003; Kolbe and Wüstemann, 2015; Mittal and Byahut, 2016).

Although urban greenspaces change little once established, the aforementioned research efforts were triggered mainly by the complicated relationships between urban greenspaces and changing preferences of human being (Van Leeuwen et al., 2010). The nature of the hedonic price method also contributed to the abundant literature since site specific findings from the model for a particular housing market cannot be widely generalized (Smith, 1983). In addition, the dynamic status of real estate markets (i.e., real estate boom and bust) primarily influences revealed preferences and economic values for urban greenspaces (Peiser and Schwann, 1993; Cho et al., 2011).

Some econometric issues associated with spatial dependence, such as spatial autocorrelation and heterogeneity, were also tested (Kim et al., 2003). These efforts focused on objectively eliciting the monetary value of urban greenspaces already generated in the real estate market. However, the estimated amenity values of different types of urban green spaces, using the hedonic price method, are not reliable if the real estate market is extremely unstable, like the one in the Seoul metropolitan area, mainly due to governmental interventions and "overheated" speculation (Guzman, 2019). Thus, discrete choice experiments for stated preferences might be a reasonable alternative to the hedonic price method (Lanz and Provins, 2013). By employing the experimental residential choices considering homeownership and residential types, the economic values of urban green spaces can be properly estimated for representative households in Seoul. Also, pecuniary externalities can be approximated and differentiated from technological externalities for optimal provisions of green spaces.

3. Discrete choice experiments

Then, how do urban green spaces influence choices of urban dwellers for their residential places? Urban households are expected to maximize their overall utility by selecting the most satisfaction or the least dissatisfaction, including amenity values of green open spaces. The random utility function of household r for alternative i is conventionally comprised of a bundle of attributes that are measurable (V_{ir}) and the stochastic component (ϵ_{ir}). Residents' utility is a function of choice attributes X, sociodemographic characteristics S, homeownership O, and residential type R as shown in Eq. (2). The indirect utility function can be specified as Eq. (3). Alternative specific constant (ASC) measures the remaining utility that is associated specifically with the current "status quo" residence (e.g., emotional attachment or mental inertia), making it different from other alternatives; the current study used one ASC for the two alternatives.

$$V_{ir} = f(X, S, O, R) \tag{2}$$

$$V_{ir} = ASC + \alpha(\beta_r^{APT} X^{APT}) + h(\beta_r^{HOU} X^{HOU}) + \beta_r^{ALL} X^{ALL} + \beta_{r\mu} X_\mu \tag{3}$$

where α and h are a dummy variable respectively for apartment dwellers (α=1, otherwise 0) and house dwellers (h=1, otherwise 0); X^{APT}, X^{HOU} and X^{ALL} are a vector for the non-payment attributes that are respectively associated only for apartment dwellers and house dwellers, and both; β_r^{APT}, β_r^{HOU} and β_r^{ALL} are respectively their coefficients; X_μ is the payment attribute; and $\beta_{r\mu}$ is the payment coefficient. As described in Table 1, several choice attributes were applied differently between residential types.

Mixed random parameter logit (MXRP) models were applied to examine preference heterogeneity and test the hypothesized relationships (McFadden and Train, 2000; Train, 2003; Choi and Fielding, 2013). In contrast to multinomial logit models, assuming homogeneous preferences, MXRP models allow a distribution of mean amenity values or WTPs that can be linked to homeownership and sociodemographic variables for a potentially significant relationship. The choice probability of MXRP models can be described using that of the standard multinomial logit model (Louviere et al., 2000), observed throughout a density function of each β estimate ($f(\beta)$):

$$P_{ir} = \int \frac{exp\,V_{ir}}{\sum_{j=1}^{J} exp\,V_{jr}} f(\beta) d\beta \tag{4}$$

Parameter estimates and their distributional properties are determined by maximizing the log-likelihood for the choice models to explain the residential choice responses (i.e., maximum likelihood estimation). Then, household characteristics such as homeownership can be tested for a significant explanatory power for heterogeneous preferences. This can be done by interacting explanatory variables with attribute parameters with a significant distribution. For instance, the homeownership variable can be allowed to interact with parameters of choice attributes to examine significance of interactions. Then, Eq. (3) is further extended to be Eq. (5), where w_r is a vector of the interaction parameters with O.

$$V_{ir} = ASC + \alpha[(\beta_r^{APT'} + w_r^{APT}O))X^{APT}] + h(\beta_r^{HOU'} + w_r^{HOU}O))X^{HOU}] + (\beta_r^{ALL'} + w_r^{ALL}O)X^{ALL} + (\beta_{r\mu}{}' + w_{r\mu}O)X_\mu \tag{5}$$

After all, *WTP* values for a marginal change (*MWTP*) of a non-payment attribute X_k can be estimated as a negative ratio (as shown in Eq. (6)) between its population moment $\widehat{\beta_k}$ and the population moment of a monetary parameter $\widehat{\beta_\mu}$, which might be a relatively reliable and accurate *WTP* estimator by avoiding the situation that preference heterogeneity is unreasonably constrained (Sillano and de Dios Ortúzar, 2005; Choi, 2020). This approach is in line with the parametric bootstrapping (Krinsky and Robb, 1986) that is commonly applied to estimate confidence intervals of mean *WTP* values. When the interaction parameters with *O* are significant for both β_{rk} and $\beta_{r\mu}$, Eq. (6) can be further specified as Eq. (7).

$$MWTP_{k} = -\frac{\widehat{\beta_k}}{\widehat{\beta_\mu}} \tag{6}$$

$$MWTP_{k} = -\frac{\widehat{\beta_k} + \widehat{w_k}}{\widehat{\beta_\mu} + w_\mu} \tag{7}$$

4. Research hypotheses

Although urban green open spaces and their amenities can be considered as public goods, justifying public financing or market interventions, their values might be internalized limitedly into the prices of local residential properties at varying degrees (i.e., pecuniary externalities) depending on the availability of nearby greenspaces. The public goods characteristics of urban green spaces make the estimation of green amenity values more difficult and complicated (i.e., existing technological externalities) than what studies of hedonic pricing might have showed (Morancho, 2003; Kong et al., 2007;

Melichar and Kaprová, 2013; Mittal and Byahut, 2016; Eom et al., 2019; Łaszkiewicz et al., 2019; Sohn et al., 2020). In this light the full gravity of residential preferences for urban green spaces might be better measured in stated preferences with a meaningful experimental design using discrete choice experiments.

