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MEASURING PROPERTY TAX INCIDENCE:

A MAXIMUM LIKELIHOOD APPROACH

by

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Abstract

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The Measuring Property Tax Incidence: A Maximum Likelihood Approach

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Taxes on agricultural land may be capitalized into the value of the land or they may be shifted either forward or backward. An empirical investigation of the rate of capitalization using maximum likelihood procedures suggests that capitalization may not be as prevalent as expected. Recent changes merit further investigation.

Key words: property taxes, land values, incidence

MEASURING PROPERTY TAX INCIDENCE:
A MAXIMUM LIKELIHOOD APPROACH

Property taxes are one of the major cost elements in American agriculture. In 1972, property tax payments were 25% greater than total expenditures for fertilizers and lime (USDA, 1973a). It is generally assumed that property taxes are capitalized into the value of the land. Recently Mieszkowski (1972) suggested that at the macro level property taxes may be shifted forward to the consumer or backward to other factors of production rather than being capitalized in property values. Drummond employed an empirical procedure suggested by Hall to test Mieszkowski's predictions. The statistical results failed to support the hypothesis that property taxes are fully capitalized, but the results were not conclusive. This paper presents a more substantive empirical test of the incidence of property taxes on agricultural land in the United States.

LAND MODEL

Assume a perfectly competitive, neo-classical market in which all agricultural land is rented out (realizing that much of the land is rented to the owner himself). Further assume that the supply of land is highly inelastic[1/] and that the demand for land is not a function of speculative pressures but instead is determined by its productive attributes.[2/] The owner of the land pays all property taxes. For static equilibrium to exist in the land market both the renter and the owner must be in equilibrium. That is, the rent paid by the renter must equal the value of the marginal product of land, and the owner must receive a return net of taxes

on the value of the land that is equal to the opportunity cost of his available capital.[3/] Thus there are two equilibrium conditions:

$$\text{Renters:} \quad M_v = R \tag{1}$$

$$\text{Owners:} \quad V(i) = R - T \tag{2}$$

where:

M_v = the value of the marginal product of land,

R = the rent paid by the renter,

T = the value of property taxes paid by the owner,

i = the opportunity cost of the owner's capital, and

V = the market value of the land.

Combining (1) and (2) gives:

$$M_v = V(i) + T \tag{3}$$

In other words, the value of the marginal product of land must be sufficient to pay an adequate return to the owner and to cover property taxes. In a perfectly competitive static equilibrium, renters and owners will adjust the intensity of use of land and other factors such that (3) is satisfied. This condition may be restated as:

$$M_p(P) = V(i + t) \tag{4}$$

where:

M_p = the marginal physical product of land,

P = the price of the aggregate product, and

t = the effective tax rate on agricultural land.

Equation (4) demonstrates that the land market may adjust to a change in property tax rates in a variety of manners. It is generally accepted that as t changes, the modified property taxes are capitalized into property values

causing V to vary inversely with t.[4/] Studies of land values by Drummond and White, and by Pasour have shown cross-sectional interstate differences in property tax rates to be associated with land value differences. These results support the theoretical expectation that property taxes are capitalized into property values. But they do not preclude the possibility of land market adjustment to tax rate changes through variation in either M_p, P or i.

HYPOTHESIS

The central hypothesis of this paper is that property taxes are not necessarily fully capitalized into property values but instead may be shifted either forward or backward. While capitalization is certainly possible, equation (4) suggests that other adjustments in the land market are also possible in reaction to a change in property taxes. Three other variables (i, M_p and P) may also adjust to reestablish equilibrium after a change in the tax rate.

Backward shifting of the property tax occurs when increased property taxes cause an increase in the demand for land substitutes such as fertilizers, lime and machinery. If the supply of land substitutes is less than perfectly elastic, their prices would increase. Non-agricultural users of these factors of production would share a portion of the tax burden as would consumers of agricultural commodities as a consequence of increased costs of production. Therefore, if M_p were to adjust to tax rate changes, this would indicate backward shifting of the property tax to other factors of production which are substitutes of land.

Forward shifting occurs when changes in property taxes result in changes in food and fiber prices. For this to occur, increased tax levels must be incorporated into the cost structure of the production unit rather

than being capitalized into lower property values. That is, if property taxes were to increase, property owners would attempt to increase rental rates by the amount of tax.[5/] Increased rental rates would increase average fixed costs of the renter, ceteris paribus, and the break-even price for the production unit would go up. Marginal units would be driven out of production and product prices would increase.

The key question in this chain of events is whether the owner can, in fact, adjust rental rates to reflect tax changes. If this question is analyzed within the neoclassical theory of a perfectly competitive firm, then the answer must be that the land owner is unable to increase rental rates and that tax adjustments are capitalized into land values. In the neoclassical model of the firm, rent determination occurs on the margin and a perfectly elastic demand curve confronts the firm. However, if this question is analyzed within an aggregate, long-run market framework, then an increase in taxes would cause an upward shift in the supply of food and fiber as marginal land is driven out of production. Increased food prices would be passed through the renter to the landlord as compensation for the additional tax burden.

