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TESTING THE TIEBOUT HYPOTHESIS IN THE U.S.

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In this study, the Tiebout hypothesis is extended in the context of the capitalization of property taxes and local public services. The Tiebout hypothesis is tested, using a fixed effect panel data model. To reduce endogeneity between capitalization rates and property taxes, IV *(Instrumental Variable) estimate is used. The empirical result from* IV *estimates shows that the coefficient for property tax is close to zero. This fact indicates that property taxes are capitalized almost 0% into house value and the Tiebout hypothesis is satisfied here.*

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Keywords: Tiebout Hypothesis, A Fixed Effect Panel Data Model, Capitalization of Property Taxes, Instrumental Variable Estimate

I. INTRODUCTION

Tiebout (1956) explained the existence of efficient resource allocation in local economies. His argument is that local residents vote with their feet, choosing the local government that provides the best combination of taxes and local public goods. His hypothesis based on five assumptions: jurisdictional choice, information and mobility, no inter-jurisdictional spillovers, no scale economies and head taxes.

The Tiebout hypothesis is extended in the context of the capitalization of property taxes for housing. Hamilton (1975) developed the Tiebout model,

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using property taxes. Main difference between his assumptions and the simple Tiebout model is that local governments finance public services with property taxes, not head taxes. Property taxes induce householders to sort themselves in relation with housing consumption.

If property taxes change house values under the assumption that other variables are constant, we can say that property taxes are capitalized. When house values are decreased by the full amount of the present value of property taxes, property taxes are entirely capitalized. When property taxes are not capitalized into house values at all, the Tiebout hypothesis can be satisfied.

Whether public policies are fair can be determined by evaluating property tax capitalization. Assessment reform depends on the extent to which property taxes are capitalized into house values. For example, one region (A) levies more property taxes than public services compared with the other region (B), the house value in region A would decrease. On the other hand the house value in region B would increase, since the region B provides more public services. Therefore inefficiency exist between these two regions and asset reform occurs.

There have been a lot of debates on the Tiebout hypothesis. Bewley (1981) shows counterexamples to several interpretations of the Tiebout hypothesis. On the contrary, Wooders (1978) and Conley and Wooders (1997) argue that the Tiebout hypothesis can be satisfied. They show that "small group effectiveness is almost equivalent to the definition of the type of local public goods economy Tiebout described in his original paper". McGuire (1991), Brueckner (1994), Bartolome (1990), Schwab and Oates (1991), and Epple and Romano (1994) support this argument.

For empirical study, many economists, Pozdena (1988), Engel, Lillien, and Waston (1985), and Muth (1982), have adopted the user cost model to analyze the Tiebout hypothesis. In other words, when analyzing the capitalization of property taxes, most of them have used the user cost model, since a no-arbitrage condition is required to provide a structure to the model of capitalization rates. This study also uses the user cost model to test the Tiebout Hypothesis.

Empirical studies have no consensus although many studies have analyzed the capitalization of property taxes (see Yinger et al 1988). This makes it quite difficult to draw implications about the Tiebout hypothesis. The followings are the main reasons to get unreliable results. First, simultaneity between capitalization rates and property taxes can bias estimators. Also, missing some important variable can result in omitted variable bias. Finally, specification errors might exist. These econometric reasons provided different conclusions and little agreement on the degree of capitalization. In extreme cases, some studies show 100 % capitalization of property tax and, on the other hand, some show 0% capitalization. The 0% capitalization supports the Tiebout hypothesis.

The main purpose of this study is to test Tiebout Hypothesis, using modified user cost model and the fixed effect model to get more significant results. A standard user cost model is specified and refined as an empirical model. To overcome problems of the previous studies, the households expectations of rental appreciation are included in the model as in Hamilton and Schwab (1985). A fixed effect model is used with panel data that contain annual data based on 18 large cities in the United States and 10-year time periods.

To develop econometric methodology, IV (Instrumental Variable) method for panel data is adopted. Simultaneity problem can be reduced by using the IV method, since variables that are endogenous with capitalization rates are excluded from instrumental variables. To avoid omitted variable bias, not only property taxes but also households expectations of rental appreciation, and interest rates are included in the model.