Seoul, similar to most cities worldwide, has undergone rapid urbanization with a large-scale residential construction of apartments as the predominant choice of urban residents (OECD, 2012), and equitable distributions of green open spaces might be in question (Nesbitt et al., 2018). As shown vividly in the previous studies based on hedonic prices, homeowners or their properties enjoy pecuniary externalities, while tenants' values have been given little research interest. Then, homeownership might work as a useful device to differentiate between property values in the market and tenants' user values. When they are equivalent, we may say that amenity values are fully internalized as pecuniary externalities, without any remaining technological externalities. The public goods nature of urban green spaces prohibits us from expecting this situation. The more logical expectation is to have a significant technological externality; thus, a significant homeownership impact.

Homeowners who dwell at their own properties might perceive high amenity values from urban greenspaces because of their investment perspective and expected longevity of residency. Tenants might perceive lower amenity values because of a relatively short planning horizon and a lack of vested interest in the properties. Tenants as temporary users might consider whatever available during the contracted period only for their own interests as actual users, not for those of potential future buyers or the real estate market. Accordingly, we follow the conventional hypothesis that there is a non-zero pecuniary externality to support higher amenity values for homeowners (WTP^{OWNER}) than those of tenants (WTP^{TENANT}), ceteris paribus. Assuming the same technological externality regardless of homeownership, the difference might be a proxy indicator of the minimum pecuniary externality that is solely enjoyed by homeowners because we are not sure how much tenants also internalize the pecuniary externality. In the same logic, the technological externality (WTP^{TENANT}) is the maximum.

H1: $WTP^{OWNER} > WTP^{TENANT}$

Another aspect of the nature of public goods is a market failure with a shortage of green spaces. Notwithstanding the rapid growth in apartment dwellings, the economic values of urban green space amenities might be different between highly concentrated apartments and non-apartment houses that are relatively less constrained by space. Choices of residential types might imply differing values of pecuniary and technological externalities. Without any prior studies known to us, the logical expectation is that households residing in more spatially concentrated apartments have a differing marginal economic value for green open spaces (WTP^{APT}) than those in a single- or multi-family house (WTP^{HOU}):

H2: $WTP^{APT} \neq WTP^{HOU}$

III. Data collection

1. Choice attributes

In order to devise a useful set of choice attributes for residential preferences of green spaces, a literature review was conducted to know how green spaces were defined as attributes. According to the review, there are four general types of greenspaces: mountain/forests, rivers/lakes, urban parks, and private areas such as gardens and green coverages within residential areas (Kim et al., 2007; Kim and Choi, 2012; Panduro and Veie, 2013; Kolbe and Wüstemann, 2015). Furthermore, residential buildings can be classified as apartments and single- or multi-family houses (e.g., Kulu and Vikat, 2007). Regardless of property tenure arrangements, apartments are commonly occupied by single households, whereas houses are occupied by single or multiple households.

Different underlying characteristics between apartments and houses required a differing set of attributes for residential choices; thus, a split sample survey. The literature showed two general ways that urban dwellers perceive amenity values from green spaces: a "view" of green spaces from their residence and "access" within a given time frame or distance from their residence to a particular green space (Morancho, 2003; Kim et al., 2007; Lee and Kim, 2014; Mittal and Byahut, 2016).

As hypothesized above, structural differences between apartments and houses are likely to bring residents to a different set of greenspace-related attributes depending on their residential types. According to a focus group study in April 2016, involving eight household representatives who mostly held ownership or had a plan to buy a new place of residence, green space views were only relevant to those residing in apartments, but not much to those in non-apartment dwellings. This was because most houses do not enjoy a commanding height of green spaces, but private gardens. When there is a view for house dwellers it is commonly shared by neighbourhood houses, such as a mountain view. Therefore, the view attribute, together with the brand power of construction companies and green coverage, were adopted only for current apartment dwellers, while private gardens only for current house dwellers. Some focus group participants also argued that they were not happy with a view of rivers or lakes because of its melancholic feeling. As per accessibility to green open spaces, schools and subways, most focus group participants agreed that "a walking distance within 10 minutes" is a rough but clear way to describe whether or not any residence has access. Thus, these were equally applied to both residential types. And the "price" variable was used for the payment vehicle.

As a result, ten attributes were applied for apartment-based households and eight attributes for house-based households. They are shown in Table 1. The *VIEW* variable was a categorical one with five levels, and accessibility (*ACESS*) to three individual types of green spaces were adopted as a dummy: *MOUNT*, *RIVER* and *PARK*. Another challenge was to generalize different scales and ranges of residential costs: the payment attribute. For instance, they are in 100 million KRW (1 US$ = 1,100 KRW as of January 20201) for owners or tenants who pay a one-off deposit, but in 100,000 KRW for tenants who pay a monthly rent. A transformation mechanism was required so as to deliver a same payment burden across different residential types and ownerships. As an alternative, for the design purpose the payment attribute was taken as a relative price change in per cent against what respondents provided as their current price (e.g., a 20% increase or decrease from the current price): a pivot design (Hensher et al., 2005: p. 180). In order to make the choice situations realistic and meaningful, however, respondents were presented actual prices as a round-up figure (e.g., 480 million KRW).

