Growth and Change, Vol 18:4 (Fall, 1987), pp 11-47

Land Value Taxation and New Housing Development in Pittsburgh

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ABSTRACT Incentive and liquidity effects of Pittsburgh's land value tax system are hypothesized to encourage new housing development. To test this hypothesis, an econometric model is estimated using building permit data for the dependent variable and tax rates and other determinants of new housing demand and supply for the independent variables. For the case of new housing, it is shown that the incentive effect is significant but the liquidity effect is not. The incentive effect is found to encourage increases in the number of new units constructed in Pittsburgh rather than increases in the average cost of new units.

PITTSBURGH IS ONE OF A SMALL NUMBER of cities in the United States which employ a land value tax system. Most U.S. cities apply the same tax rate to both the land and improvement components of real property value. Under a *land value tax* system, however, land is taxed at rates higher than those levied against buildings and other improvements. Incentive and liquidity effects of shifting the tax burden from improvements to land are hypothesized to encourage development. This study looks specifically at the effects of Pittsburgh's land value tax on new housing development.[1] In this study, *new housing development* refers to the construction of housing units in new structures; the term does not refer to the creation of new housing units by rehabilitating or converting existing buildings.

Recent changes in the land and improvement tax rates in Pittsburgh provide a basis for econometric analysis of the effects of the tax rates on development. Since 1978, the land tax rate has increased substantially while the improvement tax rate has fluctuated. In 1978, the city tax rates were 4.95

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percent on the assessed value of land and 2.475 percent on the assessed value of buildings. In 1979, the city's land tax rate was raised to 9.75 percent while its building tax rate remained at 2.475 percent.[2] The county and the school district also levy real estate taxes in Pittsburgh, although each of those jurisdictions applies the same rate to both land and improvements. Taking into account the school district and county rates, the total land rate in 1979 was 14.5865 percent and the improvements rate was 7.3115 percent. By 1984, the total land tax rate had climbed to 22.05 percent and the total improvement tax rate had increased to 9.6 percent. Beginning in 1980, new construction became eligible for tax abatements; this reduced the effective improvement tax rate somewhat.[3]

Previous Studies

Writing in the mid-1960s, Heilbrun (1966) noted that he was unable to find any conclusive evidence of the effects of land value taxation on urban housing markets. Since the mid-1960s, several researchers have completed econometric studies of the effects of real estate tax rates on the supply of housing services or, more generally, structural services.[4] Tanzer's 1985 cross-sectional study of 91 Standard Metropolitan Statistical Areas (SMSAs) concluded that a given percent reduction in the structure tax rate results in equal percent increases in housing quality and quantity. Pollock and Shoup's 1977 study of the tourist hotel district in Waikiki, Hawaii, suggested that elimination of the tax on structures would result in a significant increase in the amount of investment in hotels. Grieson's 1974 general equilibrium study reached a similar conclusion with respect to the supply of structures, in general, using aggregate data for the United States. None of these studies explicitly addressed the possible effects of increases in the land portion of the real estate tax.

In contrast, a few researchers have examined the effects of land taxes. Mathis and Zech (1982) undertook a cross-sectional analysis of 27 cities in Pennsylvania (including Pittsburgh) and found no evidence that those cities with land value tax schemes experienced more development than those with standard real estate taxes. Mathis and Zech's analysis was marred, however, by their misspecification of the tax variable as the ratio of the improvement and land tax rates.[5] The relationship between that ratio and the level of development is theoretically ambiguous. Pollakowski's 1982 study of the liquidity effects of the land portion of Pittsburgh's real estate tax found a statistically significant relationship between land tax payments and the probability of transfer of a property. Pollakowski was unable to determine whether properties were improved after transfer, however. Writing at about the same time as Heilbrun, Richman (1965) commented: "Whether or not the Pittsburgh graded tax has proved to be beneficial to the city is difficult

to establish" (p. 260). This is still true today, because the negative results obtained by Mathis and Zech may be attributable to the methods employed by those researchers, and Pollakowski's results are inconclusive.