The paper is organized as follows. In the second section, the user cost model is assumed and data sources are explained. To be easily applicable to the fixed effect model and data problem, the model is modified. The third section discusses estimation issues and empirical results. The implications about the Tiebout hypothesis is then derived. Conclusions and summary are presented in the fourth section.

II. THE ANALYTICAL FRAMEWORK

2.1. An Empirical Model

The user cost model is used as a theoretical model to test the Tiebout Hypothesis. The capitalization rate, $\tilde{w}$, is defined as the ratio of rent (RE) to house value (HV) at any time:

$$\frac{RE}{HV}=\tilde{w} \tag{1}$$

It is assumed that the house value, HV, is equal to the present discounted value of a flow price of housing services (rent) less the present discounted cost of owning a property:

$$HV=\sum_{t=0}^{\infty}\frac{RE_t}{(1+r)^t}-\sum_{t=0}^{\infty}\frac{C_t}{(1+r)^t} \tag{2}$$

where $r=i(1-\tau_y)$, and i is a nominal interest rate. The cost at time t can be expressed as:

$$C_t=(\tau_p(1-\tau_y))HV_t$$

where τ_p is the property tax rate and τ_y is the marginal income tax rate (thus, $\tau_p(1-\tau_y)$ represents the effective property tax rate).[1)]

To consider householders expectations for rents, it is assumed that householders have adaptive expectation as implied by Hamilton and Schwab (1985). They showed empirically that householders rely on the past value of rents in the housing market. Initially, their concern was to investigate rationality in the housing market. However, their results do not satisfy the rational expectation hypothesis since households rely on the past value of rent.

It seems too simple to allow the expectations of all future rental rates to be the same. Because many cities in the data are growing or declining over time, rental prices may change in the same way, especially if housing supply is not perfectly elastic. Expectations are assumed to be governed by an appreciation, a. This rate can be represented by the following form and treated as a random walk,

$$a_t = \frac{(RE_t - RE_{t-1})}{RE_{t-1}}$$

Thus, the expectation process for the rental price is derived from this equation,

$$E[RE_{t+s}] = (1+a)^{t+s} RE_t \tag{4}$$

where RE_{t+s} is the rental value at time s after time t, REt is the rental value of a certain time t.

From equations (1), (2), (3), and (4), capitalization rates can be derived. The following form is presented by adding time subscription:[2)]

$$\frac{RE_t}{HV_t} = \frac{(r_t - a_t) + \tau_t(1+r_t)}{(1+r_t)} \tag{5}$$

where τ is equal to $\tau_p(1-\tau_y)$.

The theoretical model (5) is objectionable on a number of theoretical grounds. The most important one comes from the role of property taxes. According to the theoretical model, property taxes are purely a cost of ownership, which means ignoring the fact that the property tax is one of several sources of local public services. However, in the Tiebout hypothesis, local governments use tax collections very efficiently in the form of provision of public services. If this is true, then rents should rise roughly by the amount of per capita tax revenue and hence the property tax rate should have no effect on capitalization.

To test the Tiebout hypothesis, it is needed to estimate the coefficient of

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[1] Here the depreciation rate and/or maintenance is ignored, since differentiating them from fixed effects is almost impossible in estimation.

[2] See the Appendix for how to derive this formula in detail.

property taxes in equation (5). Can we say that the Tiebout hypothesis is not true when the parameter of the property tax is zero? It should not always be true. Under conditions in which all other variables are constant, it is always true. However, if the Tiebout hypothesis is true, this parameter must be zero. Additionally, to identify the role of expectation behavior and significance of interest rates, parameters for these variables are also included.

Finally, the following model is obtained after linearizing equation (5) and adding city subscription (i):

$$\left(\frac{RE}{HV}\right)_{it}=\beta_r\left(\frac{r}{1+r}\right)_{it}+\beta_a\left(\frac{a}{1+r}\right)_{it}+\beta_\tau \tau_{it}+\delta_i+u_{it} \tag{6}$$

2.2. The Data and Calibration

In any econometric analysis, to obtain more reliable results, the volume of data is crucial. However, it is not easy to find time-series or cross-sectional data sets which satisfies this condition. As a solution, panel data is used in this study. The data includes 18 large cities in the United States and covers 10-year annual time period from 1982 to 1991. These data are from several different sources. Data features and sources are reported in the Appendix 2.

