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# Demand for urban forests in United States cities☆

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**Abstract**

Extensive economic investigations have shown a variety of benefits derived from urban forests, but study on demand for urban forests remains limited. This study investigates the impact of selected potential factors on the demand for urban forests at the city level. An empirical economic model is used to examine and estimate the demand for urban forests in all cities with population over 100,000 in the United States. The empirical findings suggest that the demand for urban forests is elastic with respect to price and highly responsive to changes in income. Urban forest area increases as total population grows but at a lower rate than population growth.


*Keywords:* Population growth; Economic development; Urban land value; Urban forests; United States

## 1. Introduction

Trees have been recognized as an important component of urban landscapes. Like other forms of municipal infrastructure, urban trees provide a variety of values and services, including energy savings, improved air quality, aesthetics, health benefits, habitat for birds and other wildlife, and recreation enhancement. These factors are reflected in higher real estate prices, lower energy bills, and greater attraction to tourists and talented people and businesses (Bradley, 1995; Dwyer et al., 1992; Orland et al., 1992). Indeed, recent evidence shows that amenities function as new drivers for urban growth and communities dynamics (Clark et al., 2002).

While many studies on urban forestry have analyzed the benefits of urban trees (e.g., Gorman, 2004; McPherson et al., 1999; Dwyer and Miller, 1999; Thompson et al., 1999; Tyrvainen, 2001), very few studies have been conducted to investigate the demand for urban trees including the factors that influence this demand. Although it is obvious that urban forest canopy cover correlates with ecological and geographic factors as well as urban patterns, it is less known how socioeconomic conditions affect the urban forest demand. This issue is not only interesting from academic perspectives, but also has important policy implications.

Essentially, economics is the study of choice. An important aspect of economic choice is associated with the enjoyment of environmental amenities versus the enjoyment of traditional economic goods. Trees in cities can provide a variety of benefits, but they are not free. To have trees in cities, people not only need to bear the huge opportunity costs of the contributed land within urban areas, but also need to allocate a large amount of public funds to planting and maintenance. Therefore, any community has to face the tradeoff in allocation of its limited fiscal budget between planting trees and other purposes, and the tradeoff in allocation of its limited land between planting trees and other alternative uses. Individuals have to make the decisions of what lot size they should purchase for their homes and in which kind of urban settings they would like to live. So lot size and tree presence reflect, to some extent, the market forces determined by the welfare of the citizens and their preferences. Developers choose to build homes and develop landscape that they feel will attract buyers. Homeowners may modify their landscape to some degree based on their taste and affordability even after their purchase. Therefore, the presence of city trees also reflects individual choices. However, developers and individuals have to follow zoning, landscape and tree ordinances that are usually determined at city level.

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The purpose of this study is to investigate the impact of economic behavior on the demand for urban forests. We first discuss the major benefits of urban trees, then we formulate demand for urban trees. Cross-sectional data of all cities with population over 100,000 in the United States are used to estimate the demand for urban forests. Conclusions and discussions are presented at the end.

## 2. Urban forests as economic goods

Urban forests are economic goods that provide a variety of benefits. Trees in urban landscapes moderate temperature and microclimates, thereby reducing the need for air conditioning and thus saving energy (Heisler, 1986; McPherson, 1990; Meier, 1991; Oke, 1989). Urban trees help improve air quality and sequester carbon (Nowak, 1993; Nowak and McPherson, 1993; Rowntree and Nowak, 1991; Smith, 1981), help stabilize soils, reduce erosion, improve groundwater recharge, control rainfall runoff and flooding (Sanders, 1986), reduce urban noise levels (Cook, 1978), and provide habitat that increases biodiversity (Johnson, 1988). Based on modeling of air pollution, storm water mitigation and energy impacts, the Urban Ecosystem Analysis of the Washington, DC Metropolitan Area concluded that tree cover reduced storm water storage costs by $4.7 billion and generated annual air quality benefits of $49.8 million (American Forests, 2002).