〈Table 1〉 Choice attributes for apartments (APT) and houses (HOU)

Attributes	Description	Levels	APT	HOU
View	Living room view of apartment buildings, a cityscape, an urban park, a river/lake, a mountain/forest	Apartment, cityscape, park, river, mountain	✓	
Access (Within 10 minutes walking)	Having access to urban parks	Yes, no	✓	✓
	Having access to rivers or lakes	Yes, no	✓	✓
	Having access to mountains or forests	Yes, no	✓	✓
Subway stations	Having access to subway stations	Yes, no	✓	✓
Brand power	Brand power of the construction companies (e.g., Samsung “Raemian”and Deawoo “Prugio”)	Yes, no	✓	✓
Top schools	Linking to top middle or high schools	Yes, no	✓	✓
Primary schools	Easy access to primary schools	Yes, no	✓	✓
Coverage	Most parking lots located underground	Yes, no	✓	
Gardens	Having private gardens	Yes, No		✓
Price (%)	Percent of the current price/rent provided by respondents	-20, -10, 0, 10, 20	✓	✓

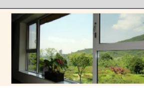
2. Experimental and questionnaire designs

Given the primary information that individual respondents provided about their current dwellings, residential types automatically triggered different choice frameworks, either apartments or houses, in a split sample online survey. In each framework, choice sets were comprised of three options: the current "status quo" characteristics as defined by respondents and two alternatives for a new residence. As shown in Table 1, Fig. 1 and Fig. 2, residential choice questions were described with ten attributes for apartments (one categorical variable with five levels for a view, eight dummy variables, and one interval variable for a price) and eight attributes for houses (seven dummy variables and one interval variable for a price).

Due to the different numbers of attributes, two experimental designs were prepared separately for the apartment and house frameworks for a split sample survey. Unlabelled and balanced choice experiments required twenty choice sets for apartments (i.e., the minimum 14 degrees of freedom (4+8+1+1=14)) and 10 choice sets for houses (i.e., the

〈Figure 1〉 A choice set example for apartment dwellers

C2. If there were only three residential options available for you to buy or rent, as shown below, which one would you choose? The first option A indicates your present apartment.

Attributes	Current Apartment A	Apartment D	Apartment E
View			
Access [within 10 minutes walking]	X X Parks	Mountains/forests Rivers/lakes Parks	X Rivers/lakes X
Center [within 10 minutes walking]	Yes	Yes	X
Brands	Yes	Yes	Yes
Top schools	Yes	X	Yes
Primary schools	Yes	X	X
Coverage			X
Price	**500 million KRW**	**400 million KRW**	**600 million KRW**

〈Figure 2〉 A choice set example for house dwellers

C2. If there were only three residential options available for you to buy or rent, as shown below, which one would you choose? The first option A indicates your present house.

Attributes	Current Apartment A	Apartment D	Apartment E
Access [within 10 minutes walking]	X X Parks	Mountains/forests Rivers/lakes Parks	Mountains/forests X X
Center [within 10 minutes walking]	Yes	Yes	Yes
Top school	Yes	Yes	X
Primary school	Yes	Yes	X
Garden	X		
Monthly rent	**250 million KRW**	**225 million KRW**	**200 million KRW**

minimum 9 degrees of freedom (7+1+1=9)) (Hensher et al., 2005). A simple blocking rule was applied to choice questions involving apartments so as to offer the first half or the second half of the twenty choice questions to individual respondents in a random manner. As a result, each questionnaire included ten choice questions. Also, choice sets were created using *D*-optimal efficient designs (Ferrini and Scarpa, 2007), where estimation results from a pilot study involving 100 respondents were used as priors for the final experimental designs.

Questionnaires were largely comprised of three main parts. The first part was about the current residential types and homeownership, respondents' attitudes about their residential areas, such as air quality and presence of unpopular facilities, activities in greenspaces, and past purchasing experience. The second part was to create a hypothetical framework for residential choices, tailor-made a priori to suit the responses in the preceding part so to acquire realistic responses. Respondents were introduced to a set of attributes of their residential types and asked to choose their current levels one by one, including the current prices or what they paid. The intention of this excise is to make them familiar with the framework and the attributes. As described in the introduction, Korea has the unique “Jeonse” payment system for tenants. According to the preceding responses about current prices, the payment attribute was designed to take one of three formats consistently throughout whole questionnaires: a transaction price for homeowners, and a one-off deposit (“Jeonse”) or a monthly rent for tenants. Then, they were informed that in the following ten questions they were assumed to purchase or rent a new residence. After ten choice sets were completed, such as Fig. 1 or Fig. 2, the third part was about general socioeconomic backgrounds.

As a result, respondents provided the information about the current conditions of the ten attributes for apartment dwellers or the eight attributes for house dwellers, including the payment attribute. These responses were spontaneously formulated to provide a “status quo” option for the later choice questions (i.e., a pivot design), as shown in Fig. 1 and Fig. 2, and the other two alternatives and their attribute levels were determined based on the experimental designs as explained above. The payment attribute was tricky to deliver realistic and consistent changes across respondents because of the three payment formats with largely dissimilar amounts. For instance, transaction prices and one-off deposits are mostly in 100 million KRW, with a wide range, whereas monthly rents are in 100 thousand KRW. Because a realistic payment range for individual respondents was critically important, the payment attribute was designed to have per cent changes proportional to respondents’ current payment levels, individually tailor-made, thanks to the flexibility and adaptability of online survey systems (Hensher et al., 2005: p. 180).

An online survey was conducted in July 2016, by a survey company (EMBRAIN PUBLIC) that offered one of the biggest online panels in South Korea. A split-sample design was used based on the number of registered households (i.e., 3.5 million households) and their residential types (i.e., 66% apartment-dwelling) across 25 administration units in Seoul. A total of 1,000 effective online questionnaires were collected, where 500 questionnaires were for apartment-based households and 500 for house-based households.

