Journal of Urban Economics 86 (2015) 9–25

Contents lists available at ScienceDirect

Journal of Urban Economics

www.elsevier.com/locate/jue

Hedonic markets and sorting equilibria: Bid-function envelopes for public services and neighborhood amenities

John Yinger *

Syracuse University, USA

ARTICLE INFO

Article history:
Received 19 April 2014
Revised 19 November 2014
Available online 12 December 2014

JEL classification:
H75
R2

Keywords:
Hedonics
Capitalization
Sorting
Demand for public services

ABSTRACT

Hedonic regressions with house value as the dependent variable are widely used to study public services and neighborhood amenities. This paper builds on the theory of household bidding and sorting across communities to derive bid-function envelopes, which provide a form for these regressions. This approach allows for household heterogeneity and multiple amenities, yields estimates of the price elasticity of amenity demand directly from the hedonic without a Rosen two-step procedure, and provides tests of hypotheses about sorting. An application to Cleveland area data from 2000 yields price elasticities for school quality and neighborhood ethnic composition and supports the sorting hypotheses.

1. Introduction

House-value regressions, also called hedonic regressions, are a central empirical tool of urban economics and local public finance. This tool has been used to study many topics, including the demand for public services and environmental quality, property tax capitalization, the trade-off between housing and commuting costs, and racial prejudice and discrimination. Scholars have long recognized that these regressions capture both bidding by households of a given type and sorting of different household types across locations. Many studies of amenity demand use the two-step method in Rosen's seminal (1974) article to separate these two effects, but this approach runs into an endogeneity problem that has proven to be difficult to solve. This paper draws on the theory of local public finance to derive a practical alternative approach. This new approach facilitates consideration of household heterogeneity and multiple amenities, leads to direct estimates of service and amenity demand elasticities, and makes it possible to test sorting hypotheses.

The foundation of this paper is the theory of household bids for housing in locations with different public services or neighborhood amenities. The bid functions in this paper are based on constant-elasticity demand functions for public services, neighborhood amenities, and housing. These functions involve household heterogeneity from both observable and unobservable factors. The main theorem from the literature on household sorting (namely, that households sort according to the slopes of their bid functions) makes it possible to derive the envelope of the household bid functions across household types and to incorporate it into a house-value regression. Most parametric specifications in previous studies are special cases of the one derived here.

This derivation emphasizes the distinction in Rosen (1974) between a household type's marginal willingness to pay for an amenity and movement along the bid-function envelope, which involves a change in household type. I show how to separate these two effects and to test the sorting theorem. This approach can accommodate cases in which an "amenity" has positive value for some households and negative value for others. In addition, I show that some studies make inconsistent assumptions about the forms of the envelope and of the underlying bid functions.

The second part of the paper estimates this new approach using all house sales in the Cleveland area in 2000. The methods developed here, combined with extensive controls for housing and neighborhood traits, yield estimates of the price elasticity of amenity demand and of the sorting parameters, plus support for the sorting theorem, for a school district's high school performance

* Address: Center for Policy Research, 426 Eggers Hall, Syracuse University, Syracuse, NY 13244, USA. Fax: +1 315 443 1081.

E-mail address: jyinger@maxwell.syr.edu

http://dx.doi.org/10.1016/j.jue.2014.12.001
0094-1190/

and for a neighborhood's ethnic composition. Bidding and sorting are more difficult to separate for several other school performance measures.

2. Preview of the literature

This section introduces the literature; a more complete review and comparisons with my approach appear in Section 4. The core studies model how households bid for housing across communities with various levels of public services and property taxes and then sort into communities (Ellickson, 1971; Epple et al., 1984; Henderson, 1977; Wheaton, 1993). This literature, reviewed in Ross and Yinger (1999), predicts that property taxes and public services will be capitalized into the price of housing. A large empirical literature on capitalization inspired by Oates (1969) has also appeared. Recent contributions on public service capitalization include Bayer et al. (2007), Black (1999), Brasington (2002, 2007), Brasington and Haurin (2006), Clapp et al. (2008), and Kane et al. (2006). Studies on tax capitalization are reviewed in Yinger et al. (1988) and Ross and Yinger (1999).

A related literature on "hedonics" estimates the impact of product attributes on product prices. Housing attributes include features of the house's location, such as school quality. This literature, reviewed in Sheppard (1999) and Taylor (2008), goes beyond estimating the impact of public services on house values to exploring the underlying demand for these services. Many studies follow the Rosen (1974) two-step procedure: (1) regress product price on product attributes (the hedonic) and (2) find implicit prices of attributes by differentiating the hedonic and estimate household demand for each attribute as a function of its implicit price and other things. In the Rosen framework, a household's marginal willingness to pay for the amenity or MWTP equals the implicit price at the level of the amenity it receives. Because this MWTP applies only to marginal changes in the amenity, however, it is of limited usefulness in welfare analysis; examples in Rosen show that welfare analysis generally requires the demand estimates from his second step.