Economic Effects of Shifting Taxes from Improvements to Land

Microeconomic theory suggests that shifting the tax burden from improvements to land will encourage development in two ways. These are the liquidity and incentive effects. The liquidity effect results from increasing the land tax rate, while the incentive effect results from decreasing the improvement tax rate.

The liquidity effect has two components. One component is the effect on current landowners, who must bear increased holding costs and who are thereby encouraged to improve their properties or sell to someone who will. Bentick (1979) shows that land taxes affect the timing and type of development:

> Land taxes which are based on the current market value of land . . . divert land and saving from investment projects with a long gestation period to those which produce returns relatively quickly. This is because the market value of land reflects its future rentals, so that a tax on market value causes taxes to be levied ahead in time of the returns on which the tax is based, thus creating a liquidity problem which cannot be solved by a perfect capital market. (p. 860)

The other component of the liquidity effect is simply the obverse of increased holding costs. This obverse component is due to capitalization of the tax. The relationship between the tax rate, b, and the capitalized market value of the land, L, is:

$$(1) \quad L = E/(r + b),$$

where E is the economic rent of the land (before any tax) and r is the discount rate (Becker 1969). It is clear that, as b approaches infinity, L approaches zero. Capitalization of the land tax makes it easier for potential developers to acquire land and should thereby encourage development. Becker (1969) observes: "The benefit would be the equivalent of an automatic perpetual loan to the developer for purposes of land acquisition in the amount of the capitalized value of the land tax" (pp. 35-6).

The incentive effect is reflected in a supply curve for structures which is lower than it otherwise would be. As shown in Figure 1, a reduction, A, in the tax on structures shifts the supply curve, S, downward by an amount equal to the tax reduction, to S'. This results in both a decrease in the price (from P to P') and an increase in the quantity (from Q to Q') of structural services supplied. The extent of the incentive effect depends, of course, on the elasticities of supply and demand for structural services.

In contrast, increases in the tax on land do not affect the supply of land because the supply of land is totally inelastic. The fixed total amount of

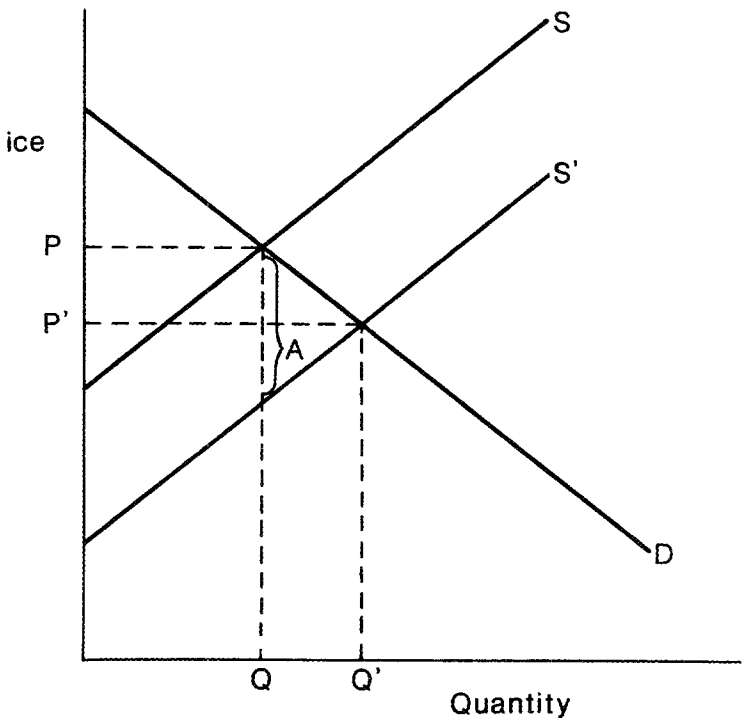

FIGURE 1. Effects of a Tax Reduction on the Supply of Structures.