IV. Results and discussion

The split-sample online survey produced two datasets of residential types, involving 1,000 representative households in Seoul. As shown in Table 2, household characteristics are dissimilar between the two samples. First of all, asymmetric homeownership compositions are evident. About 64% of the households in the apartment sample are owners, while it is 37% of those in the house sample. Nonetheless, owner households are

〈Table 2〉 Sample compositions for apartment and house dwellers

Variable		APT (%)	HOU (%)	Variable		APT (%)	HOU (%)
Age	19-29	46 (9.2)	82 (16.4)	*VIEW*	Apartment	254 (50.8)	
	30-39	179 (35.8)	181 (36.2)		Cityscape	119 (23.8)	
	40-49	200 (40.0)	152 (30.4)		Park	22 (4.4)	
	>50	75 (15.0)	85 (17.0)		River	28 (5.6)	
Gender	Male	249 (49.8)	232 (46.4)		Mountain	77 (15.4)	
	Female	251 (50.2)	268 (53.6)	Access	*PARK*	317 (63.4)	259 (51.8)
Marriage	Married	401 (80.2)	298 (59.6)		*RIVER*	233 (46.6)	159 (31.8)
	Single	95 (19.0)	192 (38.4)		*MOUNT*	227 (45.4)	170 (34.0)
	Other	4 (0.8)	10 (2.0)	*CENTER*		383 (76.6)	383 (76.6)
Education	Tertiary	378 (75.6)	309 (61.8)	*BRAND*		293 (58.6)	
Income monthly (10,000 KRW)	<300	52 (10.4)	133 (26.6)	*SCHOOL*		269 (53.8)	286(57.2)
	300-499	168 (33.6)	186 (37.2)	*PRIMARY*		323 (64.6)	291(58.2)
	500-699	142 (28.4)	110 (22.0)	*COVER*		314 (62.8)	
	700-899	81 (16.2)	35 (7.0)	*GARDEN*			163(32.6)
	>900	57 (11.4)	36 (7.2)	Student primary school or below	Present	203 (40.6)	137 (27.4)
Household size	1	23 (4.6)	80 (16.0)		None	297 (59.4)	363 (72.6)
	2	77 (15.4)	88 (17.6)	Student mid-high schools	Present	128 (25.6)	99 (19.8)
	3	156 (31.2)	130 (26.0)		None	372 (74.4)	401 (80.2)
	4	193 (38.6)	151 (30.2)	Ownership	Owner	318 (63.6)	185 (37.0)
	>5	51 (10.2)	51 (10.2)		Tenant	182 (36.4)	315 (63.0)

slightly over-represented in the samples because the owner rates were respectively about 57% and 27% in the census data in 2015 (KOSIS, 2017). Households living in apartments are more likely to be married with kids, with a relatively high income level, education, or owners of the property, while relatively young (less than 30), single, or tenant households are more likely to reside in a single- or multi-family house. About 77% of the households have a subway within the walking distance (about 10 minutes) regardless of the residential types. Furthermore, being a catchment area for top middle or high schools is slightly higher for the house dwellers, whereas the apartment dwellers have an easy access to primary schools. When there is a student or kid present in the households, they are more likely to reside in apartments than houses.

Sample compositions are also significantly different between the two residential groups when their current status of green amenities are considered. Among the apartment dwellers, about 51 % of the sample have a view of apartment buildings, 24% a cityscape, 15% a mountain, 6% a river/lake and 4% a park. These rates support that a view of natural green spaces is a generally rare amenity, with three quarters of apartment dwellers in Seoul see either apartment buildings or a cityscape.

Access to green spaces is generally better for apartment dwellers than house dwellers. More than 63% of the households for the apartment sample have an urban park within the walking distance of 10 minutes, 47% a river/lake and 45% a mountain, while the compositions are lower for the house sample to be 52%, 32% and 34%, respectively. The accessibility anomalies between the two types of residence across three green space types were all statistically significant at the 0.05 level, when tested using a cross-tabulation analysis. Also, those having a good green coverage are 63% of the apartment dwellers, while 33% of the house dwellers have a private garden. The difference was also statistically significant at the 0.05 level. This means people living in apartments are more likely to enjoy privatized green spaces, either private or shared with their peers, than those living in single- or multi-family houses. As contended by Nesbitt et al. (2018), the equity issue might exist in Seoul, discriminating those living in houses.

1. Discrete choice models

The two datasets included 15,000 choice responses for each residential type, which were analysed using Nlogit 4.0. For simulation of random parameters, 500 halton draws were applied. The final discrete choice models and their parameter estimates for basic and advanced models are shown in Table 3. They have a good fit with a pseudo R^2 value between 0.30 and 0.31. Significantly negative *ASC* parameter estimates indicate that house dwellers hold a significant preference or attachment toward the current residence against new alternatives, at the 0.05 level, even after the given set of other factors were taken into account. In contrast, the attachment effect is not significant for apartment dwellers.

Most estimates of the two basic models with random parameters for apartment dwellers (APT-S1) and house dwellers (HOU-S1) are significant at the 0.05 level with the expected signs. Their standard deviation parameters are also mostly significant, indicating presence of preference heterogeneity. Some exceptions are access to rivers/lakes (*RIVER*) and access to mountain/forests (*MOUNT*) for the apartment sample, and access to primary schools for the house sample.

Homeownership was hypothesized as a major factor influencing the extent to which urban residents attach economic values to green open spaces due to differing expectations and prospects involving residence (e.g., longevity of interests and property values). As shown in Eq. (1), homeowners might enjoy both pecuniary and technological externalities, while tenants might enjoy the latter only. In order to test the first hypothesized relationship, the homeownership variable was allowed to interact with parameters of significant preference heterogeneity, first without other explanatory variables for preference heterogeneity (APT-S2 and HOU-S2 in Table 3) and then together with them (APT-S3 and HOU-S3 in Table 3). Significant interaction terms are only shown in Table 3.

