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The capitalization of school quality into house values: A review

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ABSTRACT

This paper provides a comprehensive review of empirical studies on the capitalization of school quality into house values that have appeared since 1999. We explore their methodological innovations and capitalization results. Most studies find significant capitalization especially for educational outputs, although the magnitudes are smaller for studies with fixed-effects estimation strategies. These studies find that house values rise by below 4% for a one-standard deviation increase in student test scores. Although major conceptual and estimation challenges remain, much progress has been made on this topic.

1. Introduction

House values provide a window into household demand for public services, including public school quality. Starting with Oates (1969), many scholars have explored the impact of school quality and local property taxes on house values, using a wide range of methods and data sets. This literature has expanded significantly in recent years as measures of student performance on standardized tests, which are key indicators of school quality, have become more widely available. Studies published before 1999 are reviewed in Ross and Yinger (1999), but a comprehensive survey of the studies published since then is not available.[1] This paper is designed to fill this gap. We explore methodological innovations in the recent literature and ask whether recent studies consistently find a significant impact of school quality on house values.

This paper proceeds as follows. Section 2 provides a conceptual framework for thinking about school quality capitalization. Section 3 presents a methodological review of 50 capitalization studies and their results. Section 4 concludes the paper with suggestions for future research.

2. Conceptual framework

This section develops a conceptual framework for public service capitalization and discusses the implications of this framework for empirical work on the topic.

2.1. Bidding and sorting

As presented in Ross and Yinger (1999), the standard model of school quality capitalization builds on five central assumptions. First, households fall into distinct income-taste classes, and households in a class are assumed to have

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[1] Recent views of the ''hedonics'' literature, which addresses the relationship between house values and amenities in general, include Chin and Chau (2003), Guilfoyle (2000), and Taylor (2008). These reviews, however, do not focus on school quality capitalization. Gibbons and Machin (2008) review some of this literature, but do not provide a comprehensive coverage of issues and articles.

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identical demand for housing, school quality, and other goods. Second, mobile households can move at no cost across jurisdictions until households of the same class obtain the same utility level, leading to an equilibrium in which no household has an incentive to move. Third, only residents in a jurisdiction can benefit from school services provided there, and the same services are received by all households in a given jurisdiction. Fourth, an urban area has many communities with fixed boundaries that offer different school qualities and effective property tax rates. Fifth, all households are homeowners.

A household's budget constraint requires income to equal spending.

$$Y = Z + PH + tV = Z + PH + t\frac{PH}{r} = Z + PH + t^{*}PH = Z + PH(1 + t^{*}) \tag{1}$$

where Y is the household's income; Z is a numeraire good; H is units of housing services, which are sold at price P; t is the effective property tax rate, which is equal to [(nominal tax rate × assessed values)/market (or sales)values]; V is the market value of a house and equal to PH/r, where r is the appropriate discount rate; and $t^{*} = t/r$.

The household's problem is to determine how much to pay for H given the quality of local public services, S, and the effective tax rate, t. This problem can be specified by determining the maximum price a household will pay for housing associated with a given S, holding their utility constant. More technically, the household problem is defined by solving (1) for P and maximizing the result with respect to H and Z subject to a utility constraint. Or, maximize

$$P = \frac{Y - Z}{H(1 + t^{*})} \tag{2}$$

subject to

$$U(Z, H, S) = U^{0}(Y) \tag{3}$$

where U^{0} is the utility achieved by households with income Y.