Urban trees also make neighborhoods aesthetically more appealing and add to the value of property (Schroeder, 1989). Previous hedonic price analyses showed clearly that trees increase the value of residential properties and that people are willing to pay more for housing with trees (Anderson and Cordell, 1985, 1988; Morales, 1980; Payne and Strom, 1975). More recently, Crompton (2001) concluded that a quality forest or green space has a positive economic ripple effect on nearby properties. Appraised property values of homes that are adjacent to parks and open spaces are typically about 8–20% higher than those of comparable properties elsewhere. Rental rates of commercial office properties were about 7% higher on sites having a quality landscape, which included trees (Crompton, 2001).

Studies on how trees affect shoppers' behavior in retail business districts have been addressed as well. These studies generally employed the contingent valuation method. Consumers claim they are willing to pay more for products in downtown shopping areas with trees, versus in comparable districts without trees (Wolf, 2005). Customer service, merchant helpfulness, and product quality are all judged to be better by shoppers in places with trees (Crompton, 2001).

Evidence also shows that urban forests may reduce human stress levels (Ulrich, 1984), promote social integration of older adults with their neighbors (Kweon et al., 1998), and provide local residents with opportunities for emotional and spiritual fulfillment that help them cultivate a greater attachment to their residential areas (Chenoweth and Gobster, 1990). Furthermore, the presence of trees and "nearby nature" in human communities generates numerous psychosocial benefits. Kuo (2003) found that having trees within high density neighborhoods lowers levels of fear, contributes to less violent and aggressive behavior, encourages better neighbor relationships and better coping skills. Other studies have shown that hospital patients recover more quickly and require fewer painkilling medications when they have a view of nature (Ulrich, 1984). Finally, office workers with a view of nature are more productive, report fewer illnesses, and have higher job satisfaction (Kaplan, 1993).

## 3. Economic model of the demand for urban forests

In a city, trees can broadly be divided into two categories by ownership. The first category includes the trees on public lands, e.g., trees in city parks and along city streets. All city citizens share and bear the costs of public trees together. Determining the presence of these public urban forests is a public choice on the public-owned land and streets. The second category of trees in the city refers to private trees, e.g., trees in individual yards and private lots. Individuals choose their subdivision/neighborhoods and the lot size based on their own preference and income. Someone may argue that urban forests are not subject to individual choice. For example, people who like trees will not move from Phoenix to Boston simply because Boston has more trees. However, these tree enthusiasts are able to move from a treeless part of Phoenix to a tree rich part. Hence, from a dynamic perspective, developers and city planners consider the expectations of their citizens in regard to trees, landscape and lot sizes. The owners also have some capacity to modify landscape after they purchase their houses. Therefore, the situation of urban trees and landscape could eventually satisfy each individual's preferences and affordability. In some situations, public trees and private trees might substitute for each other. Based on Escobedo et al. (2006), public urban forest structure is related to the socioeconomic strata of Santiago's different municipalities. The total public urban forest budgets were greater in the high socioeconomic strata. Regardless of this, when we look at the sum of private and public trees across a city, this summation reflects the average or aggregated demand for urban forests in that city, no matter how the share between public and private trees might differ from another city.

It could be very interesting to see how the share between these two affects the demand for urban forests, and how they substitute for each other. Unfortunately, no data currently exist on the different shares between public and private trees among cities. Hence, we aggregate the public and private trees at the city level, or alternatively at the level of per capita average amount. But we do think this is acceptable as an empirical study. Either public demand or private demand are mixed by individual choice as well as public choice. The share of public forests to some degree is individual choice since the budget, the land use are subject to the citizen approval. The share of private forests to some degree are subject to public choice since each individual (or developers) are subject to zoning, lot size regulation, landscape and tree ordinance that are determined by public choice. In terms of price of urban forests, it is not uncommon of trading between public land and private land. The costs of planning and maintaining trees should not vary very much between public domain and private sector.