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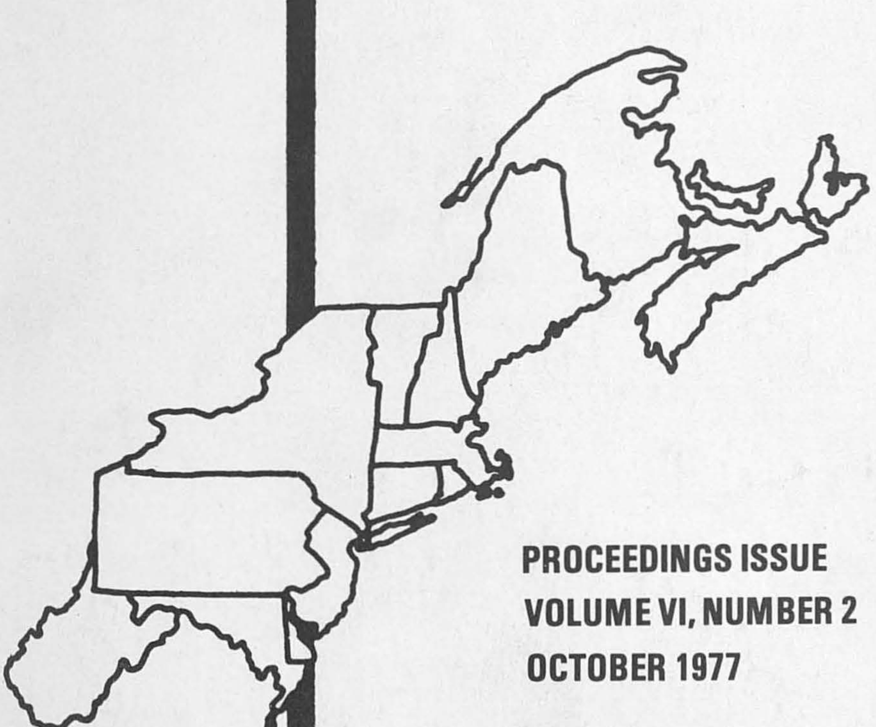

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POPULATION AND FARMLAND VALUES IN THE NORTHEAST*

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Agricultural problems associated with population growth have been analyzed in the Northeast for some time. The loss of cropland and the effect on agricultural output have been documented by Otte [7] and Krause [5]. In addition to the actual loss of agricultural land, changes in land-use, taxation and agricultural input infrastructure continue to be analyzed. Indeed, rural land-use policy researchers in the Northeast have provided national leadership for several institutional innovations, e.g. agricultural districts, transferable development right sales and differential assessments. The Conference on Rural Land-Use Policy in the Northeast held at Atlantic City in 1974 and the on-going regional research project, "Rural Land Use Policy in an Urbanizing Environment" attest to the continued research in this area.

To date however, the effects of population growth on farmland values have not been documented. It has usually been hypothesized that farmland values are affected in a positive manner as nearby populations increase. The purpose of this paper is to estimate the magnitude of the affect that population has on farmland value. Additionally, the responsiveness of farmland values to population changes is estimated. This relation, as the reported estimates will reveal, has important land use policy implications for the Northeast.

THE MODEL

Farmland Value at the aggregate level is hypothesized to be a function of two components: an "exogeneous to farmland" variable (Urbanization) and an "endogeneous to farmland" variable (Agricultural Value). These two components of farmland value reflect the twofold use of farmland in the Northeast; 1) a factor of agricultural production

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and 2) a potential outlet for population dispersion and/or expansion. The following general model illustrates this relationship:

$$(1)\ FV = f(U, AV).$$

After correcting for differences in agricultural value (AV) associated with productivity, this general framework allows for the statistical measurement of the impact of urbanization (U) on farmland value (FV). By this procedure, the price effect of factors associated with urbanization, such as development (industrial and residential) and speculation in agricultural land, are statistically isolated from the agricultural value of farmland. The model is not intended to be predictive in the sense of determining a price level for farmland site specific, but rather explanatory with respect to selected components influencing value.