The second hypothesis suggested the relationship that households dwelling in

〈Table 3〉 Parameter estimates using random parameter logit models

Variable	Apartment			House		
	APT-S1	APT-S2	APT-S3	HOU-S1	HOU-S2	HOU-S3
ASC[a]	-0.0750	-0.1118	0.0034	-0.2515**	-0.2946**	-0.2396**
V-CI	0.0189	-0.0013	0.0054			
V-PA	-0.1730	-0.1897*	-0.2130*			
V-RI	0.2390**	0.2654**	0.2934**			
V-MO	0.4320**	0.3999**	-0.3899			
PARK	0.2948**	0.2815**	0.2862**	0.4293**	0.4243**	0.4527**
RIVER	0.3313**	0.3339**	0.3530**	0.3272**	0.3274**	0.3876**
MOUNT	0.2643**	0.2536**	0.2753**	0.3659**	0.3817**	-0.1742
CENTER	0.9441**	0.9503**	0.9532**	1.0555**	1.0342**	0.9144**
BRAND	0.3379**	0.3292**	0.3269**			
SCHOOL	0.4934**	0.4834**	0.3197**	0.3531**	0.3474**	0.1659**
PRIMARY	0.3868**	0.3968**	0.2555**	0.2624**	0.2701**	0.2558**
COVER	0.3304**	0.3340**	0.3432**			
GARDEN				0.6930**	0.7716**	0.5301**
PRICE	-0.0333**	-0.0481**	-0.0451**	-0.0397**	-0.0388**	-0.0640**
V-MO:AGE[c]			0.0200**			
RIVER:CHILD[c]						-0.2317**
MOUNT:AGE[c]						0.0138**
CENTER:GEN[c]						0.2657*
CENTER:EDU[c]						0.2100*
CENTER:CHILD[c]			0.4410**			-0.4123**
SCHOOL:CHILD[c]						0.5381**
SCHOOL:MIDHIGH[c]						0.2225*
PRIMARY:CHILD[c]			0.3711**			
GARDEN:GEN[c]						0.2678**
GARDEN:OWNER[c]					-0.1882**	
PRICE:OWNER[c]		0.0251**	0.0231**			
PRICE:INCOME[c,d]						0.0456**
Standard deviation parameters						
NsASC[b]	1.9223**	1.8123**	1.9938**	1.5328**	1.4961**	1.4126**
NsV-OP[b]	0.1749	0.2235**	0.2951			

〈Table 3〉 Parameter estimates using random parameter logit models (Continued)

Variable	Apartment			House		
	APT-S1	APT-S2	APT-S3	HOU-S1	HOU-S2	HOU-S3
NsV-PA[b]	0.4070**	0.4124**	0.4625**			
NsV-RI[b]	0.3330**	0.3579**	0.2577			
NsV-MO[b]	0.4437**	0.3633**	0.3875**			
NsPARK[b]	0.3031**	0.3656**	0.3545**	0.2946**	0.3013**	0.3673**
NsRIVER[b]				0.3282**	0.3308**	0.3434**
NsMOUNT[b]				0.3589**	0.3347**	0.2894**
NsCENTER[b]	0.7933**	0.7887**	0.8409**	0.8008**	0.8431**	0.8223**
NsBRAND[b]	0.2940**	0.3061**	0.3564**			
NsSCHOOL[b]	0.4519**	0.4603**	0.4411**	0.5763**	0.5508**	0.5291**
NsPRIMARY[b]	0.3094**	0.3347**	0.3425**			
NsCOVER[b]	0.3175**	0.2939**	0.2886**			
NsGARDEN[b]				0.4456**	0.4448**	0.5028**
NsPRICE[b]	0.0563**	0.0532**	0.0563**	0.0505**	0.0517**	0.0041**
Model fit						
LL	-3847.25	-3854.61	-3811.18	-3846.03**	-3844.20	-3774.75
X^2	3291.62**	3276.91**	3363.77**	3294.07**	3297.73**	3436.62**
Pseudo R^2	0.30	0.30	0.31	0.30	0.30	0.31
AIC	1.55	1.55	1.54	1.55	1.55	1.52
Respondents	500	500	500	500	500	500

[a]Alternative specific constant (*ASC*) stands for two alternative options against the current "status quo" option.
[b]These are derived standard deviations of parameter distributions, assumed to be normally distributed.
[c]Interaction terms show how much a particular parameter with a significant preference heterogeneity is explained by ownership (OWN=1 for owners), age (*AGE*), gender (GEN=1 for female), education (*EDU*=1 for a university degree, monthly household income in 10 million KRW (*INCOME*), students (*CHILD*=1 for a kid under grade 6; MIDHIGH=1 for a student between grades 7 and 12).
*Significant at the 0.05 level, **Significant at the 0.01 level.

different residential types have inequivalent amenity values. Because *MWTP* estimates for accessing the three types of urban green spaces were commonly available between the apartment and house samples, as can be seen in Table 1, a pair of mean *MWTP* estimates for a particular green space type can be examined for their statistical relationship using a convolutions approach (Poe et al., 1994). According to this approach, individual estimates within a *WTP* distribution are compared with those within another *WTP* distribution in order to form a new distribution of differences. The probability for the final distribution to include zero determines the statistical relationship between the two *WTP* distributions. The probability figure needs to be smaller than 0.0250 for the two *WTP* distributions to be different (i.e., a two-sided test) or 0.0500 for any side to be larger than the other at the 0.05 level (i.e., a one-sided test).

2. MWTP values of green spaces

Resulting *MWTP* estimates are shown in Table 4. All measured *MWTP* values of green amenities are significant and substantial at the 0.05 level, and their relative values on average ranging between 16% and 33% of the current residential price. The range of the amenity values are within the boundary of capitalization effects of previous hedonic studies (Mittal and Byahut, 2016). Among the four visual alternatives for the apartment sample, a view of mountains is most preferred with an average value of 33% of the current price, ceteris paribus, followed by a view of a river/lake (27%), an urban park (20%) and a cityscape (20%). Access to waterfronts displays a strong impact on the residential preferences with on average 20% of the current price, followed by urban parks (18%) and mountains (16%). Generally speaking, the relatively scarce forms of green amenities (see Table 2), such as views, are linked to high preferences. This might be because households residing in the same apartment buildings or complex are likely to share the same or similar boundaries for accessibility, while their green space views can be dissimilar depending on the floor levels and directions.