Recently, Mieszkowski (1969, 1972) has suggested that a distinction must be drawn between the local (firm level) and the global (market level) impact of property taxes. Suppose that every taxing district in the United States increased property tax rates by a given amount. In this case, global property tax increases would be included in the rent charged by owners and would be passed on as a portion of the fixed costs of the firm. Marginal land would be driven out of production, shifting the supply curve upward. In equilibrium, these additional fixed costs would be passed on to the consumer. The property owner would receive a rental

payment sufficient to provide a return on the land equal to that of other capital, and to pay the property tax. So at the global level, forward shifting of property taxes is possible and may be anticipated.

Now assume that one county imposes an additional local tax over and above the uniform, global property tax. Individual local land owners face an elastic demand curve such that product prices and rents are determined by conditions in the aggregate market. Neither the price of the product nor the rent charged by the landlord could be adjusted if the firm is to remain in the market. Consequently, net return to the owner would fall, as would local property values. Hence, a differential local tax above the global tax rate would be capitalized into property values, and the global portion of the tax would be shifted forward to the consumer.[6/] In this case, the incidence or burden is shared between consumers (who bear the global portion) and land owners (who bear the local portion).

Equation (4) is consistent with neo-classical firm theory. Property taxes are fully capitalized into land values. But the above discussion suggests that capitalization may be partially offset if either forward or backward shifting of property taxes occurs. The equilibrium rental rates in equation (4) may be modified to include a variable capitalization rate Θ:

$$M_p(P) = V(i + \Theta t) \qquad (5)$$

If $\Theta = 1.0$, then (5) reduces to the neoclassical model in (4). If $\Theta < 1.0$ then $1.0 - \Theta$ is the proportion of the property tax that is shifted. Hence, the hypothesis is that Θ is not necessarily equal to 1.0 for agricultural land in a global context.

ESTIMATION PROCEDURES

The hypothesis is tested using a form of the Cobb-Douglas production

function that is non-linear in logrithms:

$$lgQ = lg\alpha + \beta_1 lg\ L + \beta_2 lg\ K + \beta_3 lg\ (V(i + \theta t))$$

where:

V = the value of farm land excluding buildings (USDA, 1973c, Tables 2-49).

i = the opportunity cost of capital, assumed constant at five percent.

t = farm real estate taxes per $100 market value (USDA, 1973c, Tables 2-49). In 1969 the value of t ranged from a minimum value of $0.25 to a maximum of $2.43.

Q = realized gross farm income (USDA, 1973b, Table 6)

L = the value of all farm labor computed by dividing hired labor expense (USDA, 1973a, Table 8) by the annual average number of hired workers on farms (USDA-SRS). This implicit wage is then multiplied by the annual average number of total farm workers (hired and family (USDA-SRS) to give total labor value.

K = capital is equal to production expenses plus depreciation. All data used in the estimation of K are from USDA, (1973b, Table 8). K is computed as the sum of total current farm operating expenses plus depreciation and other consumption of farm capital minus miscellaneous expenses and hired labor expenses.

θ = the property tax capitalization rate

The labor and capital variables are measured as flow variables. The last term of (6) is taken from equation (5) showing equilibrium rent determiniation. The extent of property tax shifting is determined by the model through the estimation of the property tax capitalization or shift parameter θ. If the value of θ is near 1.0 then the rental value of land includes property taxes and property taxes have been fully capitalized. If, on the other hand property taxes are shifted forward or backward, then the estimated value of θ should be near zero indicating that the property tax is not material to the determination of rent values in a manner similar to that of any other cost element.

The parameters of (6) were estimated using national cross-sectional data in which each of the 48 states was treated as an observation. All data were drawn from USDA series. Estimates were made independently for each year between 1950 and 1970. The inclusion of θ makes (6) non-linear in logarithms. Consequently, it cannot be estimated using ordinary least squares regression procedures. Instead a maximum liklihood search procedure developed by Just and Fletcher was employed. Basically this procedure searches for the value of θ that will minimize the error sum of squares by first searching a coarse grid and then searching a finer grid in the region of the θ chosen in the first search. The value of θ was constrained to the range between zero and one. The estimated values of θ for each year are listed in Table 1. All β coefficient estimates are significantly different from zero at the one percent level and all R^2 statistics were above 0.98.