The following functional form was specified from (1):

$$(2)\ FV = \beta_o + \beta_1 D_{70} + \beta_2 D_{\Delta} + \beta_3 S + \beta_4 A + u$$

where

FV = average farmland value per acre (1974)

D_{70} = 1970 population per square mile (density)

D_{Δ} = percentage change in density, 1960-1970

S = average agricultural sales per acre (1974)

A = average farm size (1974)

u = random disturbance.

D_{70} and D_{Δ} are proxies for urbanization. The inclusion of D_{Δ} allows for the growth rate of population density to enter the model, so the effects of urbanization are not based on purely cross-sectional data. It is expected, a priori, that D_{70} and D_{Δ} will have estimated coefficients that are positive in sign. The proxy for agricultural value is S, the value of agricultural sales per acre. Farm size, A, is included to correct for impact of average tract size on the per acre value. The coefficient for S is expected to be positive as agricultural sales should have a positive impact on farmland value; this is supported by Hammill [4]. A negative coefficient for A is expected. Clonts [2], Bovard and Hushak [1], and Lindsay and Willis [6] lend support to this contention.

Farmland value per acre, value of agricultural sales per acre and farm size are all county averages from the 1974 Census of Agriculture, Preliminary County Reports, [8]. Density (1970 population per square mile) and percentage change in density from 1960 to 1970 are from the County and City Data Book, 1972 [9]. Density and percentage change in density were based on 1970 census data that were judged to be superior to the 1974 population "estimates".

County observations for the Northeast Farm Production Region, commonly used by the USDA, comprise the data set used in this paper. The Northeast Farm Production Region was further separated into four subgroups; 1) New England, 2) Middle Atlantic, 3) Standard Metropolitan Statistical Areas (SMSA's) and 4) non-SMSA's. The SMSA and non-SMSA groupings were only possible for the Middle Atlantic states, since the SMSA's are defined at the town level for New England. These various groupings of counties in the Northeast Farm Production Region are depicted in Figure 1. Further, for a county to be included in the analysis, at least 5% of the total land area had to be in farmland. This arbitrary exclusion criteria resulted in both heavily urbanized counties and heavily forested counties to be omitted from the study.

Farmland value as reported by the Census of Agriculture is the subjective value of farmland provided by the farm owner and is supposed to reflect market value at the time of the census. A landowner would be expected to incorporate the results of recent sales of nearby land into the estimate; hence, both agricultural and urbanization (if present) values are contained in the figure. One problem with using FV is that the value of buildings is included as well as land value. This is not expected to be a severe problem since 1) FV is expressed on a per acre basis, and 2) the Northeast Farm Production Region and the subregions used in this paper delineate similar types of agriculture. Further, when the dominant factor in determining FV is due to urbanization, the "salvage" value of the existing buildings is probably minimal. The proxy for agricultural value (S) is admittedly gross. Operations such as feedlots, poultry production and nurseries are included even though sales from such enterprises are not closely related to land productivity. Hence, the use of S may overstate the agricultural value portion of FV. By using the county as the unit of observation, any errors associated with S should be diluted and distributed throughout the counties.

Summary statistics for the variables used in estimating (2) are presented in Table 1 for all geographical areas analyzed in this paper. The arithmetic means are very similar among the Northeast, New England and Middle Atlantic counties for all variables. As expected, a substantial difference exists between means for the SMSA and non-SMSA counties in the Middle Atlantic group.

THE RESULTS

Equation (2) was estimated for the five county groupings using ordinary least squares techniques with the corresponding results