The magnitude of economic values for green spaces was similar for the house sample, but with different preferences for individual amenities. The most influential green amenity is access to an urban park with 22 % of the current residential price, ceteris

〈Table 4〉 Average MWTP as per cent changes of the current property value

Variable		APT-S1 (95% CI)	HOU-S1 (95% CI)	APT-S3 (*AGE*=41, *CHILD*=1)	
				Owners	Tenants
View (Against a view of apartments)	Cityscape	20.06 (12.92, 30.08)	N.A.	40.87	19.97
	Park	20.06 (12.92, 30.08)	N.A	31.21	15.25
	River	27.33 (16.24, 41.26)	N.A.	54.18	26.47
	Mountain	32.88 (21.24, 49.57)	N.A.	40.87	19.97
Access (Within 10 minutes walking)	Park	17.66 (12.16, 25.25)	21.54 (17.15, 26.93)	25.96	12.68
	River	19.72 (13.87, 28.00)	16.50 (11.64, 21.90)	32.02	15.65
	Mountain	15.80 (11.00, 21.70)	18.44 (14.26, 23.70)	24.97	12.20
Subway stations (Within 10 minutes walking)		56.64 (44.70, 74.26)	53.38 (43.71, 65.63)	86.45	42.25
Brand power		20.24 (14.49, 28.69)	N.A.	29.65	14.49
Top mid-high schools		29.56 (22.25, 40.05)	17.83 (13.59, 22.70)	69.00	33.72
Easy access to primary schools		23.07 (16.96, 31.11)	13.15 (9.23, 18.31)	56.83	27.77
Coverage/gardens		19.74 (13.85, 28.22)	35.23 (27.45, 44.85)	31.13	15.21

paribus, followed by access to mountains (18%) and rivers (17%). Also, given the fact that a significantly smaller proportion of house dwellers had access to green spaces than apartment dwellers (see Table 2), private gardens display a significantly higher economic value of 35%. Choices of residential types might influence the extent to which households associate with their surrounding green spaces and resulting amenity values.

Similarities and anomalies between the two residential types were also apparent when preferences for the conventional variables of residential satisfaction were considered. As the most important factor for residential choices, access to a subway station has a relative value of 57% for the apartment sample and 53% for the house sample. This result signifies that mobility is an essential element for urban livelihoods regardless of residential types in Seoul. The next important factors are access to top middle/high schools and an easy connection to primary schools with 30% and 23% of the current price of the apartment sample, respectively. In contrast, their relative values are lower for the house sample to be 18% and 13%, respectively, while the private garden stands as a major factor with 35% of the current price, ceteris paribus. Furthermore, the brand power of the construction company and having most parking spaces underground for a green coverage on the surface have the residential value of about 20% of the current price for the apartment dwellers.

3. The impact of homeownership

The extent to which homeownership (i.e., owners vs. tenants) influence the amenity value of green open spaces (H_1) was found to be different between the two residential types. According to the estimation results using MXRP models, as shown in APT-S3 Table 4, apartment owners hold a significantly larger mean *MWTP* estimate across all green space attributes than that of apartment tenants. According to Eq. (5), the homeownership impact on the amenity value of green spaces was tested as the interaction terms. The estimation results in APT-S2 of Table 3 show that the interaction parameter is positively significant at the 0.05 level, ceteris paribus, when the homeownership variable is a sole explanatory variable for preference heterogeneity. Based on Eq. (7), the owners tend to hold a smaller marginal utility of money (i.e., $\beta_{\mu}' + w_{\mu} = -0.481 + 0.0251$) than tenants; thus, increasing their *MWTP* values as a homeowner premium for apartment dwellers. As can be seen in APT-S3 of Table 3, the significant impact subsists when other socioeconomic characteristics are controlled together, such as age, gender, education, household income, and presence of a child or student. The homeownership impact was substantiated in the last two columns of Table 4. The resulting *MWTP* estimates of apartment dwellers for green amenities are about two times larger for owners than those for tenants. As a consequence, the first hypothesized relationship can be accepted for apartment dwellers.

On the other hand, in the case of house dwellers, estimation results of HOU-S2 of Table 3 show that the homeownership variable as the sole explanatory variable for heterogeneous preferences has a significant interaction parameter for private gardens at the 0.05 level, ceteris paribus. However, the impact disappears when other explanatory variables are controlled, as shown in HOU-S3 of Table 3. Thus, we reject the hypothesized impact of homeownership on the amenity value for house dwellers.

4. The impact of residential types

A pair of mean *MWTP* estimates for accessibility to individual green space types were compared in a statistically meaningful way between the apartment and house samples. When the convolutions approach was applied (Poe et al., 1994), the probability figures for the two value estimates to be the same were 0.1718 for a park, 0.2364 for a river/lake and 0.2237 for a mountain. Because the second hypothesis assumed different mean *WTP* values, the probability figure must be smaller than 0.0250 to reject their equivalence at the 0.05 level. Consequently, because value equivalence cannot be rejected for all types of green spaces, we rather reject the second hypothesis.

