# FACULTY WORKING PAPERS

AN HEDONIC STUDY OF THE EFFECTS OF EROSION CONTROL AND DRAINAGE ON FARMLAND VALUES

by

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Faculty Working Paper No. 109 September 1987



DEPARTMENT OF ECONOMICS AND BUSINESS
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA

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Various improvements can be made to farmland, including clearing or draining the land and controlling erosion. Individual landowners must decide whether to undertake such improvements. These decisions require knowledge of the value of the improvements as well as the costs. In addition, there are various government programs designed to encourage (or in some cases to discourage) changes in the characteristics of farmland. Evaluating such programs also requires estimating the benefits of the resulting changes.

Estimating the value of improvements (or conversely the costs of damages) sometimes has been done by estimating the increased (reduced) productivity of the land and then placing a value on that productivity (e.g., Walker, 1982). However, it is also of interest to study the value placed on such improvements in the land markets because these markets will take into account adjustments resulting from the improvement, some of which may not be foreseen in a productivity study.

There have been various studies of the relationship between farmland values and the characteristics of the land. For example, such an "hedonic"[1] equation has been used by Chicoine (1981) to examine the behavior of farmland values when the land is subject to urban influences. Pope (1985) used similar techniques to show that characteristics related to consumptive uses of rural land as well as agricultural productivity influence land values.[2] Several articles (Miranowski and Hammes, 1984; Ervin and Mill, 1985; and Gardner and Barrows, 1985) have used hedonic techniques to study the effects of soil quality and erosion on land values. Miranowski and Hammes found that three measures of topsoil quality (topsoil depth, potential erosivity, and pH) all had the expected signs and were statistically significant. On the other hand, the other two studies had mixed results and generally concluded that land values were not predictably related to actual or potential erosion.

Potentially land value studies can be used to address important policy issues as well as develop information that may be useful to farmers. However, the design of the study and the interpretation of the results must be carefully considered. The hedonic model frequently has been used in urban economics to study the characteristics of houses, and some of the articles cited have referred to part of that literature. However, there are significant differences in the hedonic model as it has been applied to a consumer product such as housing and the hedonic model as it should be applied to an agricultural factor of production such as land. This paper utilizes an hedonic model of factors of production, discusses using the model to value land improvements, and demonstrates its application.

The next section discusses a model of the relationship between the characteristics of a parcel of farmland and its price. This hedonic price schedule is the equilibrium result of the interaction of farmers and landowners in the land market. The behavior of each of these groups is discussed briefly. The relationship between the results based on rental prices and the results based on asset or sales prices is also considered. The third section discusses some uses for hedonic results. In the fourth and fifth sections these theoretical developments are used in an empirical study.

**Valuing the Characteristics of Farmland**

Studies of farmland values can be done in terms of sales prices or rental prices. Initially it is useful to develop a model of the determination of rental prices of farmland, since these flow prices are most relevant to production decisions. A farmer who operates on his own land can be considered implicitly to rent the land from himself and has the option of renting to someone else. However, the asset price of farmland is also of interest. The asset price represents the present value of the expected stream of future rental payments that the land will command. Thus, changes in the land or its use that are expected in the future will influence the asset price of the land but not the current rental price. In this paper the determination of rental prices is discussed first and then used in explaining the determination of asset prices. For this empirical study better data were available on farmland sales.

The rental price for a parcel of farmland depends on the characteristics of the parcel. These characteristics might include number of acres, topsoil depth, topography, soil productivity, and any number of other characteristics desired by farmers. Thus, there is a functional relationship between rental price and the characteristics of the farmland. This is the hedonic price equation.[3] If it were possible to costlessly separate the characteristics of one parcel and repackage them into other parcels, then arbitrage would result in a linear hedonic function. Since it is obviously quite costly or impossible to repackage the characteristics of farmland, the functional form of the price equation is not restricted to be linear. Typically, the actions of an individual demander or supplier of land will not affect the equilibrium price schedule[4], although the individual can influence the rental price he pays by altering his choice of characteristics. While an individual cannot affect the rental price schedule, that schedule is determined by the interaction of farmers bidding for the use of land and landowners offering the land for rent.