land in a city is represented by the vertical supply curve, S, in Figure 2. Immediately upon imposition of the tax, the demand for land, D, will decrease because the price of land will increase by the amount of the tax, T, from P to P'. However, landowners must ultimately pay the tax because the supply of land remains the same. Netzer (1966) explains this very clearly:

> It is generally agreed that taxes on the value of bare land—the sites themselves exclusive of applications of reproducible capital in the form of grading, fertilizer, and the like—rest on the owners of the sites at the time the tax is initially levied or increased. The tax cannot be shifted because shifting is possible, under reasonably competitive conditions, only if the supply of sites is reduced. But the supply of land is, for all practical purposes, perfectly inelastic. Individual landowners will not respond to an increase in land taxes by withdrawing their sites from the market, since doing so will not affect their tax liability. Indeed, their only chance of reducing the burdensomeness of the tax relative to their income streams is to seek to raise the latter by encouraging more intensive use of the sites they own. Collectively, landowners cannot reduce the stock of land: If individual landowners wish to liquidate in the face of higher taxes, they must sell the sites to other owners. (p. 33)

To return to Figure 2, the price of land services will drop from P' back to P and the net amount received by the landowners will drop to P''.

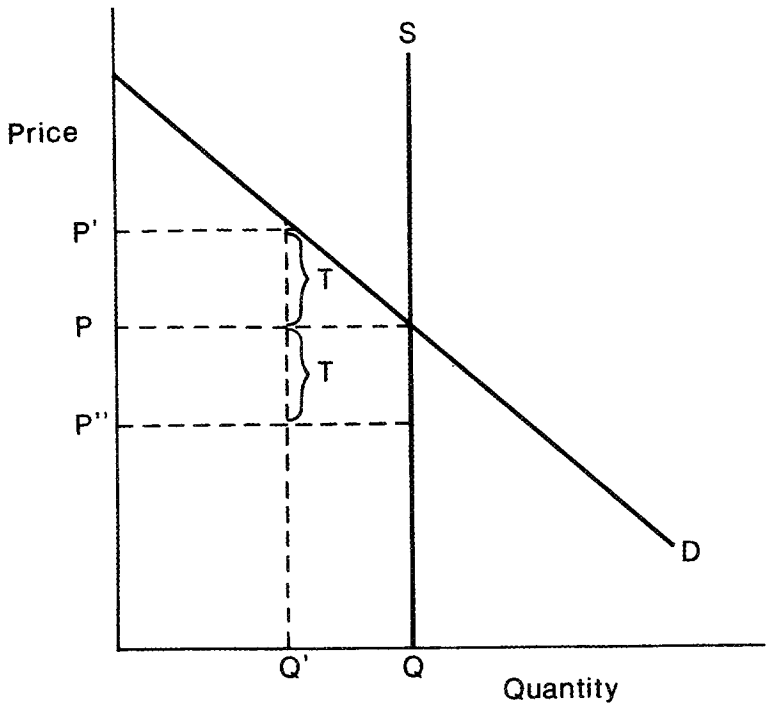

FIGURE 2. Effects of a Tax on Land.

A Simple Model of the New Housing Market

The new housing market is divided into two submarkets—one for new rental housing and the other for new owner-occupied housing. By treating owner-occupants as landlords who rent housing services to themselves, it is possible to model the new housing market with a single set of demand and supply functions. On the demand side, the quantity demanded, Q_d, is determined by: the average rent for new housing services, R_n; the average rent for existing housing services, R_e; average household income, Y; the number of households, N; and the prices of other goods and services, P_x. To the extent that the new housing market is a market for owner-occupied housing,[6] the nominal home mortgage interest rate, r, is also a demand side variable.[7] An immediately obvious problem is that R_e is not exogenous—it is dependent on Q_d. A solution to this problem is to use a lagged value of R_e.

