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Systematic Assessment Error and Intrajurisdiction Property Tax Capitalization: Comment*

I. Introduction

Ihlanfeldt and Jackson (IJ) [6] recently have presented a new approach for estimating the extent to which property tax assessment errors are capitalized into housing prices. Their method involves: (1) dividing assessment errors into systematic and random components and (2) estimating the impact of each on values of houses drawn from a single taxing jurisdiction. As IJ indicate, attention to this general topic is warranted in order to test the "new view theory" of the property tax discussed by Mieszkowski [8]. This theory predicts that deviations around the average metropolitan tax rate will be fully capitalized into housing prices if productive factors are mobile within housing markets and if large numbers of alternate housing units are available to consumers. The available empirical evidence bearing on this proposition, however, is rather mixed. Church [2] and Lewis and McNutt [7], for example, found high rates of capitalization while Wales and Wiens [9] and Chinloy [1] obtained evidence that little capitalization occurs. In applying their approach to data from the 1976 Annual Housing Survey for St. Louis, IJ found that both systematic and random errors are highly capitalized in housing prices, though the latter type of error is capitalized more heavily than the former.

This note argues that IJ's methodology is deficient in both concept and in implementation. More specifically, their approach suffers from serious econometric weaknesses, which undermine the validity of their results. One problem treated, which relates to econometric identification, appears to be quite difficult to solve and may present difficulties in interpreting other work in the property tax capitalization literature. Section II presents the IJ method and section III presents the critique. Implications and conclusions are drawn out in section IV.

II. The IJ Approach

The approach which IJ have proposed for estimating the extent to which assessment errors are capitalized into housing prices involves four steps. In the first step, a hedonic price equation is estimated in the form shown in equation (1)

$$V_i = \exp\{\Sigma_j \alpha_j X_{ji} + \epsilon_i\} \tag{1}$$

where V_i denotes the value of the ith property, the X_{ji} denote structural and neighborhood characteristics and α_j denotes unknown hedonic coefficients to be estimated. No variables

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measuring assessment errors are included among the X_j. In the second step, antilogs of the predicted property values, $\hat{V}_i$, are generated from a least squares estimate of equation (1). In step three, the assessment error (AE) for each property is calculated according to

$$AE_i = T_i - \bar{t}\, V_i \tag{2}$$

where T_i denotes property taxes paid on property i, and $\bar{t}$ is the mean effective property tax rate in the sample. AE_i then is decomposed into a random component and a component that varies systematically with market value by regressing

$$AE_i = \beta_0 + \beta_1 \hat{V}_i + \phi_i . \tag{3}$$

The predicted, rather than the actual, market value is used as the regressor in equation (3) in order to deal with the inevitable correlation between V_i and ϕ_i. Finally, in step 4, an estimate of intrajurisdictional capitalization of assessment errors is obtained from the regression

$$V_i - \hat{V}_i = \gamma_0 + \gamma_1 SAE_i + \gamma_2 RAE_i + \theta_i \tag{4}$$

where $SAE_i = \hat{\beta}_0 + \hat{\beta}_1 \hat{V}_i$ denotes systematic assessment error and $RAE_i = AE_i - A\hat{E}_i$ denotes the random error component.

This procedure was applied to 1,321 observations on single family residential properties drawn from the 1976 Annual Housing Survey (AHS) sample of St. Louis, Missouri homeowners. IJ found a negative and significant estimate for β_1, implying that higher priced houses tend to be systematically underassessed. Additionally, they estimated $\hat{\gamma}_1 = -22.02$ and $\hat{\gamma}_2 = -42.59$, and rejected the null hypotheses that γ_1 and γ_2 equal zero. Thus they concluded that: (1) both types of assessment errors are fully, if not overcapitalized, into housing prices and (2) random assessment errors are capitalized more heavily than their systematic counterpart. This second conclusion supports the view that the housing market examined is segmented by housing quality.

