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PENNSYLVANIA FARMLAND PRICES AS A FUNCTION OF LAND QUALITY AND DISTANCE FROM METROPOLITAN AREAS

Roger H. Downing and Hays B. Gamble

ABSTRACT

Data on 268 farm sales in 10 counties throughout Pennsylvania in 1977 were analyzed using a hedonic price model. Problems associated with the influence of parcel size and buildings on per acre land values appear to have been overcome. Proximity of farms to metropolitan centers and the quantities of different types of land on a farm were important explanatory variables. Values per acre were computed showing the effects of those variables on price. Values for non-tillable land, high productivity tillable land, and land suitable for on-site sewage disposal tended to cluster within a \$650-\$700 price range per acre at 85 miles from the nearest SMSA.

INTRODUCTION

This paper reports the results of a recent study which examined the factors influencing farmland values throughout Pennsylvania. Recent farmland value studies reported in the literature concentrate on relatively small areas, for example Craig and Mapp, Colyer, and Northcraft and Small. While these studies provide insight into factors influencing values in concise land markets, they cannot provide a perspective of land value changes over broad geographical areas reflecting diverse markets. One recent study (Morris and Lindsay) relates population density, farm sales per acre and farm size to farmland values for the New England and Mid-Atlantic regions. Two recent studies (Castle and Hoch, Reinsel and Reinsel) using national data provide insight into why current farmland values appear higher than would be indicated by capitalizing the net returns to agriculture from the land component only. In brief, factors other than land productivity are important determinants of the market values of farmland, such as accessibility to urban centers, land suitability for non-farming uses, the presence or absence of amenities, future anticipated earnings in farming, and particular characteristics of buyers and sellers.

Our interest here is to identify the factors that are important in explaining variations in farmland values over a broad geographical area that contains a diversity of soil quality, topographical features, land uses, and nearness (remoteness) to urban centers. Pennsylvania reflects all of these. There are 13 SMSA's within the state, and 9 more are within 100 miles of its borders, yet there are many remote rural areas in which agricultural and forestry are dominant land uses.

The authors are Research Assistant and Associate Director, respectively, The Institute for Research on Land and Water Resources, The Pennsylvania State University.

THE MODEL

We use hedonic price equations based on the model developed by Freeman, Griliches and Rosen, whereby sale prices are regressed on a set of explanatory variables. Specifically, the various attributes or characteristics of a property serve as surrogates for the flow of services provided by that property (and its location) when attempts are made to relate selling price to service flows. This follows from the belief that people, in choosing a property and its location, reveal their preferences by their willingness to pay for certain land and locational characteristics. If people value nearness to employment or certain natural amenities, the real estate market should reveal these preferences.

An economic relationship must therefore exist between market price and the quality and quantity of services that any given property provides the owner. Location -- nearness (accessibility) to employment, markets, and recreational opportunities, as well as distance or remoteness from undesirable environmental variables -- is one attribute that can provide a number of such services. This relationship implies that for consumer equilibrium in the real estate market, price differentials must arise among various locations which compensate consumers for the differences in property services associated with specific locations. Otherwise, consumers would not remain at particular locations and locational choice for new entrants would be restricted. Because of mobility and the ability to buy and sell in the land market, consumer equilibrium requires that for identical properties in all respects at two different locations, except that location 1 is near an urban center and location 2 is well removed, the price of land at location 2 must be less than that at location 1 by an amount which will compensate buyers for the additional travel time and travel costs they perceive at location 2. Otherwise, the consumer would be better off at location 1. Hedonic prices represent compensating price differentials, since individuals are assumed to choose locations such that price differences among different property characteristics are equalized at the margin (equilibrium willingness to pay).

We used the linear form of the multiple regression model to explain variation in the selling price of farmland, expressed as follows:

$$(1) \quad V_i = b_o + \sum_{j=1}^{n} b_j X_{ij} + \mu$$

where V_i = the deflated selling price of the i^{th} property,

b_o = constant term,

X_{ij} = independent variables from 1 to n associated with the i^{th} property,

μ = an error term, assumed to be randomly distributed, reflecting all other unexplained variations.

Distance variables were expressed in log forms, because the relationship between distance (as from an urban center) and land values is not linear.