Figure 1
Northeast Farm Production Region and Subgroupings

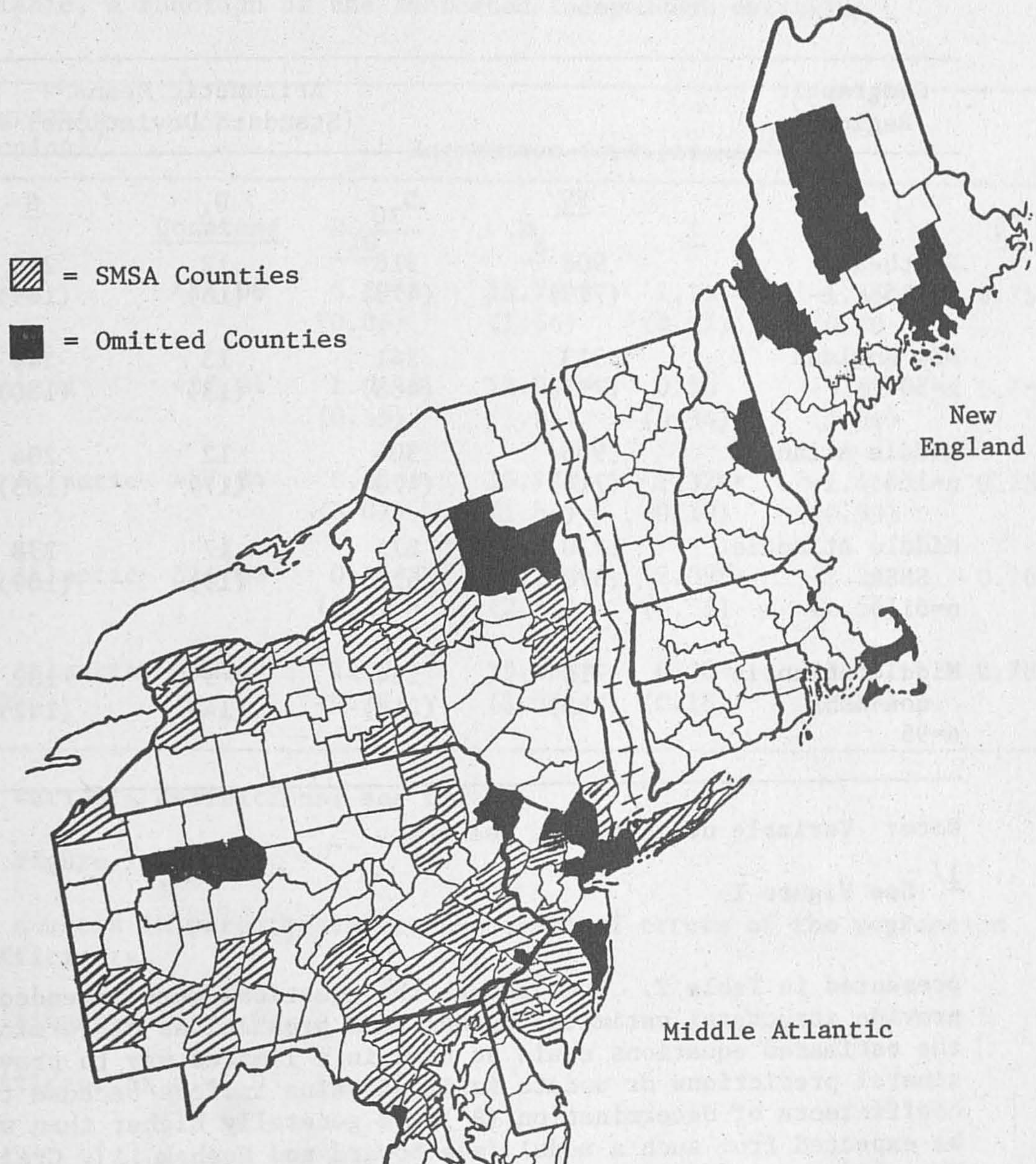

Table 1
Summary Statistics for the Dependent
and Independent Variables by Region and Subregions

Geographic Region[1/]	Arithmetic Means (Standard Deviations)				
	FV	D_{70}	D_{Δ}	S	A
Northeast n=215	908 (719)	316 (473)	12 (16)	216 (169)	174 (63)
New England n=59	913 (731)	341 (483)	13 (13)	249 (180)	180 (74)
Middle Atlantic n=156	906 (716)	306 (470)	12 (17)	204 (163)	171 (58)
Middle Atlantic SMSA n=61	1210 (870)	575 (612)	17 (19)	238 (189)	146 (46)
Middle Atlantic non-SMSA n=95	710 (515)	134 (218)	9 (14)	182 (142)	188 (59)

Note: Variable definitions, see text.

1/ See Figure 1

presented in Table 2. Even though the equations were intended to provide structural estimates rather than predictions of farmland value, the estimated equations could be used in a limited way to provide general predictions or update farmland value indices because the coefficients of determination (R^2) are generally higher than would be expected from such a model (see Bovard and Hushak [1], Craig and Mapp [3] and Lindsay and Willis [6]).