Average marginal income tax rates is calculated, since both property tax rates and interest rates are tax-deductible. *Statistics for Individual Income* published by the Internal Revenue Service is used for the calculation. The same procedure that used by Barro and Sahasakul (1983) is relied on determining average marginal income tax rates.

We need to note deficits of the data sets. These deficits come from using the surveys by ACCRA, instead of hedonic indexes of rent and house value as in Phillips (1988). Local chambers of commerce report local prices of goods and services to ACCRA. These surveys are designed to broadly assess temporal and regional variation in the cost of living. Therefore, such surveys may have considerable noise. Also, the reporting of data by local chambers is voluntary and, hence, somewhat sporadic. As a solution, here panel data set is used to get more observations of data. More obseavation seems reliable results.

Endogeneity might exist between property taxes and capitalization rates. It is required to be very careful about controlling this problem, since it is critical to setting up an empirical model and generating instrumental variables in an estimation procedure. IV method is used to overcome endogeneity, paying particular attention to the selection of instrumental variables.

Fixed factor should be considered for heterogeneity of housing services. The reasons of including fixed factor are as follows: Using the ACCRA data, instead of hedonic indices on rent and house values, heterogeneous housing services can be ignored. General shifts in the housing market might exist. Also, it is needed to allow for many cities- and time-specific effects, including changes in hedonic prices. Differences between rental hedonic and house hedonic prices are contained in the hedonic price changes.

2.3. Estimation Issues

More general form of the fixed-effect model is derived from equation (6):

$$\left(\frac{RE}{HV}\right)_{it} = \lambda_{it} + \beta X_{it} + v_{it} \tag{7}$$

where λ_{it} represents fixed effects, which can be a function of the difference between rental and house value hedonic indexes. These factors are assumed to vary across cities and time. The X_{it} is a vector of observable time-variant and unit-variant variables, $X_{it} = [r/(1+r),\ a/(1+r)]$, and $\beta = [\beta_r,\ \beta_a]$. The v_{it} consists of δ_i and u_{it} as in equation (6). The δ_i is an observable time-invariant and unit-variant variable, and u_{it} is an unobservable time-variant and unit-variant variable.

Now, the method of how to estimate this formula is discussed. The equation (7) can be estimated with LSE (Least Squares Estimator). However, the coefficients estimated by LSE would be reliable only if error term (v_{it}) is uncorrelated with regressors. In fact, the error term (v_{it}) which consists of δ_i and u_{it} is correlated with regressors. Therefore, the estimators by LSE would be biased.

If GLS (Generalized Least Squares) method is adopted, the homoskedasticity assumption of LSE can be overcome. However, the correlation between regressors and error term(δ_i) is still unsolvable. To evade this problem, the mean (or first)-differenced fixed effect model is used as an alternative. In the mean-differenced fixed effect model, parameters are estimated by removing δ_i under the condition of existing a correlation between δ_i and some components of W_{it}.

Nonetheless, if LSE is adopted to estimate the fixed-effect model with mean-differenced or first-differenced variables, the coefficients of the time-invariant intercept and variables cannot be estimated since these variables are purged with δ_i.

On the contrary, with IV estimation, all coefficients in the fixed effect model are estimated; even any correlation between δ_i and regressors is allowed to exist. The parameters of all coefficients can be estimated by using instrumental variables, instead of removing some variables. Alternatively, if a MLE (Maximum Likelihood Estimator) is used, it is required to specify the form of heteroskedasticity and burdensome computation for results. However, if IV estimation is used, it is quite easy to estimate parameters with a simple mathematical procedure. Moreover, if simultaneity exists, it is more convenient to use IV estimation than MLE in controlling this problem.