On the supply side, the quantity supplied, Q_s, is determined by: the average rent for new housing services, R_n; the prices of operating and

maintenance inputs, P_o and P_m; and the land and improvement tax rates, b and z. In addition, there is a need for a variable, G, to capture the effects of tax incentives affecting the flow of capital into new housing in new relative to existing buildings. It is assumed that operating and maintenance inputs are in perfectly elastic supply so that their prices are exogenously determined.

In summary, the demand and supply functions are

$$(2) \quad Q_d = f(\mathrm{R_n}, R_e, Y, N, P_x, r),$$

$$(3) \quad Q_s = f(R_n, P_o, P_m, b, z, G),$$

where $Q_d = Q_s$. The relevant reduced-form equation is

$$(4) \quad \log Q = \beta_0 + \beta_1 \log R_e + \beta_2 \log Y + \beta_3 \log N + \beta_4 \log P_x + \beta_5 \log r + \beta_6 \log P_o + \beta_7 \log P_m + \beta_8 \log b + \beta_9 \log z + \beta_{10} \log G + u,$$

assuming a log-linear relationship between quantity and the various elements of demand and supply.

Proxies and Expected Signs

Given the length of the study period (1978 to 1984), it is necessary to use monthly data in order to have sufficient observations for analysis. Virtually the only available monthly measure of new housing development is the dollar value of building permit applications.[8] It is assumed that there is a reasonably uniform relationship between the values given on building permit applications and the actual costs of construction. Even though permits may substantially underestimate or overestimate costs, if they do so uniformly, there will be no distortion in the results.

The building permit data were deflated to January 1978 dollars using Boeckh's *Building Cost Index Numbers*.[9] The data contained substantial seasonal and irregular fluctuations that were smoothed using a twelve-month centered moving average.[10] Permits for residential buildings constructed by nonprofit organizations and the Pittsburgh Housing Authority were deleted from the data to the extent that it was possible to identify such permits.

The variables, their proxies, and the expected signs of their coefficients are given in Table 1. The proxies for average rent for existing housing services and the prices of other goods and services are straightforward. The first is the consumer price index for shelter costs for Pittsburgh, lagged one month, while the second is the consumer price index for all items except shelter for Pittsburgh.[11] The proxy for the price of operating inputs is the consumer price index for home heating fuels and other utilities for Pittsburgh. The proxy for the price of maintenance inputs is an index of residen-

TABLE 1. PROXIES AND HYPOTHESIZED SIGNS OF COEFFICIENTS

Variable	Proxy	Hypothesized Sign of Coefficient
Q	The dollar value of building permits for new residential buildings deflated to January 1978 dollars and smoothed to eliminate seasonal and irregular fluctuations.	
R_e	Consumer price index for shelter for Pittsburgh, lagged one month.	+
Y, N	M: Resident employment in Pittsburgh	+
P_x	Consumer price index for all items except shelter for Pittsburgh.	+
r	i: The nominal home mortgage interest rate for Pittsburgh.	−
	s: An estimate of the dollar value of city-subsidized mortgages for new housing.	+
P_o	Consumer price index for home heating fuels and other utilities for Pittsburgh.	−
P_m	An index of residential construction costs for Pittsburgh.	−
b	The nominal land tax rate.	+
z	The nominal improvement tax rate adjusted for the effects of tax abatements.	−
G	The dollar value of residential rehabilitation projects taking advantage of federal income tax incentives for rehabilitation.	−

tial construction costs for Pittsburgh derived from Boeckh's *Building Cost Index Numbers.*

The Pittsburgh area has lost a substantial number of manufacturing jobs in recent years. Monthly statistics are available on the amount of resident employment in Pittsburgh (i.e., the number of workers residing in Pittsburgh regardless of place of work).[12] These data provide a meaningful and convenient proxy for the combined effects of average household income and the number of households.

