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Tropical Vegetation and Residential Property Value: A Hedonic Pricing Analysis in Singapore

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ABSTRACT

Effective urban planning depends on knowing homebuyers' preferences for neighbourhood features that provide different amenities, such as managed parks and trees. As the expansion of tropical urban areas into biodiversity hotspots is predicted to more than double by 2030, knowing homebuyers utility from different vegetation types can contribute to global biodiversity conservation strategies. We used the hedonic pricing method to estimate the economic value of managed, spontaneous and high conservation value vegetation to Singapore public housing using a mixed effects model. On average vegetation had positive effects on property selling price, accounting for 3% of the average property's value, or a total of S$179 million for all public housing apartments sold over 13 months. These effects were almost entirely driven by managed vegetation, which had positive marginal effects on price for 98.1% of properties. The estimated marginal effects of high conservation value vegetation were mostly negative (90.5%% properties), but positive for properties without much managed vegetation nearby. The estimated marginal effects of spontaneous vegetation were mixed and mostly small. To reconcile the goals of protecting high conservation value vegetation and maximising homeowner utility, new public housing developments should contain more managed vegetation but be away from high conservation value vegetation.

1. Introduction

Vegetation provides services to society that are often not quantified, and are subsequently undervalued in land-use decision making (Daily et al., 2009). Various stated and revealed preference methods exist to determine vegetation value, including the hedonic pricing method applied to residential property selling prices. The hedonic pricing method assesses how different combinations of neighbourhood, structural and environmental characteristics (including neighbourhood vegetation) influence the price consumers are willing to pay for a property (Rosen, 1974). Vegetation variables are commonly included in hedonic pricing analyses because vegetation provides positive amenities in the form of ecosystem services, which include aesthetic value, recreation, mitigation of the urban heat island effect and improvement in air quality.

Proximity to nature areas has been identified as an important determinant of property price around the world, with recreational parks having clearer positive effects than forest. In a review of the literature, we found that distance to the nearest recreational park was identified having positive and statistically significant effects on house prices eight times (Cho et al., 2006, 2009b; Kaufman and Cloutier, 2006; Poudyal et al., 2009; Sander and Polasky, 2009; Song and Knaap, 2004; Troy and Grove, 2008; Tyrvainen, 1997) and insignificant effects four times (Cho et al., 2009a; Kong et al., 2007; Mahan et al., 2000; Nicholls and Crompton, 2005), whereas distance to nearest forest was positive and statistically significant twice (Mansfield et al., 2005; Tyrvainen and Miettinen, 2000) and insignificant six times (Irwin, 2002; Jim and Chen, 2006; Kong et al., 2007; Mueller and Loomis, 2008; Powe et al., 1997; Tyrvainen, 1997). In South China and Hong Kong, similar effects of nearby vegetation on property price were observed. Metrics of park quantity or accessibility were significant in all three studies that considered it (Chan et al., 2008; Chen and Jim, 2010; Jim and Chen, 2010). In two of these studies the presence of a park within a neighbourhood explained 10–11% and 15% of property price, respectively (Chan et al., 2008; Jim and Chen, 2010). The quantity of woodlands was considered in one study and found not to have a statistically significant effect (Jim and Chen, 2006).

However few of these studies were conducted in tropical areas. Of 83 hedonic-pricing studies we identified (see supplementary material for full list of references) that included vegetation as an explanatory variable, 61 were in temperate ecozones (as defined by Breckle, 2002) while only six were found in tropical ecozones (five in Hong Kong or Guangdong; one in Brazil), the remaining fifteen studies were located in

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Mediterranean forests, woodlands and scrub (9); deserts and xeric shrublands (4); and boreal forests and taiga (2).

The lack of knowledge about homebuyer's preferences for neighbourhood vegetation in tropical areas needs to be addressed directly, because preferences are known to vary geographically and estimated values cannot be simply transferred from other regions (Brander and Koetse, 2011). For example, one study in a desert ecozone found that neighbourhood greenness was the variable with the strongest effect on property selling price, potentially due to greenness naturally being a rarer feature in the desert landscape (Bark et al., 2009). This contrasts with temperate forest ecozones where vegetation is commonly not the most important variable (property structural characteristics are more influential). One possible reason differences exist between the tropics and other locations is that ecosystem services (or, in some cases, disservices) relevant to homebuyers vary in type and magnitude across ecozones. For example, urban forests in tropical areas can cool the climate through evapotranspiration and shade. In tropical Singapore the difference in temperature between a forest and urban location can be up to ~7 °C, (Roth and Chow, 2012), enough to moderate the urban heat island effect and dramatically reduce the risk of heat stress in cities where the temperature is regularly > 30 °C (Makaremi et al., 2012). In contrast, the urban heat island effect in temperate locations can have either a positive or negative effect depending on the time of year. More information about the economic value of natural vegetation to residents of tropical cities is needed to ensure a fair and efficient planning process in these cities.