Farmers who wish to use the land in the production of crops provide the demand for this differentiated factor of production. The characteristics of the farmland influence the production that is possible on that land, given the levels of other inputs. Farmers must compete for the use of any parcel of land. To obtain that use a farmer will be willing to bid the difference between the expected profit level before land rents and the normal profit level. The price the farmer is willing to pay for a land parcel can be represented by a bid function that depends on the characteristics of the parcel, the prices of outputs and other inputs, the profits of the farmer, and farmer characteristics that influence management ability. In equilibrium, a farmer will use the parcels of land where his bid exceeds that of others. The farmer's marginal bid or willingness to pay for each characteristic of land will be equal to the marginal price of that characteristic in the market. It also must be true that the farmer's total bid for a parcel actually used must equal the rental price.

Obviously the supply of rental land comes from landowners. Some of the characteristics of a parcel of land are within the control of the landowner, while other characteristics cannot be changed. Landowners maximize the difference between the rental price they receive and the costs they incur by altering the characteristics within their control. For characteristics within their control, landowners would offer different amounts of those characteristics for different prices. For the characteristics of land that cannot be affected by the owner, the offer price is completely demand determined. The price for which the landowner is willing to rent the land can be represented by the offer function, which will depend on both the characteristics that are exogenous to the land owner and the characteristics that are under his control, his profit level, and prices for inputs used in modifying land characteristics.

The equilibrium rental price schedule for farmland is established through the interaction of farmers demanding land and landowners providing it. Farmland with particular characteristics goes to the farmers making the highest bids and is provided by landowners with the lowest offer prices.

These hedonic techniques have been discussed in terms of rental prices. Sometimes better data are available on sales prices of land than on rental prices. What modifications are necessary to use such asset prices? If people rent land for a relatively short period of time, their only interest will be in the current productive capabilities of the land. Thus, the rental prices will reflect only those current capabilities.[5] On the other hand, the value of land as an asset depends on the present value of future rents. The land may be used for different purposes in the future, so different characteristics may be relevant. These characteristics would then influence asset value but not rental value. For example, proximity of farmland to a major population center might increase land values even though it did not increase agricultural productivity. In the same vein, a characteristic that is of value in agricultural use, such as soil productivity, may be discounted in the asset price if that characteristic is not as highly valued in some alternative use (e.g., commercial use) that is anticipated in the near future.

The existence of property taxes also makes the relationship between rental prices and assets prices more complex. The rental price reflects the productivity of the land. In the absence of property taxes, the asset price of the land would be the present value of the expected future rents or the present value of expected productivity. However, the owner of the land will only receive the rental price net of taxes. Thus, the sales price of a parcel of land will be equal to the present values of anticipated rents after taxes and not the present value of the expected productivity. This effect is partially offset because property tax payments are deductible in calculating income taxes. This reduces but does not eliminate the underestimation due to the property tax.

## Using Hedonic Results

Hedonic results can be used in several ways. The theory of land rental prices developed in the previous section can be used as a basis for valuing land improvements (i.e., evaluating changes in the characteristics of land). Improvements made by an individual landowner or in response to public policies with a limited scope will not influence the equilibrium price schedule, and therefore valuing the improvements with land value studies is quite straightforward. Suppose one wishes to evaluate the benefits of a land improvement made by an individual landowner. Such a "small" improvement will change the prices of the improved land but will leave the market price schedule unchanged. This is because the market is made up of a large number of parcels of land, so the improvement of one or a few parcels will not appreciably change the price of parcels other than those directly affected. The land that is improved will simply move from one category to another. Before the improvement the profit levels for all farmers with comparable abilities were equilibrated. After the improvements the profit levels will still be equilibrated at the same level. If profits increased on the newly improved land, others would bid for that land raising its price to the level of comparable parcels. The unusual profits would disappear. Thus, there is no willingness on the part of the farmers to pay for the improvement. On the other hand, owners of the improved land receive all of the benefits of the improvement in increased rents. The net benefits are then the increase in rental price of the affected parcels less any costs to the landowners of the improvements. The change in rents can be forecast easily, since the constant price schedule is known from the hedonic equation. The landlord's willingness to pay for the change is simply the change in rental price along that schedule when the characteristic changes.