It is necessary to use two proxies for the nominal home mortgage interest rate. These proxies are the home mortgage interest rate itself[13] and an estimate of the dollar value of city-subsidized mortgages for new housing.[14] Mortgage subsidies in effect reduce the mortgage interest rate.

The land and improvement tax rates are shown in Table 2. The city, county, and school district all levy real estate taxes in Pittsburgh. Only the city, however, has a land value tax scheme, with heavier rates applicable to land. Since 1980, new residential improvements have been eligible for a three-year abatement of city, county, and school district improvement taxes. At first, use of the abatements was limited due to lack of knowledge about the abatement program. The number of abatements as a percentage of the number of building permits was quite low in 1980 (about 8 percent) but has increased substantially since then (to approximately 75 percent by 1983—see Department of City Planning and Urban Redevelopment Authority 1985, Table A4). In order to take into account the abatements, the tax rates for 1980 and subsequent years have been adjusted.[15] The adjusted tax rates are shown in the last column of Table 2.

Developers of housing in Pittsburgh have been to an increasing extent taking advantage of federal income tax credits for rehabilitation. In 1978 there were no residential tax credit projects; in 1984, however, nearly $12 million was invested in such projects. This suggests that the dollar value of such projects would be a good proxy for the effects of government pro-

TABLE 2. REAL ESTATE RATES APPLICABLE IN PITTSBURGH, 1978-1984 (in mills)

	City			School	Total		Total Structure Rate with
Year	Land	Structures	County	District	Land	Structures	Abatement
1978	49.5	24.75	21.375	29	99.875	75.125	75.125
1979	97.5	24.75	19.365	29	145.865	73.115	73.115
1980	125.5	24.75	23	29	177.5	76.75	75.23
1981	125.5	24.75	28	41	194.5	93.75	85.42
1982	133	32	29	36	198	97	78.96
1983	151.5	27	29	36	216.5	92	74.92
1984	151.5	27	29	40	220.5	96	78.16

Sources: Pittsburgh City Treasurer's Office (city and school district rates) and County of Allegheny Deed Registry and Records Management Office (county rates).

grams affecting the flow of capital into new housing in new relative to existing buildings. The data used consist of the dollar value of residential rehabilitation projects for which application was made to take advantage of federal income tax credits.[16] The expected project commencement date was used to assign projects to specific months. The monthly values were deflated to January 1978 dollars and smoothed using a twelve-month centered moving average.

As existing housing is a substitute for new housing, the coefficient of R_e should be positive. If new housing is a normal good, an increase in resident employment should result in an increase in the demand for new housing. Thus the coefficient of M should be positive. Since other goods are substitutes for new housing, the coefficient of P_x should be positive. Increases in the nominal home mortgage interest rate create an "affordability problem" (Downs 1985: 125) for potential owner occupants and, to the extent that the new housing market in Pittsburgh is a market for owner-occupied housing, the coefficient of i should be negative. The coefficient of s, on the other hand, should be positive because mortgage subsidies help to mitigate the affordability problem. Assuming that operating and maintenance costs are noninferior, increases in their prices should shift the supply curve upward and cause the quantity of new housing produced to fall. This implies that the coefficients of P_o and P_m should be negative. The coefficients of b and z, the land and improvement tax rates, should be positive and negative, respectively, for the reasons given earlier. The coefficient of G, the dollar value of residential tax credit projects, should be negative to the extent that those projects represent a diversion of capital from new construction to rehabilitation.

Results

Initial estimation of the model indicated a need to introduce a dummy variable, D, to capture the effect of the inordinately large total dollar value of building permit applications for January 1983.[17] The data used to construct the monthly building permit series show that the high value for January 1983 was attributable to one project. In smoothing the building permit data, the effect of this anomalous project was spread over a period of 13 months. It is appropriate to adjust for the effect of that project by using a dummy variable with a value of 1 for the months of July 1982 through July 1983 and 0 for all other months.