III. A Critique

Unfortunately, there are three problems in the design of IJ's analysis which not only cast considerable doubt on the validity of their results, but also suggest that the approach presented in Section II should be avoided in future studies of intrajurisdictional property tax capitalization. These problems involve: (1) identification of the property value equation, (2) an arbitrary division of AE_i into systematic and random components, and (3) biased and inconsistent estimates of the capitalization rates. Each of these three problems may have resulted from IJ's failure to adequately consider the structural model underlying their four step procedure. In any case, IJ do not present an explicit structural model, even though one is needed to guide both the estimation strategy and the interpretation of results. Consequently, a structure consistent with IJ's procedure is outlined below in an effort to establish a framework for understanding the three problems just listed.

The structural system can be written as

$$\ln V_i = \Sigma_j \alpha_j X_{ji} + \eta_1 SAE_i + \eta_2 RAE_i + u_i \tag{5}$$

$$AE_i = \beta_0 + \beta_1 V_i + \nu_i \tag{6}$$

$$AE_i \equiv T_i - \bar{t}\, V_i \tag{7}$$

$$SAE_i \equiv \hat{\beta}_0 + \hat{\beta}_1 \hat{V}_i =' \hat{A}E_i \tag{8}$$

$$RAE_i \equiv AE_i - \hat{A}E_i \tag{9}$$

where u_i and v_i are disturbance terms and the η_i (which presumably are negative) give the percentage by which V_i is reduced per dollar of SAE_i and RAE_i, holding structural and neighborhood effects (the X_{ji}) constant. Viewed in this way, the first three steps of IJ's procedure amount to no more than running least squares on the reduced form equation for V_i (i.e., V_i on the X_{ji}) and estimating equation (6) using the predicted values from that equation (the $\hat{V}_i$) as instruments. The fourth step, then, is a stepwise procedure for estimating the marginal contribution of SAE_i and RAE_i on V_i.

The first problem in IJ's analysis concerns the identification of the hedonic price equation. In particular, equations (5)–(9) can be compressed into the following two equation model by noting that $AE_i \equiv SAE_i + RAE_i$, substituting equation (7) into both equations (5) and (6), and rearranging terms.

$$\ln V_i = \Sigma_j \alpha_j X_{ji} + \eta_2 T_i - (\eta_2 \bar{t}\,) V_i + (\eta_1 - \eta_2) SAE_i + u_i \tag{10}$$

$$T_i = \beta_0 + (\beta_1 + \bar{t}\,) V_i + \nu_i \tag{11}$$

Inspection of these equations reveals that there are no variables excluded from (10) that appear in (11). In addition, there appears to be no compelling justification for imposing identifying restrictions on the covariance between u_i and v_i. Hence, equation (10) is not identified; i.e., the hedonic property value equation is indistinguishable from the tax equation. This identification problem in IJ's model, unfortunately, is not merely coincidental. If the specification of equation (6), and therefore equation (11), was expanded to include additional explanatory variables, those variables generally would comprise a subset of the X_j and would not contribute to identifying the hedonic property value equation. In other words, equation (10) began as a reduced form hedonic relationship, thus making it difficult to find variables which affect T_i but not V_i.

One way to circumvent this difficulty is to replace the tax equation shown in (11) with an identity, which relates T_i to the exact variables used in the property assessment process. In this situation, the error in equation (11) always would be zero, and, hence, uncorrelated with u_i in equation (10). Moreover, if V_i did not appear in the tax identity, then equation (10) would be a member of a recursive system and estimable by ordinary least squares. A potential stumbling block to adopting this approach, which was recognized by Wales and Wiens [9], is that the structural and neighborhood variables in the most readily available data sets may not correspond exactly to those used by assessors. In that event, a nonzero correlation would be expected in equation (10) between u_i, which may capture those unmeasured factors, and T_i. However, this correlation could be driven to zero, at least in principle, by combining data on the value, structural, and neighborhood characteristics of properties with supplementary information on those properties drawn from the property tax administration system.

