Population

1981

THE DIRECT AND INDIRECT EFFECTS OF POPULATION GROWTH ON HOMEOWNER PROPERTY TAXES*

Shepard C. Buchanan**

and

Bruce A. Weber***

ABSTRACT

A model for estimating the direct and indirect affects of population growth on property taxes is fit to data for Oregon counties. Results suggest that increases in population did lead to increases in homeowner property taxes in the mid-1970s, primarily through the effect of population on assessed values.

* Paper selected for presentation at the American Agricultural Economics Association annual meetings, Clemson, South Carolina, July 26-29, 1981.

** Economist, U.S. Forest Service, Provo, Utah. Formerly research assistant in the Department of Agricultural and Resource Economics, Oregon State University.

*** Associate Professor, Agricultural and Resource Economics, Oregon State University.

Population growth and rising residential property taxes are often linked in the public mind. The popular hypothesis that population growth causes property taxes to increase, particularly for homeowners, has led to calls for tax reform and population growth management at the state and local levels.

If, in fact, population growth does increase property taxes, particularly those of the homeowner/voter, then public officials have an interest in how and why this increase occurs. With this knowledge they can, if they wish, change the legal framework of the property tax system so as to alter the tax impact of population growth.

If on the other hand population growth does not, under the present legal structure, affect local property taxes, public officials can tell thos who would control population growth that reducing the rate of growth is not likely to affect their taxes. More importantly, a clear understanding of the relationship between population and property taxes should illuminate other possible causes, perhaps indirectly related to population growth, of the rise in homeowner's property tax bills.

This paper is an attempt to establish whether in fact population growth is empirically linked with increasing residential property taxes and, if such a link is found, to determine the extent to which it occurs through the assessment system as opposed to the local government budgeting process. In so doing, it builds upon a substantial literature in which economists have sought to model local fiscal behavior. Models of local fiscal behavior have been developed over the past several decades out of the "expenditure determinant" literature of the early 1940's in which local government expenditures were "explained" by a series of variables selected without theoretical underpinnings. Recent contributions to this literature have much more carefully specified models. These studies, summarized by Deacon (1977 A, 1977 B) and Hirsch (1977), have focused on the demand for public goods and services and draw increasingly on public choice theory for their theoretical base. Fox and Sullivan (1980) have explicitly used this theoretical base in their estimates of the expenditure impacts of population growth. This paper extends this literature in two ways. First, it broadens the scope of the analysis from an emphasis on local government expenditures to a more complete model of fiscal behavior which includes revenues and assessment variables. The enlarged scope of analysis turns out to be important because of the strong influence of population on assessments.

Secondly, it allows for the possibility that population may indirectly affect property taxes. Previous models have been built upon the restrictive assumption that population and the other explanatory variables are independent in their effects on property taxes. The resulting estimates of the impact of population on expenditures or taxes have yielded estimates of the partial effect of population, holding other variables constant. The formulation in this paper permits estimation of indirect effects of population on taxes through its effect on intermediate variables, such as the age of the housing stock, personal income, and population density. Quite different results are obtained with this more complete alternative formulation.

The model developed in this paper is estimated for the State of Oregon and addresses the question of how population growth affects the property tax bills of the average homeowner.

A Model of Residential Property Tax Bills

The tax bill of the Oregon homeowner is the product of the assessed value of the owner's home and the tax rate applicable to all property owners in his/her tax code area (a tax code area is an area which includes all properties paying taxes to the same set of local governments). A model of residential tax bills then has two submodels: one for estimating the tax rate and the other for estimating the assessed value of a single family residence. These two submodels and the residential tax bill equation which relates the two are identified in Table 1.

Table 1. Structural Form Equations: Model of Residential Property Tax Bills

Tax Rate Submodels:

(1) $Q \equiv \frac{L}{T}$

(2) $L = \beta_{20}\, P^{\beta_{21}} Y^{\beta_{22}} S^{\beta_{23}} A^{\beta_{24}} R^{\beta_{25}}$

(3) $R \equiv \frac{V}{T}$

(4) $T = \beta'_{40} P^{\beta'_{41}} Y^{\beta'_{42}} E^{\beta'_{43}} R^{\beta'_{44}}$

(5) $V = \beta_{50} P^{\beta_{51}} Y^{\beta_{52}} H^{\beta_{53}} B^{\beta_{54}} A^{\beta_{55}}$