The empirical results are as follows:

$$\log Q = \underset{(0.92)}{-0.19} + \underset{(1.17)}{0.72}\log R_e + \underset{(1.81)^{*}}{1.04}\log M + \underset{(2.53)^{**}}{3.88}\log P_x - \underset{(0.19)}{0.05}\log i + \underset{(5.35)^{***}}{0.24}\log s - \underset{(1.14)}{0.96}\log P_o - \underset{(7.43)^{***}}{5.07}\log P_m \quad (5)$$

$$- \underset{(1.73)}{0.41 \log b} - \underset{(4.14)}{2.36 \log z} - \underset{(0.30)}{0.003 \log G} + \underset{(14.19)}{0.72 D}.$$

The absolute values of the t-statistics are given in parentheses and the estimates marked by *, **, and *** are significantly different from zero at the 10, 5, and 1 percent levels, respectively. The high R^2 value of 0.98 indicates that virtually all of the variation in the dependent variable is explained by the independent variables. All of the coefficients have the expected signs except for the coefficient of the land tax rate.

There are two possible explanations for the sign of the land tax rate coefficient. One possibility is that assessed land values in Pittsburgh are based in part on the value of improvements, with the result being that the land tax rate is actually applied in part to improvement values. This seems unlikely, however, as assessment practices in Pittsburgh (i.e., in Allegheny County) are relatively sophisticated.[18] The other possibility is that the land tax rate is not a significant determinant of the level of new housing construction, but happens to be collinear with other variables which are significant. Regression of the land tax rate on the other independent variables demonstrates a serious problem of multicollinearity. This leads to the conclusion that the land tax rate is not a determinant of the level of new housing construction activity.

On the other hand, the improvement tax rate is a highly significant determinant of the amount of new housing construction in Pittsburgh. Since the coefficients in the log-linear model are elasticities, a 1 percent decrease in the improvement tax rate, z, should result in a 2.36 percent increase in the dollar value of new housing. This implies that a 5 percent decrease in the improvement tax rate, such as that which occurred at the beginning of 1983, should have resulted in about an 11.8 percent increase in the dollar value of new housing construction. Given the mean monthly amount of new housing construction during the study period ($1,076,042), this would represent an increase in construction activity of over $125,000 each month (in January 1978 dollars).

An increase in the dollar value of housing construction could reflect an increase in the number of new units, an increase in their average cost, or both phenomena. Estimating the model with a measure of the number of new units as dependent variable yields an elasticity estimate of -2.79 for the improvement tax rate variable. As before, this coefficient is significantly different from zero at the 1 percent level. In this case, the estimated coefficient for the land tax rate is not significantly different from zero. This supports the conclusion that the land tax rate is not a determinant of the level of new housing construction activity. Given the mean monthly number of new housing units during the study period (about 32.7), a 5 percent decrease in the improvement tax rate would have resulted in about a 14 percent increase in the number of units—about 4.5 additional units each month. Estimating the model with a measure of the average cost of new units as the dependent variable yields estimated coefficients for the improvement and land tax rates that are not significantly different from zero.

Conclusions

The results of the study suggest that, during the 1978-1984 study period, the land tax rate has not had a significant effect on the development of new housing in Pittsburgh, while the improvement tax rate has had a substantial effect. In other terms, Pittsburgh's land value tax has had an incentive effect but not a liquidity effect with respect to new housing. The results also indicate that the improvement tax rate affected the number of new housing units constructed in Pittsburgh, but not their average cost.