If the improvement to be evaluated affects a large number of land parcels, then the price schedule is changed. However, as shown in Freeman (1975), Lind (1975), and Bartik (1985), under certain circumstances it is possible to use the initial price schedule to provide an upper-bound for the value of the benefits of the improvements. The necessary conditions for this to hold are that the other characteristics of the land are not changed in response to the improvement and the landowner's costs are uninfluenced by the improvement. For some types of agricultural policies, these assumptions may be reasonable. If these assumptions cannot be justified, the benefits of improvements can still be estimated. However, the techniques are more complex than those used here (see Palmquist, 1987).

This use of hedonic results to estimate the benefits of improvements in the characteristics of farmland assumes that land markets reflect the value of the productivity of land. If one wishes to test this efficiency of land markets, the results of hedonic studies of land prices can be compared with estimates of the value of the improvements in land in terms of productivity enhancement. The maintained hypothesis in this case is that the direct measures accurately capture the value of increased productivity since there will be no substitution of inputs in respose to the changes.

**Data Collection**

Erosion control is an important issue throughout most of the country, and drainage of farmland can have important effects on the productivity of a tract of land in many areas. To demonstrate the use of land value studies in evaluating land improvements such as erosion control or drainage, the above model was applied to data from North Carolina.

Cross-sectional data for this analysis came from a survey that included sales that occurred during the period October 1, 1979 to March 31, 1980 (Danielson, 1981). Persons surveyed included brokers, realtors, appraisers, bankers, tax supervisors, loan representatives and others knowledgeable about farm sales. The part of the survey used in this study contained information on actual sales of farmland during the survey period. The survey yielded 252 observations having a full complement of the data needed for this analysis. The survey provided data on the characteristics of each tract, as well as on the buyer and the seller of the tract. The characteristics of the land parcels included soil quality, the percentage of the parcel in croplands and in forestlands, the presence and quality of buildings, the quantity of tobacco quota, the size of the tract, and a variety of other information on the land.

The survey data were supplemented with several pieces of county-level information from the 1980 Census of Population. These variables represented the population growth in the area and the urban pressures on the farmland. Information on these nonagricultural influences was necessary, since the prices used in the study were real estate market prices or asset prices, not rental prices. Since there are 100 counties in North Carolina, county data provide good information on the changes in the surrounding area. The population density of the county in which the parcel was located was used to measure current population pressures, while the rate of increase of that population was used to capture expectations of population growth. The presence of housing development near the tract measured more localized urban pressure, while the presence of a community water system near the tract indicated the availability of urban services. Finally, an interaction term between soil quality and urban influence was included. This was done because the present value of future agricultural productivity would be greater if the land were expected to remain in agriculture than if it were expected to be converted to urban use in the near future. As discussed above, the necessity of this type of interaction term arise because sales prices rather than rental prices are used.

Information obtained from the U.S. Soil Conservation Service was used to estimate the level of several soil characteristics for each tract. These included agricultural productivity, the need for drainage, erosion level and the suitability of the land for septic tanks. Ideally, these soil characteristics would be measured through on-site evaluation. However, this was not feasible because of the large number of tracts in the survey and their being scattered throughout the state. Instead, a procedure was developed to generate this information from existing soil survey data and studies. First, the tracts were located on maps by a process of triangulation using information on the county and two nearest towns and their distances. Then, with the help of a soil scientist trained in soils interpretation,[6] tract location was transferred to a detailed soil classification map so the most prevalent of 98 soil types could be identified for each tract. Finally, 32 soil productivity groups (USDA, 1975) were matched with the soil classifications to provide soil quality measures, erosion estimates, and drainage requirements for each tract. Table 1 describes the variables used in this study.

The two variables of primary interest in this study were the susceptibility to erosion and the desirability of drainage. For erosion there are two measures that should affect land values. The first, the susceptibility of the soil to erosion, is a factor in land prices even if control efforts have prevented erosion damage. This is because erosion control efforts represent an expense for the farmer. This type of erosion effect is captured by EROSION which measures the inherent erosion potential of the soil type. Land values would also be influenced by the erosion that has already occurred on the land. The presence of such erosion was considered by the survey respondents in estimating the soil quality for the specific tract (SOILQUAL), since land with subsoils partially exposed is less productive. Thus, while it was not possible to obtain direct information on the erosion phase of the tracts, the regression at least partially controls for that characteristic.