(6) $Y = \beta_{60} P^{\beta_{61}} N^{\beta_{62}} K^{\beta_{63}} D^{\beta_{64}}$

(7) $H \equiv \frac{H_0}{H_0 + H_1}$

(8) $A \equiv \frac{P}{M}$

Residential Assessed Value Submodel:

(9) $\overline{V} = \beta_{90} P^{\beta_{91}} Y^{\beta_{92}} H^{\beta_{93}} \overline{B}^{\beta_{94}} A^{\beta_{95}}$

Residential Tax Bill Equation:

(10) $X \equiv Q \cdot \overline{V}$

Q = Property tax rate

L = Per capita property tax levy

T = Per capita assessed value of all property

P = Population

Y = Per capita income

S = Number of public school students ÷ population

A = Population density

R = Assessed value of residential property ÷ assessed value of all property

V = per capita assessed value of residential property

E = Dummy variable indicating whether county is in eastern or western Oregon

H = Proportion of housing built before 1940

B = Number of bathrooms per capita

$\overline{B}$ = Number of bathrooms per household

N = Total employment ÷ population

K = Per capita value of capital stock

D = Distance in miles to Portland

H_0 = Number of homes built before 1940

H_1 = Number of homes built since 1940

M = Area of county

$\overline{V}$ = Average value of a residential property

X = Average residential property tax bill.

Property Tax Rate Submodel

The property tax rate submodel consists of eight equations: four identities and four stochastic equations. In this model, the behavior of different types of government units is not modeled separately. The levies of cities, counties, and school districts are summed to determine the tax rate in each county. For each county then there is a single tax levy and a single tax rate. A detailed description of the model and of the rationale for its specification is found in Buchanan and Weber (1981).

Several important features of Oregon's property tax system need explanation. The property tax rate (Q) is equal to the property tax levy divided by the total assessed value of all property in the county. The tax rate is usually expressed in dollars per one thousand dollars of assessed valuation. In Oregon, there are no restrictions on the tax rates of local governments. There is, however, an important restriction on the property tax levy (the amount of property tax revenue required to balance the local government budget, i.e. the difference between planned expenditures and expected nonproperty-tax revenues). The Oregon Constitution allows the property tax levy of any district to increase by a maximum of six percent a year unless voters approve a higher amount. Districts with levies in excess of their legal tax base must submit the difference to the voters for approval. As a result, voter control extends beyond citizen involvement in the budget process, and therefore, the size of the levy is influenced by the characteristics of the community.

Average Single Family Home Assessed Value Submodel

In the second submodel, equation 9 estimates the average value of a single family residence ($\overline{V}$). This yields an estimate of the elasticity of an average property value in contrast to equation 5 which estimates a per capita value.

Property Tax Bill Equation

Equation 10 is the identity which defines the average residential property tax bill (X) as the product of the tax rate and the value of the property.

It would be possible to use the model specified above to estimate the direct effect of population on the tax levy, the assessed value of all property and the assessed value of single family residences, ceteris paribus. Such an objective would require only estimation of equations (2), (4), and (9). $\hat{\beta}_{21}$, $\hat{\beta}_{41}$, and $\hat{\beta}_{91}$ would be estimates of the elasticities of the tax levy, total assessed value and average homeowners assessed value with respect to population. Simple manipulation of these elasticities would yield elasticities of the tax rate and average homeowners tax bill with respect to population, ceteris paribus. Since $X = \frac{L}{T} \cdot \overline{V}$, the elasticity of the average homeowner's tax bill X with respect to population P ($\varepsilon_{X \cdot P}$) could be estimated as:

$$\begin{aligned} \varepsilon_{X \cdot P} &= \varepsilon_{L \cdot P} - \varepsilon_{T \cdot P} + \varepsilon_{\overline{V} \cdot P} \\ &= \hat{\beta}_{21} - \hat{\beta}_{41} + \hat{\beta}_{91} \end{aligned}$$

Such a procedure does not permit the estimation of any indirect effects that population may have on the average homeowners tax bill, for example, through its effect on per capita income. Estimation of the total direct and indirect effect of population possible, however, using a reduced form of the model outlined in the previous section.

Two more modifications in the structural form model of Table 1 are made before estimating the regression coefficients.

First, some stochastic endogenous variables (Y, V, R) appear as explanatory variables. When these variables appear on the right side of the equation their predicted values are used in a two-stage estimating procedure.