NOTES

1. Data limitations and theoretical considerations suggest that it would be difficult to assess the effects of the land value tax on other types of development, such as residential rehabilitation or office construction. For example, building permit data (the only suitable measure of construction activity) for rehabilitation projects do not distinguish between residences and other types of structures; this presents a problem in view of the likelihood that a land value tax would have different effects on different types of uses.
2. Tax rates were obtained from the Pittsburgh City Treasurer's Office and Allegheny County Deed Registry and Records Management Office.
3. See Pittsburgh Code, Chapter 265 ("Exemptions for Residential Improvements"). It should be noted that assessed values in Allegheny County (which includes Pittsburgh) are supposed to be 25 percent of market value. This means that the effective tax rates in 1984 should have been about 5.5 percent on land and 2.4 percent on improvements (not taking into account the abatements). The model specified here uses the nominal rates (adjusted for the effects of the abatements).
4. The term *structural services* is used because it allows for a common, albeit abstract, unit of measurement which takes into account all qualitative and quantitative aspects of structures. Compare Olsen's (1969) use of the term *housing services*.
5. See Coffin and Nelson's (1983) apt critique of Mathis and Zech's methods.
6. The building permit data used in the subsequent analysis include both rental and owner-occupied units, but they do not distinguish between the two.
7. As Downs (1985) points out, the supply sides of the owner-occupied and rental housing markets and the demand side of the rental housing market are essentially unaffected by the mortgage interest rate. On the other hand, the demand side of the owner-occupied housing market *is* affected:

> When nominal interest rates soar, millions of households able to purchase homes at lower rates can no longer do so. The required monthly payments become such large fractions of their incomes that lenders fear they might default. Lenders will therefore not lend these households enough to purchase homes, and they drop out of the market. This housing *affordability problem* can drastically reduce total transaction levels in real estate markets, and total capital flows into real estate. (p. 126)

8. Building permit data were obtained from the Bureau of Building Inspection, Department of Public Safety, City of Pittsburgh.
9. Provided courtesy of American Appraisal Associates, Inc., Milwaukee WI.
10. Smoothing also eliminates the adverse effects of any seasonal patterns of overestimation or underestimation.
11. All consumer price indexes were obtained from the *CPI Detailed Report*, published by the Bureau of Labor Statistics, U.S. Department of Labor. Some interpolation and extrapolation was necessary because only bimonthly data are given for Pittsburgh, beginning with April 1978 (which can be calculated from the data published for June 1978).
12. Data were obtained from the Office of Employment Security, Department of Labor and Industry, Commonwealth of Pennsylvania (Pittsburgh office).
13. Home mortgage interest rates for the Pittsburgh SMSA were obtained from the Federal Home Loan Bank Board.
14. Pittsburgh has two housing subsidy programs which provide mortgage assistance for purchasers of new homes. The Neighborhood Housing Program, initiated in 1974, provides mortgages for purchasers of new homes, while the Pittsburgh Homeownership Program, begun in 1979, provides mortgage assistance for purchase and rehabilitation of existing homes as well as purchase of new homes (Department of Housing 1985: 6, 9). The dollar values of assistance provided for new construction under each of these programs during the study period were obtained from the Department of Housing, Urban Redevelopment Authority, City of Pittsburgh.
15. The procedure for making this adjustment was to treat the total structure tax rate as a perpetuity, calculate the present value of that perpetuity, and subtract from that the present value of a three-year annuity. The resulting value, expressed as perpetuity, is the adjusted tax rate. In view of the initial lack of knowledge of the abatement program, the three-year annuities used in this calculation have been adjusted to reflect the level of participation in the program. This was accomplished by multiplying the value of the annuities by the percentages of participation.
16. Data were obtained from the Pennsylvania Historical and Museum Commission.
17. In addition, there was a need to adjust for autocorrelation. This was accomplished using the first difference method, with ϱ based on the Durbin-Watson d-statistic.
18. Allegheny County uses the Computer-Aided Mass Assessment system and, according to Dr. Charles Blocksidge, Director of Property Assessment, Appeals, and Review, land assessments are based primarily on data from sales of vacant parcels; they are never based on some arbitrary percentage of the total property assessment. According to Paul Weis, Director of Operations for the Pennsylvania State Tax Equalization Board (STEB), Allegheny County does a better job of assessment than most other counties in Pennsylvania. The STEB is responsible for validating real estate tax assessments in Pennsylvania.

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