IV estimator are estimated using following formula:

$$IV\ estimator = [QZ(ZZ)^{-1}ZQ]^{-1}QZ(ZZ)^{-1}ZY$$

where, Q represents a vector of $[\lambda,\ X]$, Z a instrumental variable matrix, and Y capitalization rates.

III. EMPIRICAL RESULTS

3.1. Instrumental Variables

How to generate instrumental variables is very crucial to get significant results. One of the great advantages of using panel data is the possibility of generating instruments within the model. As a pre-step of generating instrumental variables, it is necessary to classify them by considering whether a variable is correlated with v_{it} or not.

Error terms (v_{it}) are analyzed in the next step. An unobservable time-invariant and unit-variant error term (δ_i) can be explained as the characteristics of each city. These may include each city's domain or environmental situation. The unobservable time-variant and unit-variant error term (u_{it}) can be expressed as the changeable characteristics of each city. These error terms are observable by each city's residents but unobservable by econometricians.

Any variable correlated with v_{it} through either δ_i or u_{it} does not qualify as an instrumental variable. The data set includes lagged rent, house value, mortgage payment per month, total energy cost, property tax rates, transaction cost, average marginal income tax rates, personal income, and interest rates. However, three variables are selected as qualified instrumental variables here: total energy cost, transaction cost, and interest rates. These variables cannot affect capitalization rates, and capitalization rates cannot affect these variables. This fact means that these three variables are not correlated with error terms through either δ_i or Uit. Using these variables, sufficient instrumental variables can be generated. To generate an instrumental variable set within the same time period, different city values are used as instrumental variables (called city-based IV).

3.2. Testing the Tiebout Hypothesis

Using the instrumental variables generated, the coefficients are estimated, including fixed factors. The empirical results are reported in Table 1, using OLS, and Table 2, using IV estimate.

Table 2 shows that all coefficients are significant at the 5% significance level without any fixed factors. The capitalization rate of property taxes is 19% using city-based instrumental. However, this model does not consider any fixed effect, which could lead omitted variable bias. Therefore, time-specific fixed

[**Table 1**] The Output of the Model Using OLS

	Cap. Rates	Cap. Rates	Cap. Rates	Cap. Rates
Time-specific factors	No	Yes	No	Yes
City-specific factors	No	No	Yes	Yes
Interest rates	−0.120(−2.73)	0.768(9.42)	−0.113(−2.91)	0.977(5.18)
Appreciation rates	0.021(4.20)	0.021(4.18)	0.021(4.80)	0.020(4.96)
property tax rates	0.249(2.78)	0.347(4.03)	0.166(1.14)	0.110(0.84)
R^2	0.98	0.98	0.990	0.992

The numbers in ( ) represent t-statistics.[3]

[**Table 2**] The Output of the Model Using IV Estimate

	Cap. Rates	Cap. Rates	Cap. Rates	Cap. Rates
Time-specific factors	No	Yes	No	Yes
City-specific factors	No	No	Yes	Yes
Interest rates	−0.085(−1.85)	0.774(9.35)	−0.080(−1.95)	1.067(5.09)
Appreciation rates	0.019(3.61)	0.021(3.87)	0.018(3.87)	0.018(4.08)
Property tax rates	0.191(2.00)	0.290(3.11)	0.068(0.44)	0.044(0.31)
R^2	0.98	0.98	0.989	0.992

The numbers in ( ) represent t-statistics.

factors are included in the third column in Table 2. Here, all coefficients are also significant at 5% significance level. Interest rates have a positive coefficient (0.77) and meaningful effects on dependent variable. The property tax is again capitalized at 29% which is a similar level as in no fixed factor regression. This implies that time specific factors explain the fixed effects very little.

As a next step, then, city specific factors are included in the model to allow for mean variation in capitalization rates across cities, since capitalization rates fluctuate not only across time, but across cities. The result with city specific factors only reported in the fourth column of Table 2 shows that the null hypothesis that the coefficient of property tax equals zero cannot be rejected. This fact implies the role of property tax on capitalization rate variations is negligible. Therefore, the Tiebout hypothesis is satisfied in this model. This can happen because the property tax rate is closely related with characteristics of each city. Additionally this regrescion shows that Why factors are more important in explaining fluctuations of capitaltation rates. The outputs using OLS in Table 1 alsa provide similar results as IV estimate. They show only slight difference in the magnitude of estimated parameters.