For drainage there are also two considerations: whether the land requires drainage for crop production and whether such drainage has been done. The former measure is captured by SOILWET in the regression. Information on whether such drainage has been done is implicitly available since land requiring drainage cannot be used as cropland unless it has been drained. On the other hand, forestlands usually are only drained enough for harvesting and reforestation and the drainage is not maintained between harvests. Lands that are not used for either crops or forests would not be drained at all. Even if the original drainage effort has been made, there are still significant maintainence costs to keep land in crop production. An interaction term between SOILWET and land usage would control for the effects of drainage.

One would expect that soil quality and the percentage of cropland in the parcel also would have other effects on price. The price per acre should vary inversely with the size of the tract, because of the legal and political costs of subdividing a tract of land. The final agricultural variable concerned tobacco quota sold with the land. The poundage quota of the parcel was divided by the number of acres in the parcel to obtain a measure of the effect of the quota on the price per acre.

**Empirical Results**

The functional form of the hedonic equation is not dictated by the theory, so it was selected empirically by applying Box-Cox techniques to the most common functional forms. By this method the semi-logarithmic form was chosen as preferable. The results of this regression are given in Table 2.

All of the variables have the expected signs, and with the exception of POPCHGE and ABLDG, they are all significant at the 5 percent level or better. If the soil is wet enough to require drainage, this is estimated to cause a 25.3 percent reduction in land prices[7]. At the mean land price this represents a $374 per acre reduction[8]. The susceptibility of the soil to erosion also results in a price reduction that is equal to a $3.06 per-unit increase in the erosion potential of the land on an average tract. Soil quality also has an important effect on land prices, causing land values to differ by as much as 60 percent. A pound of tobacco quota was worth $2.78 on an average parcel of land. Cropland was worth $488 more per acre than forested land. When the percentage of the land that was not used for either crops or forests was included in the regression, it was negative as expected but was statistically insignificant. This probably was because only three percent of the land was in this category. When an interaction term between SOILWET and land usage was included, it also had little statistical significance. Since the results for the other variables were scarcely affected by the inclusion of these two variables, they were omitted in the reported regression.

How reasonable are these estimates, and how well do they correspond to estimates derived by other methods?

Drainage The soil wetness coefficient suggests that if wet soils were drained there would be on average a 33.9 percent increase in land values. To our knowledge, market data are not available for land values before and after drainage. However, at the time the sales data for this study were collected, wet soils requiring drainage for crop production were available for around $400 to $500 per acre in eastern North Carolina (Barnes,1981). Although there can be great variation in cost levels, Skaggs and Nassehzadeh-Tabrizi (1983) estimated that 1982 drainage costs for two common Coastal Plain soils (Rains and Portsmouth) could range from $80 to $400 per acre, depending on the type of drainage system implemented and on whether main ditches were in place. In North Carolina some but not all wetlands eligible for drainage are drained, so the market seems to be near equilibrium, with drainage costs approximately equal to the increase in land values. Assuming a cost of $450 for undrained land and a land market in equilibrium, these data imply that land value would rise by between 18 to 89 percent when drained if the drainage were to be undertaken by a profit-maximizing landowner. The estimate of 33.9 percent from our hedonic equation is well within this range.

Erosion The variable representing the potential for erosion on the land is the RKLS factor in the Universal Soil Loss Equation. This variable takes into account rainfall, soil type, and the length and steepness of slope. These factors are, for the most part, beyond the farmer's control on a particular tract, although conservation practices such as terracing can influence the last two factors. This is the desired variable since it measures the inherent erosivity of the soil class and cannot be influenced by temporary cultivation or conservation practices. The RKLS factor can be converted to tons of erosion per acre per year by multiplying by factors for cultivation and conservation practices. If no specific conservation practices such as contouring are used, the supporting practice factor can be assumed to equal one. However, the cultivation of any crop will reduce the erosion rate below that on continuously cleaned and tilled fallow soil. Thus, the RKLS factor must be multiplied by a factor (C) less than one to yield the erosion in tons per acre per year. For example, in the Piedmont of North Carolina continuous corn cultivation on land with average productivity using turn plowing, cut silage, and residue removal yields a C factor of .494. Other common crop rotations and practices also yield C values in the same general range. In this case, erosion in tons per acre per year would be .494 times RKLS. The coefficient in the regression indicates that a one-unit reduction in RKLS would be worth, on average, $3.06. However, a one-unit reduction in RKLS represents a reduction in soil loss of only (.494 x RKLS) tons per acre per year. Thus, a one ton per acre per year reduction in soil loss would be worth (1/.494)3.06 or $6.19 in terms of land prices.