THE DATA BASE

Ten counties in Pennsylvania were arbitrarily selected from which to gather farm sales data (see Figure 1). The selection was made to ensure as much variability in urban accessibility, soil productivity, and land use (forestry and agriculture) as possible. In the counties selected, the two major uses bidding for rural land are residential (permanent and seasonal) and agriculture (farming and timber). The least productive agricultural soils for farming are in the North Central and Northeastern portions of the state.

A large variation in distance from major urban centers was a major criterion in county selection. Six large SMSA's (those exceeding one million in population) and 11 small SMSA's (those less than one million in population) were identified.

The actual selling price for farms and farmland, which includes farm woodlots, formed the data base for the dependent variable. Sales data for 1977 from the Pennsylvania State Tax Equalization Board provided lists by counties of all farmland sales. From these lists only bona fide transactions involving 20 acres or more in the 10 study counties were selected for analysis. A major problem recognized in farmland value studies is that the per acre price, ceteris paribus, varies significantly with tract size. When an entire farm sells, the buyer is buying at the average. If he purchases additional land to add to an existing farm he is purchasing at the margin. These values can be quite different--the marginal value usually being considerably higher than the average value. To mitigate these difficulties, only properties larger than 20 acres have been selected for study. This means that properties are of such size that purchasers (farmers) will have to change some of the capital structure of the farm in order to make these purchases and, hence, they will be closer to the average than the marginal value. In total, 268 farmland sales in the 10 counties provide the data base.

A total of 23 variables were identified as being important in explaining farmland price variations and these comprised our set of independent variables. Our main concern was the influence that nearness (remoteness) to major urban centers has on rural land values. Road driving distances from individual farm parcels included in the study varied from 13 to 200 miles to the nearest large SMSA and from 13 to 89 miles to the nearest small SMSA. Travel time would have been a better indicator of accessibility, but the cost of measuring this for every farm parcel prohibited its use.

As will be seen in the analysis section which follows, distance was not included as a separate independent variable, but was interacted with the number of acres of different land types. This was done because distance works together with parcel size and land quality to influence total farm price, the dependent variable. Since the farms in our sample varied greatly in size and quality, the influence of distance alone cannot be separated at this point. As will be seen later in the report, we present a formula whereby the influence of distance on price per acre for different land qualities can be calculated.

The property tax record cards for all valid sales were examined to determine the assessed values for residences and farm structures. This was necessary in order to account for the influence that improvements have on farm price, since total price includes the entire package of real property assets, land and all structures. Since all the counties involved have different levels of assessment, it was necessary to equalize the assessed values. This was accomplished by taking all bona fide farm sales in 1977 and dividing this total figure into the total assessed values for these same farms. This gives us a true ratio or level of assessment for each county. This ratio was then used to compute an equalized true market value for the residence and farm structures (assessed value divided by true ratio = equalized market value).

County planning records showed the availability of public water and off-site sewer service to each property. From soil surveys the number of acres on each property suitable for on-lot sewage disposal systems (septic tanks) was determined.

From the Soil Conservation Service data on each county, an index of soil productivity for each farm was calculated for the acreage of tillable land. Because the county soil surveys were made at different times over the past 5-15 years and because of climatic differences, soil productivity indexes had to be equalized to the same year for the 10 counties. An index of 100 is specified as the highest corn yield for a county (see Lincoln Institute Monograph). A survey of county agricultural extension agents was done to determine the actual high corn yield in bushels per acre in 1977 in each county. Using these two pieces of information, it was possible to estimate the corn yield for each farm in terms of bushels per acre in 1977.

We determined the existence of ever-flowing streams on the various farms that were sold, as well as the number of feet of road frontage for various types of roads. Using highway maps, the distances to the nearest large and small SMSA over the best highway network route were determined for each property.

In addition to the above independent variables, the following accessibility variables were also determined for each property: within 5 miles of a state park; travel distance to nearest town of 10,000-50,000 population; actual effective tax rate on $1000 of 1977 true market values; type of zoning (agricultural, residential, industrial or commercial); farm assessment ratio; lots sold in the township in 1977; and purchaser owns other land in the same or adjoining townships. Cost constraints did not permit us to obtain landowner characteristics such as occupa-