Now we can use the envelope theorem and the first-order condition of this problem with respect to Z to derive the well-known result:

$$P_S = \frac{U_S/U_Z}{H(1 + t^{*})} = \frac{MB}{H(1 + t^{*})} \tag{4}$$

where U_S/U_Z indicates the marginal rate of substitution between S and Z, which is the marginal benefit from S in dollar terms, MB. Eq. (4) is a differential equation with a solution, $P\{S\}$, which depends on the form of the utility function. Let $\widehat{P}$ stand for the before-tax price of housing. Then using well-known results about property tax capitalization and the above formula for housing price, V, we can write:[2]

$$V = \frac{PH}{r} = \frac{P\widehat{P}\{S\}}{r + \beta t} = \frac{H\widehat{P}\{S\}}{r(1 + \frac{\beta}{r}t)} \tag{5}$$

where β is the degree of property tax capitalization. Using the approximation $\ln(1 + \epsilon) \approx \epsilon$ when ϵ is close to 0, taking the log of Eq. (5) and adding a constant, κ, and error term, ϵ, produces an estimation equation.[3]

$$\ln V = \kappa + \alpha \ln \widehat{P}\{S\} + \varphi \ln H - \left(\frac{\beta}{r}\right)t + \epsilon \tag{6}$$

The principal theoretical problem with Eq. (6) is that it applies to a single household type. Houses are sold to many household types, however, and the implicit parameters in the $\widehat{P}$ function, can vary from one household type to another. This issue can be resolved by turning to the Rosen (1974) framework and to the concept of household sorting. In this framework, Eq. (6) is the bid function for a single household type, and the housing price or value function we observe in the market is the envelope of the underlying household bid functions. Households sort according to the slopes of their bid functions, such that households with steeper bid function for S (that is, a higher ratio of MB to H) win the competition for housing in the jurisdictions where the level of S is highest. Thus, movement along the bid-function envelope reflects both change in bids as S changes and changes in household types due to sorting.

Although the logic of a bid-function envelope is well known, only a few studies have attempted to derive this envelope. Epple (1987) considers the case of a utility function equal to

$$U_i = \sum_j \theta(X_j - \alpha_{ij}) + Z \tag{7}$$

where X is a housing attribute, Z is still a numeraire good, θ and α are preference parameters, and i and j index households and housing attributes, respectively. He assumes the distributions of X and α are normal and shows that the resulting bid-function envelope, $P\{X\}$, is

$$P\{X\} = \beta_0 + \sum_j \beta_{1j}X_j + \sum_j \beta_{2j}(X_j)^2 + \sum_j \sum_{j'} \beta_{3jj'}X_jX_{j'} \tag{8}$$

In this equation, the βs are functions of the θs and of the parameters of the α and X distributions. This formulation could be applied to housing if all public service and structural traits were brought into the X vector.

Yinger (2010) derives bid-function envelopes under the assumptions that the service and housing demand functions take the constant-elasticity form; that sorting is determined by bid-function slopes (as in the standard theorem discussed above); and that the equilibrium relationship between the service level, S, and the bid-function slope, ψ, can be approximated by $S = (\sigma_1 + \sigma_2\psi)^{\sigma_3}$. Three easy-to-estimate special cases of this envelope arise when the price elasticity of demand for housing is minus one and σ_3 equals one. Let μ be the price elasticity of demand for S and C be a constant, then these cases, which can be introduced into Eq. (6), are

$$\ln\{\widehat{P}\} = C + \left(\frac{\sigma_1}{\sigma_2}\right)\left(\frac{1}{S}\right) + \left(\frac{1}{\sigma_2}\right)\ln\{S\} \quad (\text{if } \mu = -0.5), \tag{9a}$$

$$\ln\{\widehat{P}\} = C - \left(\frac{\sigma_1}{\sigma_2}\right)\ln\{S\} + \left(\frac{1}{\sigma_2}\right)S \quad (\text{if } \mu = -1.0), \tag{9b}$$

$$\ln\{\widehat{P}\} = C - \left(\frac{\sigma_1}{\sigma_2}\right) + \left(\frac{1}{\sigma_2}\right)S^2 \quad (\text{if } \mu = -\infty). \tag{9c}$$

[2] The property tax capitalization formula can be derived by applying the envelope theorem to the above household maximization problem and using the initial condition that the before-tax and after-tax prices of housing are equal when $t = 0$. See Ross and Yinger (1999).

[3] Note that $\ln r$ is included in κ.