The intriguing but anomalous relationships between the two samples might be partially explained by the fact that monthly household incomes work as a significant determinant of house dwellers' values for green spaces, as can be seen in the estimation results of HOU-S3 in Table 3. Based on Eq. (7), the negatively significant interaction term with income levels increases *MWTP* values of having access to green spaces, although it is not the case with homeownership. For instance, the mean *MWTP* value for having an urban park within the walking distance, for those living in houses, is equivalent to about 20% of the current residential price when their monthly household income equals 4 million KRW, while it is about 33% when their monthly income equals 8 million KRW. Although it might be difficult to explain the cause for the discrepancy between the two residential samples, the results might be self-evident by the fact that 77% of the house-dwelling households in Seoul were tenants in 2015 (KOSIS, 2017). The demand for green spaces is more likely to increase only when house dwellers are rich, but not when they are homeowners because the majority of houses are for rent. As argued by Poudyal et al. (2009), there might the rich-poor discrimination in the provisions of green open spaces for houses in Seoul, which might be not the case for apartments.

On the other hand, a significant difference was observed for the privatized green spaces: the mean *MWTP* value for the gardens and multifunctional coverage areas of apartments (*COVER*; 20%) is significantly and substantially smaller than that of houses (*GARDEN*; 35%) at the 0.05 level. The probability figure for difference was 0.0048. This anomaly might be a fundamental reason explaining why house dwellers, particularly the rich, prefer houses as their residential choice to apartments. The amenity value of private green spaces is the second highest after mobility, determining residential choices of house dwellers, while it is not the case for apartment dwellers.

Other residential factors also showed a significantly different economic values between apartment dwellers and house dwellers, as shown in Table 4, such as advantageous locations for entering to middle or high schools (respectively 30% vs. 18%) and a safe access to a primary school (respectively 23% vs. 13%). The anomalies might indicate different expectations that urban households consider importantly in their choices of residential types. Accordingly, the residential profile that most apartment dwellers in Seoul might want is a residence essentially with a subway station within the walking distance and within a catchment area for top mid-high schools, with a view of a waterfront or a mountain, and optionally with a primary school directly connected for safety, with one or more green spaces within the walking distance, built by famous "brand" companies, and with a green coverage. Likewise, the residential profile for house dwellers is a residence essentially with a subway station within the walking distance, with a garden, and optionally with one or more greenspaces within the walking distance and within a catchment area for top mid-high schools.

Additional anomalies were found in the impact of household characteristics between the two residential samples, as can be seen in Table 3. The older the residents are, the higher amenity value they get from a mountain view for apartment dwellers, while it is from the access value to a mountain for house dwellers. If your household has a child, for house dwellers it works as a negative factor to avoid areas near waterfronts or a subway station, but as a positive factor to be within a catchment area for top secondary schools; and for apartment dwellers as a positive factor to be near a subway station or to have a safe connection to a primary school, ceteris paribus. Furthermore, gender as an explanatory variable was only significant for house dwellers: female members of households display a higher economic value for a subway station and a private garden than male residents, ceteris paribus. Differing spatial and structural characteristics between apartments and houses might drive households' preferences to be dissimilar, reflecting their residential needs, with more complicated preferences for house dwellers.

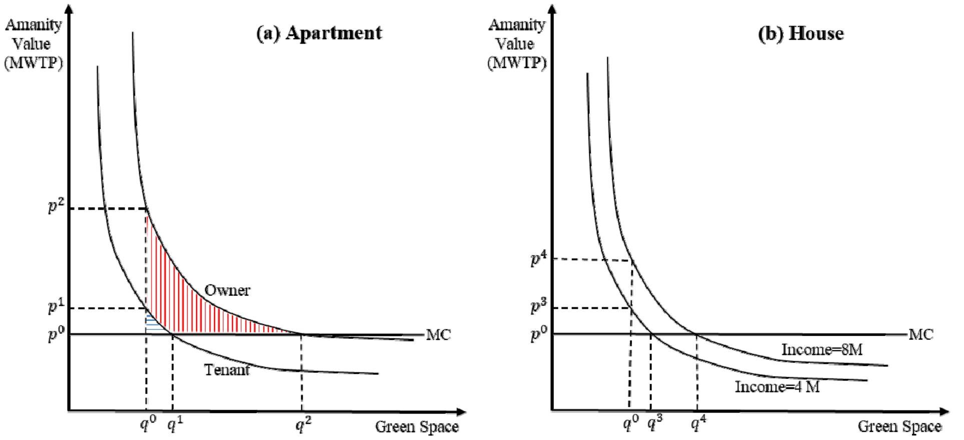
5. Residential profiles

Building on the above results, three residential profiles for urban green amenities can be also suggested. The first group of households are apartment dwellers with homeownership (about 38% of all households in Seoul), who perceive and realize the most of the amenity values from urban green spaces. The second group includes house dwellers with a relatively high income level, with or without homeownership, who also enjoy as much amenity values as one can get from urban green spaces. The third group is comprised of tenant households share a substantially diminished value from green amenities, who are either living in apartments (about 28% of all households in Seoul) or in houses with a relatively low household income. For example, the mean access values for a nearby mountain are about 25%, 21% and 12%, respectively for the three profile groups; and those of an urban park about 26%, 33%, and 13~20%, respectively.

6. Amenity values as positive externalities

As specified in Eq. (1), amenity values of green open spaces as public goods are comprised of pecuniary and technological externalities, and homeownership has contrasting effects between apartment and house dwellers. Figure 3(a) visualizes economic values of green spaces for households living in apartments. The results above proved that homeowners have as twice amenity values (p^2) as tenants do (p^1) from the given amount of green spaces (q^0). Given a market failure in providing urban green spaces, the efficiency loss might be different between homeowners and tenants. When the marginal cost of green spaces is constant as p^0, the market efficiency is made with q^1 for tenants, with which their efficacy loss at the current situation is the area of horizontal lines. In contrast, homeowners with higher amenity values need q^2 to reach economic efficiency, and their economic loss at the present situation equals the two lined areas in Figure 3(a).