This estimate can be compared to those derived in three types of studies. First, one can relate erosion to reduced yields and then determine the value of the lost crops. The Soil Conservation Task Force of the American Agricultural Economics Association (1986) has estimated that a 10 percent yield reduction after 100 years of erosion on the 142 million acres of land growing the nation's corn and soybeans would result in lost productivity that would have a present value of $4.3 billion at a 10 percent rate of discount assuming that corn and soybeans are priced at $3.00 and $7.00 per bushel respectively. This is an average cost of $30.28 per acre. In a cornbelt study, Pierce et al. (1984) estimate that average yields would decline by 4 percent over 100 years with an erosion rate of 7.8 tons per acre per year. This implies that the Task Force's 10 percent reduction would result from an erosion rate of 19.5 tons per acre per year if a linear relationship is assumed. Dividing the per-acre cost estimate of the Task Force by this erosion estimate yields $1.55 as the present value of the yield loss due to an erosion rate of one ton per acre per year. This can be compared with our estimate of $6.19. Two factors suggest that the Task Force/ Pierce et al. estimate is low relative to what would be expected for our study area. First, the topsoil depths in North Carolina are less than those in the cornbelt, so a given soil loss results in a greater productive reduction in North Carolina. Second, the Task Force estimate, which assumes a high level of management to optimally replace nutrients and maintain certain soil properties, does not incorporate the costs of these practices, whereas a land value study does.

The second method of comparison is examining studies using land values. Miranowski and Hammes (1984), in their chosen hedonic equations, use only soil characteristics. They estimate that a one-unit reduction in potential erosivity (RKLS in the Universal Soil Loss Equation) results in an increase in farmland value of approximately $5.70 based on 1978 data. For comparison with this study, their estimate was adjusted to 1980 dollars using an index of Iowa farmland prices (USDA, 1984). This yielded a value of $7.58. In their conclusions they equate the one-unit change in RKLS to a change of one ton of erosion per acre per year. This suggests that they have assumed the management and practice factors of the Universal Soil Loss Equation are equal to one. Their estimate is higher than the $3.06 estimate derived in this paper. Both Ervin and Mill (1985) and Gardner and Barrows (1985) obtain more mixed results and are led to question whether, in general, farmland values capture differences in erosion.

A third type of comparison uses the user costs of soil estimates developed by Hertzler, Ibañez-Meier, and Jolly (1985). Using reasonable estimates for crop mix, crop prices, costs, etc., they estimate that .12 inches of soil eroded per acre per year would have a user cost of $8.33/acre/year. For comparison with our results, this was to converted to $0.46 per ton per acre per year using their estimate that 18.2 tons equals .12 inches of soil. With a discount rate of .05 this would have a capitalized value of $9.16 per ton per acre, while if the discount rate were .10 this value would be $4.58. These values bracket our estimate of $6.19 as revealed by land values.

<u>Other variables</u> Our estimates suggest that cropland is worth about $488 per acre more than forestland. Since timbered land can be cleared, is this possible if the land markets are near equilibrium? Clearing land in the study area at that time cost, on average, $400 per acre.[9] This is reasonably close to the estimate, especially since there are generally quality differences between land used for crops and land used for timber that might not be fully captured in the equation.