Northeast

All estimated coefficients have the expected sign and are significantly different from zero at the $\alpha = .01$ level. For each 1 person increase per square mile, farmland value per acre increases by $.69. Whereas, for a 1 percent increase in the rate of density growth, farmland value per acre increases by $15.75. Changes in D_{70} and D_{Δ} must,

Table 2
Regression Estimates for Equation 2;
1974 Farmland Value per Acre, the Dependent
Variable, a Function of the Indicated Independent Variables

Geographic Grouping[1/]	Regression Coefficients[2/]					
	Constant	D_{70}	D_{Δ}	S	A	$\bar{R}^2$
Northeast	484.06	0.69** (0.06)	15.75** (1.66)	1.13** (0.17)	-1.35** (0.50	0.75
New England	432.04	1.01** (0.15)	12.04** (3.95)	0.50 (0.34)	-0.83 (1.04)	0.78
Middle Atlantic	487.34	0.62** (0.07)	16.77** (1.84)	1.32** (0.19)	-1.41** (0.59)	0.75
Middle Atlantic SMSA	511.83	0.45** (0.11)	15.75** (2.91)	2.09** (0.35)	-2.29 (1.56)	0.76
Middle Atlantic Non-SMSA	447.69	1.30** (0.13)	15.68** (1.99)	0.40* (0.18)	-0.64 (0.47)	0.78

Note: Variable definitions; see text.

1/ See Figure 1.

2/ The numbers in parentheses are the standard errors of the regression coefficients.

**Significant at α = .01, 1 tail test

*Significant at α = .05, 1 tail test however, be analyzed simultaneously as a change in one affects the other[1/]. Further analysis of the total effect of changes in D_{70} and D_{Δ} on farmland value is presented in the following section. Increases in agricultural sales, S, per acre are associated with increased farmland values. As the average farm size, A, increases, the per acre farmland value decreases. Seventy-five percent of the total variation of farmland values was "explained" by the estimated model.

New England and Middle Atlantic

The estimated coefficients for the New England and Middle Atlantic equations are in general similar to those for the Northeast. The level of density in New England has a larger influence on farmland value than density for the Middle Atlantic states. Conversely, the rate of density change in the Middle Atlantic states has a larger influence on farmland value than in New England. The estimated coefficients of S and A in the New England equation are not significant at the $\alpha = .05$ level, however both have the expected sign and the coefficient of S is, nonetheless, significant at the $\alpha = .10$ level.

SMSA and non-SMSA Equations

Urbanization pressure is not evenly spread throughout a region or even a county. Farmland on the urban fringes necessarily is more strongly affected than farmland further away. One limitation of using the county as the unit of observation is that the pressure of urbanization is statistically spread over the entire county. The results reported in Table 2 for the Northeast, Middle Atlantic and New England probably understate the impact of urbanization on farmland values. To correct for this problem, the counties were disaggregated into two groups 1) Standard Metropolitan Statistical Area (SMSA) counties and 2) non-SMSA counties for the Middle Atlantic States (refer to Figure 1). By disaggregating the observations into two more nearly homogeneous groups, the problem of underestimation should theoretically be lessened.

The estimated coefficients for the SMSA and non-SMSA equations have the expected sign and are not dissimilar from those of the other equations previously discussed. The coefficients for D_{70}, D_{Δ} and S are significant at $\alpha = .05$ or $\alpha = .01$ levels. The coefficients for average farm size, A, are negative and significant at the $\alpha = .10$ level though not indicated so in Table 2.

1/ It may be thought that a high degree of correlation exists between D_{70} and D_{Δ}. The simple correlations range from .13 to .39 for the five equations presented in Table 2. Given these simple correlations, any multicollinearity violation would seem to be remote.

To be sure, analyzing SMSA and non-SMSA counties separately did not produce the expected results. One could even interpret the results as being exactly backwards; however, this is not the case. The estimated coefficients for agricultural sales, S, suggest that the agricultural value is more important in SMSA counties than non-SMSA with respect to explaining farmland values. The SMSA counties of the Middle Atlantic states do, in fact, account for 43 percent of all agricultural sales (dollar basis) in the Middle Atlantic in addition to being heavily populated. The effects of urbanization on agriculture, therefore, are greater than originally would be expected.