Finally, a more realistic model is estimated as suggested in the theoretical model, where both city and time specific factors are included simultaneously.

[3] Critical values of t-statistics are 1.645 under 10% significance level, 1.960 under 5% significance level, and 2.576 under 1% significance level.

Notably, the coefficient of property taxes is insignificant as the city dummy model. This means that property taxes are capitalized close to zero and have almost no effects on capitalization variation in this case. This can be taken place when city specific factors absorb the effect of property taxes. Lower capitalization of property taxes implies that the Tiebout hypothesis is true.

The coefficient of interest rates is insignificantly different from 1. The coefficients are 0.97 in the OLS regression and 1.06 in the IV regression. This provides some support for the user cost model.

IV. SUMMARY AND CONCLUDING REMARKS

In this study, the Tiebout hypothesis is tested using the user cost model. An expectation variable (rental appreciation rates), interest rates, and property tax rates are included into the model. The focus is to estimate the parameter of property tax. More importantly, implications for the Tiebout hypothesis are derived from the estimation rescets. To obtain consistent and more efficient estimators, the IV method was used for the panel data model.

Empirical results indicate that the capitalization of property taxes in the city-specific model and time and city-specific model is close to zero. This implies that the property tax is not capitalized into house values. Fixed effects of city has significant role in capitalization rate variation, while time specific factors have very small effects.

According to the Tiebout hypothesis, property tax is one of the main resources of local government. Local government uses this resource to supply local public goods and services. Thus, although higher property taxes decrease house values, supplied local public goods and services diminish the property tax effect on house values. Finally, property tax should have a very small or almost no effect on capitalization rates. This should not always be true. However, some implications can be drawn from the capitalization of property taxes in a restricted situation in which there are no other tax bases for local public goods and services. In this context, the empirical result would look very consistent with the Tiebout capitalization hypothesis.

Appendix 1

From equation (4),

$$RE_t = (1+a)^t RE$$

Substituting this into equation (2),

$$HV = \sum_{t=0}^{\infty} \frac{(1+a)^t RE}{(1+r)^t} - \sum_{t=0}^{\infty} \frac{C_t}{(1+r)^t}$$

Then, using (1), (3) and (4),

$$HV = RE \sum_{t=0}^{\infty} \frac{(1+a)^t}{(1+r)^t} - \sum_{t=0}^{\infty} \frac{T \cdot \frac{RE_t}{\tilde{w}}}{(1+r)^t}$$

$$HV = \frac{RE(1+r)}{(r-a)} - \frac{\tau}{\tilde{w}} \frac{RE(1+r)}{(r-a)}$$

Therefore,

$$\frac{RE}{HV} = \frac{(r-a)+\tau(1+r)}{(1+r)}$$

The equation (5) is derived by considering time, and the equation (6) is derived by adding time and city subscriptions.

Appendix 2

Data Features

Variable	Description	Source
LRE	Lagged rent; Rentt-1 (dollar)	ACCRA
RE	Rent (dollar)	ACCRA
HV	House value (dollar)	ACCRA
MRT	Mortgage payment per month (dollar)	ACCRA
EGY	Total energy cost per month (cent)	ACCRA
PTR	Property tax rates (%)	SAUS
TCR	Transaction cost to house value (%)	FHFBS
INT	Efficient interest rates (%)	FHFBS
MTR	Average marginal income tax rates (%)	SII
INC	Personal income (dollar)	SCB

where ACCRA: American Chamber of Commerce Research Association.

SAUS: *The U.S. Statistical Abstract* (see the table: residential property tax rates in selected large cities).

FHFBS: *Federal Housing Finance Board's monthly Survey of Rates and Terms on Conventional Single-Family Nonfarm Mortgage Loans* (see Table 8: Terms on conventional single-family mortgages by selected metropolitan areas).

SII: *Statistics for Individual Income* by the Internal Revenue Service.

SCB: *A Survey of Current Business* (see Local Area Personal Income).

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