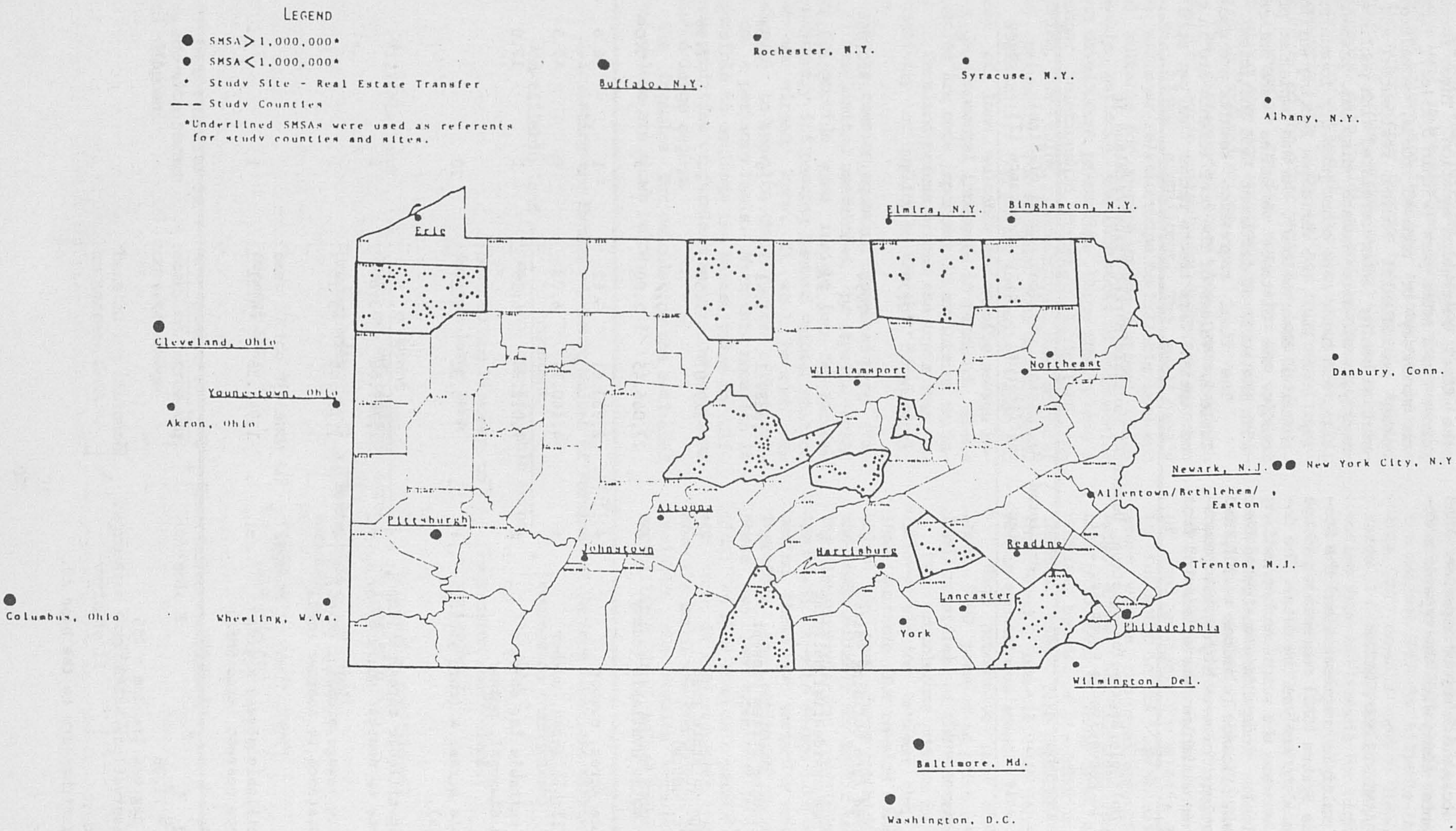

Figure 1. Location of study sites and SMSA's.

tional status, etc., which may be important land value determinants along with the type of mortgage financing.

DATA ANALYSIS AND RESULTS

Step-wise multiple regression and the Statistical Analysis System (SAS) regression package (GLM) was followed to analyze the data. The dependent variable was the actual market selling price of farmland. Independent variables that were of little significance (t values < .20), had too few observations, or were highly intercorrelated with other variables were eliminated from the final regression equation. These included: close to a state park (within 5 miles), frontage on secondary or unpaved roads, equalized tax rate, agricultural zoning, residential and commercial zoning (intercorrelated with public water supply), off-site sewage disposal, presence of silo, and owner owns other property in municipality (the last two variables lacking sufficient number of observations). As was explained previously, the distance variables were interacted with the acres of different land qualities.