Second, a reduced form of equation 4 is estimated. Since $R = \frac{V}{T}$, the actual estimating equation is:

$$T = \beta_{40} P^{\beta_{41}} \hat{Y}^{\beta_{42}} E^{\beta_{43}} \hat{V}^{\beta_{44}}$$

The equations for calculating the compound elasticities of the variables of interest with respect to population are given in Table 2. The compound elasticity of the levy (L), for example, with respect to population (P), denoted by the symbol $\varepsilon^*_{L\cdot P}$, is composed of a set of partial elasticities. The "direct partial elasticity" of L with respect to population, denoted by $\varepsilon_{L\cdot P}$, is the percentage change in L given a one percent change in P holding all other variables constant. The indirect partial elasticity of L with respect to P is the percentage change in L associated with a change in another explanatory variable (Y, for example) which is in turn associated with a change in P. This indirect partial elasticity is denoted by the symbol $\varepsilon_{L\cdot Y\cdot P}$.

Table 2. Equations for Elasticity Estimation from Reduced Form

(1) $\varepsilon^*_{Q\cdot P} = \varepsilon^*_{L\cdot P} - \varepsilon^*_{T\cdot P}$

(2) $\varepsilon^*_{L\cdot P} = \varepsilon_{L\cdot P} + (\varepsilon_{L\cdot \hat{Y}})\ (\varepsilon_{\hat{Y}\cdot P}) + \varepsilon_{L\cdot A} + (\varepsilon_{L\cdot \hat{R}})\ (\varepsilon^*_{\hat{R}\cdot P})$

(3) $\varepsilon^*_{\hat{R}\cdot P} = \varepsilon^*_{R\cdot P} = \varepsilon^*_{V\cdot P} - \varepsilon^*_{T\cdot P}$

(4) $\varepsilon^*_{T\cdot P} = \varepsilon_{T\cdot P} + (\varepsilon_{T\cdot \hat{Y}})(\varepsilon^*_{\hat{Y}\cdot P}) + (\varepsilon_{T\cdot \hat{V}})(\varepsilon^*_{\hat{V}\cdot P})$

(5) $\varepsilon^*_{\hat{V}\cdot P} = \varepsilon^*_{V\cdot P} = \varepsilon_{V\cdot P} + (\varepsilon_{V\cdot \hat{Y}})(\varepsilon_{\hat{Y}\cdot P}) + \varepsilon^*_{V\cdot H} + \varepsilon^*_{V\cdot A}$

(6) $\varepsilon^*_{\hat{Y}\cdot P} = \varepsilon^*_{Y\cdot P} = \varepsilon_{Y\cdot P}$

(7) $\varepsilon^*_{H\cdot P} =$ -1.00 (by assumption)

(8) $\varepsilon^*_{A\cdot P} =$ 1.00 (by definition)

(9) $\varepsilon^*_{\overline{V}\cdot P} = \varepsilon_{\overline{V}\cdot P} + (\varepsilon_{\overline{V}\cdot \hat{Y}})(\varepsilon_{\hat{Y}\cdot P}) - \varepsilon^*_{\overline{V}\cdot H} + \varepsilon^*_{\overline{V}\cdot A}$

(10) $\varepsilon^*_{X\cdot P} = \varepsilon^*_{Q\cdot P} + \varepsilon^*_{\overline{V}\cdot P}$

The model is estimated in logarithms using cross-sectional data from 33 of 36 Oregon counties.

Unpublished data for fiscal variables L, T, V, R, K were obtained from the Oregon Department of Revenue for fiscal year 1977. Demographic data (P,Y,S,A,N,M,D) and estimates of the age of housing variables (H, H_0, H_1) for 1977 were obtained from information published by the Oregon Department of Human Resources and the Oregon Department of Education. The 1970 Census of Housing provided data on B, the average number of baths.

Results

Regression results are presented in Table 3. Using these results and the formulas presented in Table 2, estimates of the compound elasticities are derived and presented in Table 4. Table 4 also identifies direct partial elasticities of selected variables with respect to population.

Direct Effect of Population on Homeowner Tax Bills

It is evident from Table 4 that one reaches quite different conclusions about the effect of population growth on the average homeowner's tax bill and on its components if one examines only the direct partial effects than if one looks at both direct and indirect effects as estimated in the compound elasticities.

The direct partial elasticities suggest that the average homeowner's tax bill, declined by .12 percent for each one percent increase in population. This is partly because the direct effect of population on the tax rate is negative ($\varepsilon_{Q \cdot P} = -.22$). This in turn is because population is estimated to have a greater negative direct effect on the per capita tax levy than it has on per capita total assessed value ($|\varepsilon_{L \cdot P} = -.52| > |\varepsilon_{T \cdot P} = -.30|$). Population does appear to have a positive direct effect on the assessed value of the average home ($\varepsilon_{\overline{V} \cdot P} = .10$) but this effect is not strong enough to offset the negative direct effect of population on the tax rate.