The value of tobacco quota in 1980 was estimated in this study to be $2.78 per pound. This value probably differed significantly between counties, but comparison with other average estimates is still useful. Using 1980 Federal Land Bank data for North Carolina, Seagraves and Williamson (1981) estimated tobacco quota values at $3.24 per pound in 1980 dollars. Pugh and Hoover (1981) estimated the North Carolina lease-and-transfer rate for quota in 1980 to be 37.79 cents per pound per year. In 1983 the value of quota was approximately five times the rental rate based on a survey of North Carolina County Tobacco Extension Agents. Using this capitalization rate, the Pugh and Hoover estimate represents a value of $1.89 per pound, so our estimate is well within the bounds of existing estimates.

Finally, the hypothesis that the capitalized value of future soil productivity would be less for land subject to alternative uses than for land expected to remain in agriculture was confirmed. The significant negative coefficient of the interaction term POPSOIL indicates that while soil quality is of significant value, this value is significantly reduced for land expected to be subject to urban conversion.

Uses of the results  Overall, the hedonic equation appears to perform quite well. How might the results be used? Individual farmland owners could gain additional information to assist in making investment decisions. For example, the results provide an estimate of the average increase in land value due to drainage, and this increase represents the value of the increased productivity of the land. This information can be combined with drainage cost estimates and information on government programs in making the drainage decision. Similarly, farmland owners must make decisions about participation in programs to control erosion, for example by terracing. This would reduce the soil loss, and this study provides information on the value of reducing potential erosion. The farmland owner can evaluate whether this increased value justifies the remaining costs after the cost-sharing.

The results are also useful in policy decisions. For example, the Agricultural Conservation Program provides cost-sharing for erosion control practices. The benefits of such practices include both maintaining on-farm productivity and reducing off-farm damages from sedimentation. Studies such as this one help determine the value of the on-farm benefits so that the necessary level of subsidies to obtain a particular level of erosion control can be determined. The extent of participation in this program has been relatively low, which allows valid estimation of benefits using only the first step in the hedonic estimation.

At times federal programs have conflicting objectives. Decisions concerning drainage versus preservation of wetlands have been subject to contradictory programs. On one hand, some policies lead to increased drainage. Examples are projects under the Watershed Protection and Flood Protection Act of 1954, the Flood Control Act of 1944, and commodity price support programs of various farm bills. On the other hand, other legislation attempts to preserve wetlands. Examples include the federal Duck Stamp Act and amendments providing for assessments on hunters for purchase and lease of wetlands, certain elements of the ACP, elements of various farm bills (soil bank, conservation reserve, swampbuster provisions), and the federal Water Bank Program. Studies such as this one can evaluate the benefits of drainage so they can be compared to the benefits of maintaining wetlands. While estimating the value of wetlands is an even more challenging problem than that treated here, information on both types of benefits is necessary in evaluating the usefulness of the various programs.

**Conclusions**

This paper has developed a theoretical model of the determination of the equilibrium prices of farmland with heterogeneous characteristics based on the behavior of profit-maximizing farmers and wealth-maximizing landlords. This model is then used to determine willingness-to-pay for changes in those characteristics under various circumstances. This willingness-to-pay information is useful to farmers in making decisions and is also useful in designing and evaluating government programs. The necessary estimation steps depend on the particular question being analyzed.

The empirical application of this model used data from North Carolina that provide information on the characteristics of a large number of land parcels. The results of the hedonic estimation indicate that the capitalized value of the marginal willingness to pay for a one ton per acre per year reduction in soil erosion with a typical crop is, on average, \$6.19. Drainage of wet farmland results in an average increase in value of \$374 per acre. The reasonable magnitudes of these and other coefficients is indicative of the reliability of the hedonic results. This information is valuable for individual farmers and in evaluating public programs of limited scope.