The final regression results are shown in Table 1. Values of the coefficients are in terms of entire farm tracts rather than per acre val-

Table 1. Multiple Regression Equation; Dependent Variable Market Price Farmland in 10 Pennsylvania Counties, 1977.

Variable	Predicted sign	Regression coefficient	Student t	Level of Significance (%)	Mean
Price (dependent)					$87,911
Constant		14,204.03	2.70	1	
1. Equalized farm building value	+	0.58	7.94	1	$20,064
2. Equalized residential building value	+	0.23	4.22	1	$34,353
3. Ever-flowing stream present (dummy)	+	7,838.11	1.41	16	0.33
4. Frontage on state road (100 ft. units)	+	529.07	1.50	14	2.96
5. Public water available (dummy)	+	27,066.45	2.00	5	0.04
6. Tillable acres, number	+	2,933.41	3.42	1	36.6
7. Non-tillable acres, number	+	4,140.11	6.33	1	47.5
8. Acres suitable for on-site sewage disposal, number	+	7,012.84	6.18	1	17.0
9. (Tillable acres) x (corn yield, bushels)	+	3.32	1.29	20	
10. (Number tillable acres) x (log distance to nearest small SMSA)*	-	-1,707.68	-3.60	1	
11. (On-site sewage disposal acres) x (log distance to nearest small SMSA)	-	-3,709.49	-5.25	1	
12. (Non-tillable acres) x (log distance nearest large SMSA)	-	-1,941.56	-6.21	1	

R^2 = .770
F Value = 71.06
Residual degrees freedom = 255
Number observations = 268

* All logarithms are to the base 10.

ues, an unusual feature of this model but one that avoids the problem that has plagued many other land value studies, namely, that per acre farmland prices are inversely related to the size of the tract, other factors being equal. Another feature of this model is that the value of improvements, farm buildings and residences, is accounted for separately (to the extent that their assessments are accurate) and thus makes interpretation of the other variables less difficult. The regression results show that the value of farm structures are important in explaining variations in farmland prices.

The distance variables when interacted with number of acres suitable for different purposes are all highly significant. The small SMSA's have stronger relationships to tillable land and land suitable for on-site sewage disposal, which probably reflects the influences of encroaching urban development pressures. Large SMSA's have a stronger relationship to non-tillable land, reflecting, we think, recreational uses of rural land, primarily for seasonal home developments. The availability of public (off-site) water and amount of land suitable for on-site sewage reflect developmental interests in farmland. These variables are more important in explaining variation in farmland prices across the state than the productivity or quality of the soil for agriculture.

The regression equation presented here (Table 1) has limited usefulness, by itself, other than to provide some insight into the factors significantly influencing famland values, most of which we already know. It would be much more meaningful to know how these factors affect values on a per acre basis. With this equation it is possible to estimate the market value for different qualities of farmland at various locations within a large region.

The formulas for calculating the estimated market values are shown below.

We are restricted by our data to calculate distances within 175 miles of the nearest large SMSA for non-tillable land and within 85 miles of the nearest SMSA for tillable land and land suitable for on-site sewage disposal systems. The range in corn productivity (bushels per acre) varies from 180 bushels for high quality soils to 56.6 bushels for low quality soils, with 100.6 as the mean.

Inserting the appropriate figures in the formulas, we get the per acre market values of various types of land at selected distances from SMSA's as shown in Table 2. The influence of accessibility (nearness) to major urban centers on land values is clearly evident. The desirability of land suitable for on-site disposal of sewage is reflected in its high values, particularly in areas within the usual commuting range to large urban areas. Non-tillable land commands a premium price over tillable land, even the most productive, because of its other attributes for residential uses, both permanent and seasonal. In this study, non-tillable land is mostly wooded and in mountainous areas.

High productive land commanded, in 1977, about $400 premium in price over low productive land, regardless of the distance from an SMSA.