Epple (1987) explains that with a nonlinear hedonic equation the implicit price depends on the quantity of an attribute consumed by the household and therefore is endogenous. Epple et al. (2010) and Heckman et al. (2010) provide solutions to this problem.[1] This paper builds on standard bidding and sorting models to derive a hedonic equation that allows direct estimation of the service/amenity price elasticities without a second step.

The Alonso/Mills/Muth model of urban residential structure (reviewed in Brueckner (1987)), predicts that commuting costs are reflected in housing prices. Polinsky and Shavell (1976) introduce an exogenous amenity such as air pollution into an urban model, and many studies, including Cameron (2006) and Neill et al. (2007), estimate the impact of pollution on property values. Yinger (1976) develops an urban model with neighborhood ethnic composition as an endogenous amenity; empirical studies of this topic include Bayer et al. (2007) and Zabel (2008).

3. The theory of bidding and sorting

This section derives bid-functions with constant elasticity demands, develops a new method to account for household heterogeneity and sorting, and incorporates the results into a house-value regression. The standard model assumes that households maximize utility over a continuous public service quality or amenity, S, housing services, H, and a composite good, Z, with a price of unity. Households bid for housing based on S and the effective property tax rate, τ, and households with different incomes and preferences sort into different jurisdictions. Households are assumed to be mobile, so a key equilibrium condition is that all households in an income-taste class achieve the same utility. Households live in an urban area with many local governments financed by a property tax. Everyone who lives in a given jurisdiction receives the same S, and the only way to gain access to the S in a jurisdiction is to live there. All households are homebuyers, but, depending on assumptions about property tax incidence, this model can be applied to renters, as well. This model can also be extended to multiple public services and neighborhood amenities. The household budget constraint sets household income, Y, equal to Z plus housing consumption, PH, where P is the price per unit of H, plus property taxes. A household's property tax payment is τ multiplied by its house value, $V = PH/r$, where r is a discount rate (and $\tau^* = \tau/r$), so

$$Y = Z + PH + \tau V = Z + PH\left(1 + \frac{\tau}{r}\right) = Z + PH(1 + \tau^*). \quad (1)$$

3.1. Bidding

A straightforward way to derive housing bids is to determine the maximum amount a household would pay per unit of H in different locations, holding utility constant (Wheaton, 1993). Solving (1) for P, this approach leads to the following maximization problem:

$$\underset{H,Z}{\text{Maximize}} \quad P = \frac{Y - Z}{H(1 + \tau^*)}, \quad \text{subject to } U\{Z, H, S\} = U^0, \quad (2)$$

where U^0 is the utility level obtained by households in this income-taste class and S and τ are parameters. Applying the envelope theorem, with subscripts to indicate partial derivatives, yields

$$P_S = \frac{U_S/U_Z}{H(1 + \tau^*)} = \frac{MB_S}{H(1 + \tau^*)}, \quad (3)$$

$$P_\tau = -\frac{P}{(r + \tau)} = -\frac{P}{r(1 + \tau^*)}, \quad (4)$$

The numerator of (3) is the marginal rate of substitution between S and Z, which equals the marginal benefit from S, MB_S, because each unit of Z costs \$1.

The differential Eq. (4) can be solved using the initial condition that the before-tax price, $\hat{P}$, which depends on S, equals the after-tax price, P, when τ equals zero. The solution is

$$P\{S, \tau\} = \frac{\hat{P}\{S\}}{(1 + \tau^*)}. \quad (5)$$

Differentiating (5) with respect to S yields another helpful result:

$$P_S = \frac{\hat{P}_S}{(1 + \tau^*)}. \quad (6)$$

In this context, the demands for S and H are not observed directly, but they are comparable to other demands and can be expressed in the usual way. More specifically, let us assume that the latent demands for S and H take the well-known constant-elasticity form. First,

$$S = K_S N^\delta Y^\theta W^\mu e^{\varepsilon_S}, \quad (7)$$

where W equals price (or tax price), K_S is a constant, N is a set of observable factors that influence the demand for S, and ε_S is a random error. Second,

$$H = K_H M^\rho Y^\gamma (P(1 + \tau^*))^\nu e^{\varepsilon_H} = K_H M^\rho Y^\gamma \hat{P}^\nu e^{\varepsilon_H}, \quad (8)$$

where K_H is a constant, M is factors that influence housing demand, and ε_H is a random error. The presence of these random errors raises theoretical and empirical issues to which we will return.

[1] Epple et al. (2010) builds on Epple and Sieg (1999) and Epple et al. (2001). Heckman et al. (2010) is a generalization of Ekeland et al. (2004).