DISCUSSION

The property tax capitalization rates presented in Table 1 trace a definite pattern through time. From 1950 through 1965, the capitalization rate was 0.23 or below.[7/] Throughout this period the hypothesis may not be rejected. A transition period begins in 1966 that culminates in 1969 with an estimated capitalization rate of 0.99. The results for 1970 confirm the shift from a long period of almost full shifting of the property tax ($\theta \simeq 0$) to a new era of full capitalization ($\theta \simeq 1$). The very regular and seemingly well orchestrated pattern of the 1950-65 results enhances their credibility and significance in support of the hypothesis. Nonetheless, the statistical results raise an interesting question: What occurred during the latter part of the 1960's that reversed the previous

Table 1

Estimated Rate of Property Tax Capitalization for Agricultural Land in the United States: 1950-70

Year	Capitalization Rate
1950	0.04
1951	0.03
1952	0.23
1953	0.03
1954	0.03
1955	0.23
1956	0.23
1957	0.23
1958	0.23
1959	0.23
1960	0.23
1961	0.03
1962	0.03
1963	0.23
1964	0.23
1965	0.23
1966	0.32
1967	0.45
1968	0.72
1969	0.99
1970	0.97

Note: A low capitalization rate is synonymous with a high rate of forward or backward shifting.

pattern of forward (or backward) shifting of property tax burdens, and led to full capitalization in 1969 and 1970?

Finding an answer to this question is difficult. In the remainder of this paper several alternative explanations will be reviewed briefly in the hopes that they may be suggestive of further research needed in this area.

1. Escalating food prices. If output prices increase more rapidly than variable costs, then the return to fixed factors including land will increase abruptly. Thus, the capitalization rate results for 1965-70 may reflect a shift in relative prices. However, the trend of parity rates over this period fails to support this explanation.

2. Speculative Land Market. If speculative expectations of increases in land prices were to increase substantially, then land owners presumably would be willing to accept lower short-run returns from productive activities. If rent payments are relatively sticky, then the acceptance of lower returns (i) would appear to be the same as an increase in the capitalization rate (θ). This explanation suggests a relatively rapid rate of increase in land prices during the 1960's. But with the exception of the early 1950's, the average price of land in the data used for this study has increased at a very constant 5-8% rate.

3. Changing Tax Structure. If property taxes were increasing at a relatively rapid rate during the latter part of the 1960's, then it may be that the initial impacts of the increases were capitalized into land values until such time as the tax structure and land price system reached a new equilibrium. The data neither support nor reject this hypothesis. The average tax rate in the U. S. was between \$1.02 and \$1.05 per \$100 of market value for the period 1961-67. In each of the next three years an approximate increase of \$0.04 per year brought the average to a level of

$1.16 which is approximately 15% above the average for years prior to 1967. It is questionable if an increase of this magnitude could have been responsible for the shift in the capitalization rate, and it is difficult to understand why the capitalization rate shift appears to have anticipated the tax rate increase by a few years.

4. Unrevised Data Series. The USDA data series used for the tax rate variable in (6) is estimated using a link-relative technique to measure change from benchmark years. The series used had not been corrected for benchmark data for 1970 which is now available so there may have been substantial drift in the estimates for the latter portion of the 1960 decade. Recent corrections for this drift by Stan and Courtney resulted in a 5.75% adjustment in the 1970 tax per acre figure. Equation (6) has not yet been reestimated with the revised data series.

CONCLUSION

The results presented in this paper probably raise more questions than they answer. The usual expectation that property taxes are capitalized into property values has been challenged. The results suggest that over a fifteen year period property taxes on American agricultural land were passed on--either forward to the consumer in the form of higher food prices or backward to substitute factors of production. The failure to support the hypothesis that property taxes are consistently capitalized into property values mandates additional empirical analysis. The consistency of the results is very convincing, but caution must be exercised in accepting them. A consistent hypothesis is needed to explain an abrupt shift in the capitalization rate during the latter half of the 1960's. Unfortunately, no fully satisfactory hypothesis is suggested.

The implications of property tax shifting are interesting from a policy point of view. In essence, shifted property taxes may be viewed as a production tax on food that is proportional to the amount of land used in its production. A production tax is more inequitable from either a benefits received or ability to pay point of view than a tax that is capitalized into land values. Therefore, the debate concerning the equity of the property may deserve reexamination in light of the results of this study.

FOOTNOTES

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1/Throughout this paper "land" and "property" are used synonymously to refer to non-reproducible capital. The analysis is limited to farm land only. That portion of farm property that is reproducible is not treated in this paper.

2/Speculative values could easily be included in the model as shown by Renne (p. 222-3).

3/Income taxes that might be paid on the net rental income of owners could easily be included in the model, but for purposes of simplicity these are ignored. Gaffney develops a similar model to evaluate the impact of the assumption that a single opportunity cost of capital exists.

4/To some extent, property values vary directly with tax rates, ceteris paribus, if higher tax rates result in higher public service expenditures. This effect has been verified in urban areas by Tiebout, Oates, and others.

5/This adjustment process is particularly feasible in the majority of cases where owner and renter are embodied in a single manager.

6/Note that the empirical results of cross-sectional intrastate land value studies are consistent with this argument. These studies have merely demonstrated that local differences in property taxes are capitalized into

land values.

7/ The search grid employed in the maximum likelihood procedure was sufficiently coarse to generate repeated estimates of similar magnitudes. No implications should be drawn concerning the exact magnitude of the estimates. What is relevant is the general level of θ and changes in that level.

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