One troublesome problem in this model is the intercorrelation between the tillable land and land suitable for on-site sewage disposal variables. On many farms the high productive soils and lands suitable for septic tanks are the same. The intercorrelation coefficient for tillable land and on-site sewage land was r = .59, indicating these two variables are not independent. Therefore, the estimated values in Table 2 for these two land types must be viewed with suspicion; we show them as separate values, but we do not know if they represent the "best division." When the model was run without the on-site sewage variable, the results were not nearly as good; non-tillable land values become negative at 175

Calculating the Estimated Market Values of Farmland at Various Locations Within a Region

$$\text{Non-tillable land} = \left[\frac{\text{constant}}{\text{mean, no. non-tillable acres}}\right] + \left[\begin{matrix}\text{regression coefficient}\\ \text{variable 7}\end{matrix}\right] + \left[\begin{matrix}\text{base 10 Log Distance to}\\ \text{nearest large SMSA}\end{matrix}\right] \times \left[\begin{matrix}\text{regression coefficient,}\\ \text{variable 12}\end{matrix}\right]$$

$$\text{Tillable land} = \left[\frac{\text{constant}}{\text{mean, no. of tillable acres}}\right] + \left[\begin{matrix}\text{regression coefficient}\\ \text{variable 6}\end{matrix}\right] + \left[\text{productivity level}\right] \times \left[\begin{matrix}\text{regression coefficient}\\ \text{variable 9}\end{matrix}\right] + \left[\begin{matrix}\text{base 10 log distance to}\\ \text{nearest SMSA}\end{matrix}\right] \times \left[\begin{matrix}\text{regression coefficient}\\ \text{variable 10}\end{matrix}\right]$$

$$\begin{matrix}\text{Land suitable for}\\ \text{on-site sewage}\\ \text{disposal}\end{matrix} = \left[\frac{\text{constant}}{\begin{matrix}\text{mean, no. acres for}\\ \text{on-site sewage}\end{matrix}}\right] + \left[\begin{matrix}\text{regression coefficient}\\ \text{variable 8}\end{matrix}\right] + \left[\begin{matrix}\text{base 10 log distance}\\ \text{to nearest SMSA}\end{matrix}\right] \times \left[\begin{matrix}\text{regression coefficient,}\\ \text{variable 11}\end{matrix}\right]$$

Table 2. Market Prices Per Acre for Various Types of Land in Pennsylvania at Selected Distances from SMSA's, 1977.

Distance	Non-Tillable land**	Tillable Land* high productivity	Tillable Land* average productivity	Tillable Land* low productivity	Land suitable for on-site sewage*
miles	$	$	$	$	$
15	2,156	1,909	1,646	1,501	3,486
25	1,725	1,530	1,267	1,122	2,663
35	1,441	1,280	1,018	872	2,121
45	1,229	1,094	831	686	1,716
55	1,060	945	683	537	1,393
65	919	821	559	413	1,124
75	798	715	453	307	893
85	693	622	360	214	692
95	599				
105	515				
115	438				
125	368				
135	303				
145	243				
155	186				
165	134				
175	84				

* Distance to nearest SMSA

** Distance to nearest large SMSA

miles and the R^2 value dropped to .68. A soil capable of handling on-site disposal of wastes is too important a factor in the rural land market to be ignored in any rural land value model. We felt we had to keep this variable in the model despite the high intercorrelation. We did not have this intercorrelation problem with the other two land quality variables; r values of .16 and .11 were for tillable—non-tillable and non-tillable—on-site sewage intercorrelations respectively.

Figure 2 shows a plot of the values from Table 2. Prices per acre for non-tillable land, tillable land of high productivity, and land suitable for on-site sewage disposal are within about $70 of each other at 85 miles from their respective SMSA's. The value at this distance is about $700 per acre. Such a distance would seem to be near the outer limits for most permanent residents having to commute daily to work. We suspect that the value for highly productive tillable land would not decline much at distances from SMSA's greater than this, although from our data we are unable to ascertain this. If there is little decline, then a $600-$700 value in 1977 would be a reasonable estimate of the use value for prime Pennsylvania farmland in areas close to urban centers. The increasingly higher values for all types of farmland as one approaches metropolitan areas reflects the accessibility premium paid for these lands for developmental purposes.

CONCLUSIONS

Using market sales data for Pennsylvania farms at varying distances from metropolitan centers it was possible, through regression analysis, to estimate the market value per acre of different land qualities as a function of distance to large and small SMSA's. The approach used here was able properly to account for two measurement problems that have been troublesome in earlier farmland value studies: (1) the effect of parcel size on per acre values, and (2) the influence of farm and residential structures on farmland values.