All Equations

The estimated equation for the Northeast and the subsequent equations for New England and the Middle Atlantic states along with the further disaggregation into SMSA and non-SMSA county groups as presented in Table 2 confirm the general model (1) and the functional form represented as (2). More importantly, both urbanization and agricultural value are important factors explaining farmland values in the Northeast and the four subsets of the Northeast analyzed in this paper. This relation, by holding generally throughout the Northeast, has important implications for land use research and policy formulation.

DENSITY ELASTICITY OF FARMLAND VALUE

Given the estimated coefficients in Table 2, the responsiveness of farmland value to changes in density can be calculated in the form of an elasticity. The density elasticity of farmland value is derived as follows:

Given:

$$(3)\ FV = f(D_{70}, D_{\Delta}, S, A)$$

$$(4)\ D_{\Delta} = g(D_{60}, D_{70})$$

Then:

$$(5)\ \varepsilon_D = \frac{dFV}{dD_{70}} \cdot \frac{D_{70}}{FV} = \left[\frac{\partial FV}{\partial D_{70}} + \frac{\partial FV}{\partial D_{\Delta}} \cdot \frac{dD_{\Delta}}{dD_{70}}\right] \cdot \frac{D_{70}}{FV}$$

From (2) and (5):

$$(6)\ \varepsilon_D = \left[\beta_1 + \beta_2 \frac{100}{D_{60}}\right] \cdot \frac{D_{70}}{FV}$$

Elasticities were calculated from (6) using the estimated coefficients in Table 2 and are reported in Table 3. The elasticities are quite elastic for all geographic areas, ranging from 1.74 to 2.64. For instance, a

1 percent increase in density in the Northeast would result in a 2.19 percent increase in average farmland value. These estimates of the responsiveness of farmland value to density (population) changes are quite revealing and have important policy ramifications for many land related issues. For instance, land acquisition, transfer and taxation are materially affected by the magnitude of farmland value. As the farmland value is "pushed up" by non-agricultural forces, important changes in land tenure and land use may well occur. The elasticities presented in Table 3 also illustrate the danger of incorporating land costs (based on current value) into commodity production cost estimates as is currently mandated by Congress, since items other than agricultural productivity can greatly affect farmland value. Proposed "farm bill" legislation would have target prices and loan rates directly linked to cost of production estimates. Should this proposal become incorporated in the final legislation, effects of urbanization would be inputed into commodity prices and eventually food prices.

Table 3
Density Elasticity of Farmland Value

Geographic Area1/	ε_D 2/
Northeast	2.19
New England	1.87
Middle Atlantic	2.28
Middle Atlantic SMSA	1.74
Middle Atlantic Non-SMSA	2.64

1/ See Figure 1.

2/ Elasticities calculated at data means.

CONCLUSIONS

General

A simple econometric model was hypothesized to quantify the impact of selected urbanization forces on farmland value. This hypothesis was evaluated using 1974 agricultural data and 1970 urbanization data. Further, the change in population (used to measure the change of urbanization) from 1960 to 1970 was employed. The data applied to the model were essentially cross-sectional in nature so problems of land price inflation over time were avoided. The statistical properties of the estimated equations are similar to previous studies where structural estimates were primarily dominant. In several respects the estimates reported herein are superior because they could be used for predictive purposes and not solely descriptive. The major finding of this paper is the surprisingly elastic nature of farmland values to urbanization. These elasticities are supported by "reasonably good" statistically significant coefficients.

Applications to Land Use Policy

For land use researchers analyzing the effects of urbanization on agriculture, it is not sufficient to study urbanization impacts by merely measuring agricultural land lost annually to urban uses. The economic effects go well beyond reduced land availability because of "use change." The estimated elasticities indicate that reduced availability because of a "price effect" must also be considered.

If a viable agricultural base is to be maintained in the Northeast, the focus of policies should be to minimize the "price effect" of population growth. Currently, the most widely implemented such policy in the Northeast entails taxation at current use. These policies minimize the "price effect" on the property tax bill; however, problems of land acquisition still occur. It is reassuring that transferable development rights and agricultural districts are being researched and/or implemented in parts of the Northeast. Unless policies of this nature are more aggressively pursued, much agricultural land may well be "priced out" of agricultural use as population continues to increase.

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