Table 3. Regression Results: Stochastic Equations in Reduced Form Model

Equation Number	Dependent Variable		Intercept Explanatory Variable	R^2
(2)	$\ln L$	=	$-38.48 - .52 \ln P + 5.32 \ln \hat{Y} + 1.00 \ln S - .03 \ln A + 1.09 \ln \hat{R}$ (9.67)* (.19)* (1.37)* (.34)* (.07) (.47)	.59
(4)	$\ln T$	=	$-12.63 - .30 \ln P + 2.06 \ln \hat{Y} + .01 \ln E + .54 \ln \hat{V}$ (4.58)* (.06)* (.54)* (.12) (.20)*	.60
(5)	$\ln V$	=	$10.34 - .29 \ln P - .95 \ln \hat{Y} - .07 \ln H - .42 \ln B + .05 \ln A$ (5.37) (.11)* (.62) (.10) (.09)* (.06)	.77
(6)	$\ln Y$	=	$9.06 + .01 \ln P + .43 \ln N + .06 \ln K - .06 \ln D$ (.25)* (.01) (.14)* (.03) (.01)*	.62
(9)	$\ln \overline{V}$	=	$5.00 + .10 \ln P - .36 \ln \hat{Y} - .16 \ln H + .12 \ln \overline{B} + .05 \ln A$ (3.25) (.04)* (.37) (.06)* (.07) (.04)	.85

* Indicates coefficient statistically significant at = .05 level.

Standard errors in parantheses

Table 4. Estimated Elasticity of Dependent Variables With Respect to Population

Equation Number	Dependent Variable	Compound Elasticity	Direct Partial Elasticity
(1)	Q	$\varepsilon^*_{Q\cdot P} = 0.10$	-.22
(2)	L	$\varepsilon^*_{L\cdot P} = -0.28$	-.52
(3)	R	$\varepsilon^*_{R\cdot P} = 0.20$	
(4)	T	$\varepsilon^*_{T\cdot P} = -0.38$	-.30
(5)	V	$\varepsilon^*_{V\cdot P} = -0.18$	
(6)	Y	$\varepsilon^*_{Y\cdot P} = 0.01$	
(7)	H	$\varepsilon^*_{H\cdot P} = -1.00$	
(8)	A	$\varepsilon^*_{A\cdot P} = 1.00$	
(9)	$\overline{V}$	$\varepsilon^*_{\overline{V}\cdot P} = 0.31$	.10
(10)	X	$\varepsilon^*_{X\cdot P} = 0.41$	-.12

Direct and Indirect Effects on Population on Homeowner Tax Bills

The results in Table 4 suggest that the effect of population on homeowner tax bills is not captured completely in the estimated direct partial coefficients. Changes in population apparently have an effect on other variables such as the residential fraction which in turn affect the tax levy and ultimately the average homeowners tax bill.

Tax Rate Submodel

When one takes indirect effects into account, the effect of population on the tax rate (Q) is not negative as the direct partial elasticity suggests but positive ($\varepsilon^*_{Q \cdot P} = .10$). This is due to indirect effects of population on both the per capita tax levy and on per capita total assessed value.

The total effect of population on the per capita levy is about half as large as the direct effect ($\varepsilon^*_{L \cdot P} = -.28 < \varepsilon_{L \cdot P} = -.52$). This is primarily due to the effect of population on the proportion of total assessed value in single family homes which in turn affects the levy.

Since $\varepsilon^*_{R \cdot P}$ is also positive (equation 3) there is an important indirect effect in which growth, by changing relative property values, has the tendency to increase L, partially offsetting the negative direct effect of population on levies.

The value of $\varepsilon^*_{R \cdot P}$ is positive because $\varepsilon^*_{V \cdot P} > \varepsilon^*_{T \cdot P}$. On a per capita basis, the assessed value of residential property is more elastic with respect to population than is the value of all property as a whole even though both have negative elasticity estimates.

One implication is that, with the assessment system in effect in Oregon at the time of this study, population growth apparently shifted the distribution of the property tax burden toward residential property owners.