Important variables in explaining variation in farm prices were the value of farm and residential structures on the property; the number of acres of tillable and non-tillable soils, and the number of acres of soils capable of handling on-

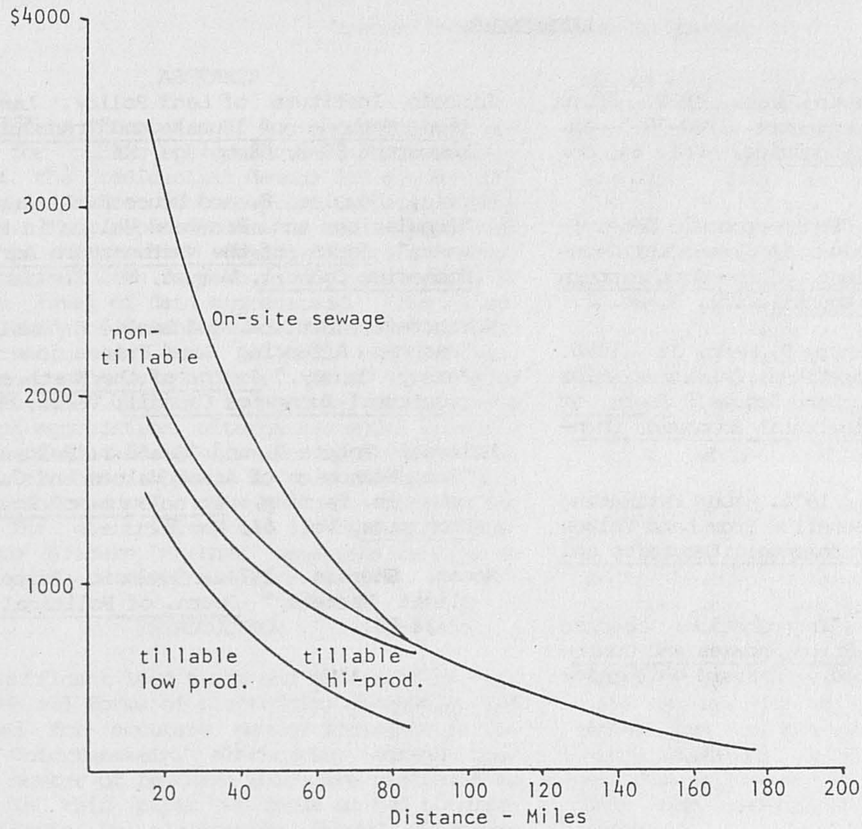

Figure 2: Relationship between distance to SMSA and market prices for various qualities of Pennsylvania farmland, 1977.

site disposal of sewage; and the accessibility or proximity in terms of driving distance to the nearest large and small metropolitan areas. Availability of public water to the farm was of somewhat lesser importance, while soil productivity, the amount of frontage on a public road, and presence of an ever-flowing stream were of minor importance.

Within 85 miles of SMSA's, farmland with soil capable of handling on-site sewage disposal systems (primarily septic tanks) commanded prices higher than the better grades of tillable land, which reflects the premium placed on land suitable for residential development (in Pennsylvania, the state requires a permit on lots of less than 10 acres approving the site for on-site sewage disposal). Non-tillable grade farmlands commanded prices slightly higher than those for tillable land within 85 miles of SMSA's, probably reflecting the natural amenities (forest and hills) associated with such lands which are especially desirable for seasonal residential use.

At about 85 miles from SMSA's, land values for non-tillable land, land suitable for on-site sewage disposal, and the best productive tillable land tended to converge within a price range of $620-$700 per acre. Values for non-tillable land continued to decline as distance from the metropolitan centers increased, until at 175 miles from the nearest large SMSA (over 1 million population) the price was $84 per acre. Although we cannot tell from our data, we suspect that beyond 85 miles the price of $622 per acre for the most productive tillable land would not decline significantly. If this is so, this would be a reasonable estimate for the use-value of good farmland in areas closer to metropolitan centers. This information would be useful to tax assessors who must estimate use-values for farmlands enrolled in preferential assessment programs.

The major weakness in this study was the high degree of intercorrelation between two independent variables which distracts from the reliability of some of the computed per acre land values. The importance of these two variables (tillable land and land suitable for on-site sewage disposal) in exploring farmland price variations necessitated their inclusion. This merely reflects a basic fact that good farmland and land suitable for development go hand in hand. Resolution of this problem in future farmland value studies would be a worthy topic for research.

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