〈Figure 3〉 Amenity values and residential types



With much uncertainty, homeowners' economic value p^2 is comprised of significant pecuniary and technological externalities. To the contrary, tenants' economic value p^1 might be mostly technological and there can be an unknown amount of pecuniary externalities. As a consequence, p^1 represents the maximum technical externalities that any households can hold for q^0 green open spaces, and $p^2 - p^1$ equals the minimum pecuniary externalities. If policy makers decided to increase green spaces, what should be the target quantity? To be conservative, the optional point is at least q^1. How about increasing the budget so to reach q^1? Although this can be politically in demand, any increase more than q^1 is not endorsed for public policies because it is economically inefficient; the marginal benefit from the unit increase is smaller than the marginal cost. Therefore, homeowners' amenity values should be not referenced for an efficient public policy, but only tenants' values.

However, the same policy approach does not work for house dwellers. As can be seen in Figure 3(b), household income differences affect the amenity values, not homeownership. The example used above can be visualized for symbolic households with a monthly income of 4 or 8 million KRW. The amenity values of the current green spaces q^0 are respectively p^3 and p^4. Then, in order to fix a market failure, where is the optimal amount of green spaces for an intervention policy? According to the empirical results above, it must be somewhere between q^3 and q^4 because there is no empirical reason for house dwellers to hold a positive pecuniary externality. Their amenity values signify the maximum technological externality. Disentanglement of the pecuniary externality from the technological externality is beyond the boundary of this paper.

V. Conclusions

Green open spaces as public goods provide positive externalities that are comprised of pecuniary and technological externalities. The study results evidenced that the differentiation between the two types of externalities is imperative for equitable provisions and efficient management of various urban open spaces, which are in question in many parts of the world, as contended in previous studies. Many studies on the economic values of urban green spaces have relied on transaction records of apartments using the hedonic price method, while non-apartment houses or tenant households rarely received a proper coverage. However, hedonic prices are internalized pecuniary externalities. A market failure with a shortage of green spaces is caused by technological externalities, justifying an intervention policy. Addressing the paucity of empirical evidence for technological externalities and preference heterogeneity, this paper critically examined the effects of homeownership on the economic values of green spaces between apartments and single- or multi-family houses.

Based on choice datasets from a split-sample survey in Seoul, the results evidenced a positively significant and substantial impact of homeownership for apartment dwellers, ceteris paribus, but not for house dwellers. Consequently, policy objectives for economic efficiency should be formulated differently between the two residential types. For apartments, the minimum pecuniary externality might be equal to the divergence between MWTP estimates of homeowners and tenants, whereas the latter signifies the maximum technological externality. Therefore, the efficiency loss could be reduced by increasing green spaces up to the critical point where the marginal cost (financial resources) is at equilibrium with tenants' MWTP values. For non-apartment houses, it might not be homeownership but the monthly household income that has a significant impact on the amenity value of green spaces. Nevertheless, tenants' MWTP value might be equivalent to the maximum technological externality, because of the lack of theoretical and empirical grounds to disentangle a pecuniary externality across diverse income levels.

The findings are novel and important for public policies to initiate an efficiency-driven target for the areas of apartments, and an equity-driven target for the areas of non-apartment houses. In general, public benefits from green spaces are equivalent to

16% to 33% of the current residential prices on average for a view or access. Different residential types might not cause a significant impact on the access values. However, different homeownership types might cause substantial anomalies between the two residential types: a substantial and significant impact of homeownership for apartment dwellers, while it might not be the case for house dwellers. Keeping everything else the same, urban dwellers are willing to pay a substantial amount of their residential cost for additional green space amenities, such as a better view or access, or for keeping them from disappearing.

Although overall value estimates might reflect the current availability of green spaces in terms of views and accessibility, diverse forms of green amenities might not follow the same trend. For instance, urban parks that are more widely accessible than mountains might show the higher welfare value. For apartment dwellers, a mountain view might be perceived with a higher value than a waterfront view, although the former is more widely available. The overall relationships between availability (scarcity) and the demand for green amenities might be more complex than expected.

As one of the main conclusions, the amenity value of green open spaces is substantially large, regardless of residential types; yet, the way households associate with green amenities might vary between the residential types for several reasons. Firstly, apartment dwellers give more weight to natural areas, such as rivers and mountains, than artificial sources, such as urban parks or cityscapes. Secondly, apartment dwellers generally show homogeneous preferences, while house dwellers display relatively more heterogeneous preferences in terms of their age, gender, income, and presence of a child. Thirdly, although mobility is the single most influential factor for every household, having a subway within the walking distance, residential profiles that households of different residential types are keen to acquire are dissimilar. Apartment dwellers might start from a catchment area for top mid-high schools with a view of a waterfront or a mountain, and then may consider other factors such as accessibility to nearby greens paces and the brand power of construction companies. On the other hand, house dwellers might look for a garden, and then for nearby greens paces and a catchment area for top mid-high schools.

There are several limitations and future research topics worth further notes. Firstly, the welfare value estimates for green spaces and other factors are marginal and conditional upon changes, keeping all other things the same. As a result, value additivity does not work in terms of the market prices of any residences, partially due to the scoping effect. Secondly, a sample size of 500 households for each residential type might work as a limitation factor for further segmentation-based data analysis. Thus, the results provide overall trends and snapshots on average for urban green amenities. Specific preferences for particular segments of population and local particularities might require a bigger sample size to be examined. Any generalization might require follow-up studies. Thirdly, the data collection was done 5 years ago in 2016, which might be difficult to reflect temporal changes of greenspaces in Seoul, particularly after COVID19. Nonetheless, it might be hard to expect rapid changes in availability of greenspaces and their comparative amenity values. Finally, the impact mechanisms of amenity values might be different depending on the unique characteristics not only of physical aspects, such as residential types, but also of sociocultural aspects, such as the way people interact each other and with natural environment. The complicated relationships and underlying mechanisms also require further studies not only to justify public investments, but also to explain complex preference heterogeneity involving, for example, differing levels of urbanization and green infrastructures, population density per a unit area, and diverse sociocultural contexts. The inspiring findings also grant an in-depth study of pecuniary externalities across differing income levels of house dwellers.

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