The need to understand homebuyers' preferences for vegetation in tropical cities is also important for biodiversity conservation. Tropical areas have high biodiversity and are urbanising rapidly. In the period 1980–2000 the urbanisation rate in tropical cities was 3.3% per year, more than one third higher than in the rest of the world (Edelman et al., 2014). In the tropical city-state of Singapore, for example, the government plans to further urbanise by constructing 700,000 new public apartments by 2030 (Singapore Government, 2013). If tropical homebuyers have a preference for living near a particular type of vegetation, this could aid biodiversity conservation efforts, provided that these preferences are known and communicated to developers or planners. In this study, we use Singapore as a case study on which to apply the hedonic pricing method and estimate tropical homebuyers' preferences for different types of nearby vegetation.

1.1. Background to Singapore's Housing Market and Homebuyers Preferences

Singapore is a city-state in Southeast Asia. With its tropical location, just over 1° north of the equator, and its highly urbanised environment, Singapore provides an opportunity to study the effects of vegetation on house prices in a tropical city (Fig. 1).

Singapore's housing market consists of both privately and publicly built properties, the planning (zoning) and approval of which is the responsibility of the Redevelopment Authority (URA), which makes all Singapore's planning decisions. Around 80% of households in Singapore (over one million) are public housing apartments developed by the Housing and Development Board (Department of Statistics Singapore, 2016). Each public housing town comprises high-rise residential blocks, often reaching > 20 floors in height. Public housing apartments within these blocks come in six major types, each of which has uniform structural characteristics, including the number of bedrooms and bathrooms, and approximate floor area. Approximately 86% of properties are three-, four- or five-room apartments. Ownership of public housing apartments within these blocks is on a leasehold basis, with the majority of residents having 99-year leases. After this period an apartment's ownership legally returns to the state. However, five years after the first owner moves in, the lease may be resold to a private buyer. This creates a large resale market for government-built and subsidised housing. The next largest group of properties (approximately 14% of Singapore households) is leasehold or freehold condominiums, which typically include extra facilities such as security guards, swimming pools and gyms. Finally, 5% of households are terraced, semi-detached or detached houses, known locally as landed properties (Department of Statistics Singapore, 2016).

Previous hedonic pricing studies in Singapore have not included vegetation-related variables. Andersson (2000) found that floor area had a very strong positive effect on house price in Singapore (accounting for 79% of the variance), with year of construction and percentage of expatriates in each condominium having weaker positive effects and distance to central Singapore having a weak negative effect (Andersson, 2000). Another Singapore study (Sue and Wong, 2010) found that variables having positive effects on house prices were floor area, public housing apartment type, apartment storey, upgrading plan, being within 1 km of a train station and being within 1 km of a school that has good academic performance.

The results from hedonic pricing studies in Singapore are generally corroborated by survey data. One survey found that transportation networks, location within Singapore (being close to the centre of a public housing town and to estate facilities) and provision of public housing estate facilities (such as retail shops, eateries and cooked food centres, transportation networks in estate, education, health related and financial related) were the most frequently cited positive aspects of public housing blocks, and that poor cleanliness/maintenance, noise and poor lift services were the most frequently cited negative aspects (Housing Development Board, 2008). Another survey found that being located close to central Singapore was the most important determinant of apartment choice, while other important aspects of properties were proximity to commercial areas, train stations and bus interchange stations, and being located on an intermediate level of a building (Yuen, 2005). A third survey assessed preferences for environmentally friendly buildings in the private housing market in Singapore (Heinzle et al., 2013). Consumers were willing to pay a premium equivalent to 20% of a property's value based on floor area, 12% for location, and 3% for proximity to commercial areas. In addition, Singaporean buyers were willing to pay an extra 8% for an apartment that is in a building with official green building certification (greenmark platinum).

2. Materials and Methods

The study area was Singapore, specifically the mainland and any island connected to it by road as of January 2014. Resale data on 15,962 public housing apartments in Singapore dating from the start of April 2013 to the end of April 2014 were deflated to a base time of April 2013 using monthly property price consumer index values produced by the Singapore Government (Singapore Government, 2014). Each public housing apartment location was geocoded using the Google API service V3, which accurately identifies point location to within 2.64 m (Benker et al., 2011). None of these properties had land attached to them. Euclidean distance of each property to all “distance to” variables and the proportion of vegetation types and sea/fresh water within each public housing neighbourhood buffer (1600 m) was calculated using ArcGIS 10 (ESRI, 2010). A 1600 m buffer was calculated as this is a commonly used metric for easy walking distance (Cohen et al., 2006; Jago et al., 2006; Norman et al., 2006). We excluded apartments with a model category of “multi-generational” because the small sample size prevented model convergence (five apartments in total). Summary statistics and sources of information for all variables used in the maximal model can be found in Table 1.

2.1. Explanatory Variables

When designing hedonic-pricing studies of property prices, selection of explanatory variables should be informed by previous research (Cho et al., 2009b, 2008; Kong et al., 2007; Mansfield et al., 2005; Song and Knaap, 2004), subject to constraints of data availability (Cho et al.,