Identification problems aside, a second problem in IJ's analysis concerns the arbitrary division of AE_i into SAE_i and RAE_i. IJ make this division based upon the structural equation (6). This equation, however, and in particular the parameter β_1, gives the *partial* rather than the *total* effect of V_i on AE_i since no feedbacks from equation (5) are taken into account. A better procedure would involve defining SAE_i and RAE_i in terms of the reduced form equation for AE_i. That reduced form equation would express $\hat{A}E_i$ as the linear combination of the X_{ji} which minimizes $\Sigma_i(AE_i - \hat{A}E_i)^2$, rather than the specific linear combination of the X_{ji} which minimized $\Sigma_i(\ln V_i - \ln \hat{V}_i)^2$. Hence, if AE_i was decomposed using the reduced form, the variation of SAE_i would be higher and the variation of RAE_i lower than if the structural form equation was used. Moreover, there is no reason to assume that V_i is the only structural determinant of AE_i. As shown by Gerking, Arnott, and Schilling [4], other variables including age, type of structure, and location also have been found to significantly affect AE_i. Nevertheless, if these additional variables are a subset of the X_j, the resulting reduced form equation would be unchanged.

Third, and again leaving identification problems aside, IJ's step four generally will produce biased and inconsistent estimates of both of the capitalization coefficients (the η_i). To more fully appreciate this limitation, refer to equation (4) in which the reduced form residuals from the property value equation are regressed on SAE_i and RAE_i. Since $AE_i \equiv RAE_i + SAE_i$ and in light of the simultaneity between equations (5) and (6), unmeasured factors embodied in θ_i must be correlated with both components of AE_i. Therefore, estimates of γ_1 and γ_2 are biased and inconsistent. IJ state, on the other hand, that the estimate of γ_2 is biased and inconsistent while the estimate of γ_1, is consistent. This claim is made after indicating that RAE_i and θ_i are correlated. However, even if no account is taken of the identity $AE_i \equiv SAE_i + RAE_i$, the estimates of *both* γ_1 and γ_2 still would be biased and inconsistent using the reasoning which IJ apply. That is, if only one of several explanatory variables are correlated with the disturbance term in a regression equation, then the least squares estimates of all of the parameters would be biased and inconsistent.

The statistical properties of the least squares estimates of equation (4) can be viewed from an alternative perspective which yields the same general conclusion as stated above. The aim in estimating equation (4) is to use a stepwise procedure to establish the partial effect of the two assessment error components on V_i after controlling for the influence of X_j. However, as Freund, Vail, and Clunies-Ross [3] and Goldberger and Jochems [5] have demonstrated, this stepwise procedure yields biased and inconsistent estimates of γ_1 and γ_2 except in the unlikely case where the two components of AE_i are orthogonal to the X_j. As alternative approaches, these authors would recommend one of two courses of action. The first of these simply would be to estimate the capitalization coefficients directly from equation (5). The second alternative would be to regress SAE_i and RAE_i on the X_{ji} in order to purge those two variables of the linear influence of the structural and neighborhood characteristics. Then the residuals $V_i - \hat{V}_i$ could be regressed on the "corrected variables" $SAE_i - S\hat{A}E_i$ and $RAE_i - R\hat{A}E_i$ in order to estimate the capitalization coefficients.

IV. Conclusion

This note has established three limitations of the approach to estimating capitalization rates of intrajurisdictional assessment errors that was suggested by Ihlanfeldt and Jackson. These limitations involve: (1) the econometric identification of the hedonic property value equation, (2) the arbitrary division of the assessment error into systematic and random components, and (3) biased and inconsistent estimates of the capitalization rates. As a practical matter, the identification problem appears the most vexing because of the difficulty in justifying the exclusion of variables from the hedonic property value equation. That equation, which essentially is a reduced form, could contain a virtually limitless number of determinants of housing values. An approach for circumventing this identification problem is recommended; however, its implementation requires merging data drawn from the property tax administration system with data from more readily available sources. In any case, the weaknesses in IJ's method for estimating intrajurisdictional property tax capitalization rates are sufficiently damaging that the method should be avoided by future investigators.

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