Average Single Family Home Assessed Value Submodel

Population growth appears to increase the average value of a single family residence. While the direct partial effect of population is not very large ($\varepsilon_{\overline{V}\cdot P} = .10$), the total effect is considerable ($\varepsilon^*_{\overline{V}\cdot P} = .31$). Population affects the average home value indirectly through its effect on the average age of housing in the community (addition of newer housing significantly increases the average home value: $\varepsilon_{\overline{V}\cdot H\cdot P} = +.16$) and through its effect on population density ($\varepsilon_{\overline{V}\cdot A\cdot P} = +.05$).

Average Homeowners Tax Bill Equation

The results of the two submodels imply that population growth is positively related to the tax bill of the average homeowner in Oregon. Since $\varepsilon^*_{\overline{V}\cdot P} + \varepsilon^*_{Q\cdot P} = \varepsilon^*_{X\cdot P}$ the estimated elasticity of an average residential property tax bill $\varepsilon^*_{X\cdot P}$ is 0.41.

Even though per capita residential property taxes may decline with population growth the average homeowner's property taxes increases with growth. Simultaneously, since $\varepsilon^*_{R\cdot P} = .20$, the proportion of the total tax burden borne by residential owners appears to be positively related to long-run population growth under the tax system existing at the time of this study.

The results indicate that from the point of view of the average homeowner, the effect of growth on the tax levying behavior of local governments is relatively less important than its differential impact on classes of property. At least three quarters of the total effect of population growth on the average homeowner's tax bill is accounted for by the effect of growth on average assessed home values.

Conclusion

State and local policymakers concerned about the dynamics of local population growth can use models such as the one developed in this paper to increase their understanding of the effects of population on local government fiscal and assessment behavior, and on property taxes for selected classes of property. It is clear from the results summarized above that partial models (those which look at only direct partial effects) are apt to yield erroneous conclusions. Under Oregon's 1977 tax system, the direct partial effect of population growth was to lower the average homeowner's property taxes. A model of direct and indirect effects of population yielded a very different result: a one percent increase in population was associated with a .4 percent increase in the average homeowner's property taxes.

A major reason for this result was that population affected the property tax rate indirectly through its effect on the share of assessed value in residential property. Population growth increased the share of total assessed value in single family residences ($\varepsilon^*_{R \cdot P} = .20$) which in turn increased the responsiveness of the tax rate to population growth.

Apparently the Oregon legislature did not need an econometric model to perceive this shift.

1979 Oregon legislature enacted a tax relief program in which among other things, the average rates of increase in assessed valuations of residential property and all other property on a statewide basis are limited to a maximum of five percent per year. This has the effect of ensuring that $\varepsilon_{R \cdot P}$ approaches zero. While individual property assessments may increase by more than five percent, residential owners as a class will not bear such a rapidly increasing proportion of the tax burden. By putting a limit on $\varepsilon^*_{R \cdot P}$ and $\varepsilon^*_{\overline{V} \cdot P}$, this measure could significantly affect the relationship between population growth and homeowner's property tax bills.

The use of an econometric model such as the one developed in this paper for estimating the direct and indirect effects of population growth on selected classes of property owners appears to have some promise. The model in this paper was developed for the Oregon economic and legal structure and to estimate impacts on homeowners. It could, however, be easily adapted to other similar tax systems and used for other similar purposes.

Such models represent a start in introducing long-neglected distributional considerations into fiscal impact models.

References

Buchanan, Shepard C. and Bruce A. Weber 1981. "Growth and Residential Property Taxes: A Model for Estimating Direct and Indirect Population Impacts." Technical Paper No. ____, Oregon Agricultural Experiment Station. Corvallis, OR.

Deacon, R.T. 1977A. "Review of the Literature on the Demand for Public Services." Paper presented at the National Conference on Nonmetropolitan Community Services Research, Columbia, Ohio.

Deacon, Robert T. 1977B. "Private Choice and Collection Outcomes: Evidence From Public Sector Demand Analysis." National Tax Journal, XXX, (No. 4): 371-388.

Fox, William F. and Patrick J. Sullivan 1980. "Revenue Needs in Growing and Declining Areas." Revenue Administration, 1979: Proceedings of the 47th Annual Meeting of the National Association of Tax Administrations. Chicago: Federation of Tax Administrators.

Hirsch, W.A. 1977. "Output and Costs of Local Services." Paper presented at the National Conference on Nonmetropolitan Community Services Research, January 1977.

Oregon Department of Education 1977. "Estimated 1976-77 Per Pupil Expenditures." mimeo, Salem, Oregon.

Oregon Department of Revenue 1977. "Local Budget Summary Sheets," mimeo, Salem, Oregon.

United States Department of Commerce, Bureau of the Census, 1970. "1970 Census of Housing." Washington D.C.