Table 1. VARIABLE DEFINITIONS, SOURCES, AND STATISTICS

| Variable | Mean Value | Standard Deviation | Definition | Source |
|---|---|---|---|---|
| PRICE | 1481. | 1080. | Price of land per acre (dollars) | N.C. 1980 Rural Real Estate Survey (RRES |
| EROSION | 72.34 | 41.36 | Estimated soil loss on tract; USLE, bare ground (tons per acre per year) | see discussion in text |
| SOILWET | .0833 | .2769 | Dummy: Soil wetness (1 if poorly or very poorly drained; 0 otherwise) | see discussion in text |
| SOILQUAL | 2.151 | 41.36 | Quality of soil rating (poor = 1, average = 2 good =3) | N.C. RRES |
| SIZE | 100.3 | 135.2 | Tract size (acres) | N.C. RRES |
| PCROP | 42.46 | 31.92 | Percent cropland | N.C. RRES |
| TALLBAC | 49.05 | 80.02 | Tobacco quota (lbs.)/acre | N.C. RRES |
| POPCHGE | 14.80 | 8.467 | County population increase (1970-1980) (percent) | 1980 Census of Pop. |
| POPDEN80 | 158.6 | 149.7 | County population density (1980) (persons per sq.mi.) | 1980 Census of Pop. |
| DHOUSING | .1230 | .3291 | Dummy: Community housing (1 if located nearby; 0 otherwise) | N.C. RRES |
| DWATER | .1071 | .3099 | Dummy: Community water (1 if located nearby; 0 otherwise) | N.C. RRES |
| POPSOIL | 339.5 | 342.7 | Interaction term, POPDEN80*SOILQUAL | 1980 Census of Pop. N.C. RRES |
| GBLDG | .0794 | .2708 | Dummy: Good quality buildings (1 if present;0 otherwise) | N.C. RRES |
| ABLDG | .1825 | .3871 | Dummy: Average quality bldg. (1 if present;0 otherwise) | N.C. RRES |

Table 2.

HEDONIC REGRESSION RESULTS

| Variable | Parameter Estimate | t-value[a] |
|---|---|---|
| EROSION | -0.002065 | -2.524 |
| SOILWET | -0.283379 | -2.283 |
| SOILQUAL | 0.239284 | 3.365 |
| SIZE | -0.001134 | -5.035 |
| PCROP | 0.002904 | 2.772 |
| TALLBAC | 0.001875 | 4.618 |
| POPCHGE | 0.005196 | 1.426 |
| POPDEN80 | 0.002364 | 3.197 |
| DHOUSING | 0.284361 | 2.962 |
| DWATER | 0.279203 | 2.859 |
| POPSOIL | -0.000695 | -2.108 |
| GBLDG | 0.250812 | 2.242 |
| ABLDG | 0.117010 | 1.473 |
| INTERCEPT | 6.354158 | 37.225 |
| R-SQUARE | 0.4460 | |
| ADJ R-SQ | 0.4157 | |

[a] All variables are significant at the 95% level or better except POPCHGE and ABLDG

## FOOTNOTES

* The authors are grateful to Dana Hoag, E. C. Pasour, Daniel Sumner, and Walter Thurman for helpful comments on an earlier version of this paper. However, they are not responsible for any remaining errors.

1. A hedonic regression relates the price of a differentiated product to the various characteristics that it provides.

2. A separate line of research on land values has been concerned with aggregate land values and has focused on the behavior of land prices over time and the effects of inflation and taxes on land values. Two recent contributions to this literature that also summarize previous works are Alston (1986) and Burt (1986). This important research is outside the area of inquiry in the present paper.

3. In a seminal article Rosen (1974) develops a theoretical model of the market for a differentiated consumer product. On the other hand, agricultural land value studies are concerned with a differentiated factor of production. Palmquist (1987) provides a detailed model of such a market that provides a basis for the empirical work presented here.

4. This is true even though the spatial nature of farmland may limit the number of potential customers for some some parcels or the number of parcels that are potentially available for some customers. As long as there is more than one potential customer for each parcel and more than one parcel available to each customer, then in the absence of collusion (which seems unlikely) the bidding process can result in competitive prices even with small numbers. In addition, if the price for a parcel of land was significantly above or below equilibrium, the geographical extent of the market would be enlarged because of the incentives created.

5. In cases where the current use of land can influence the future productivity of the land, the rental contract may stipulate certain conditions on the current usage.

6. A special thanks is given to Dr. J. A. Phillips, currently Assistant Director and State Leader, ANR/CRD, North Carolina Agricultural Extension Service, for his able assistance in developing this information.

7. For the semi-log equation used here, a consistent estimate of the relative effect on rental price of the presence of a dichotomous characteristic is given by $\exp(\beta) - 1$ where $\beta$ is the estimated coefficient (Halvorsen and Palmquist, 1980). For small samples the potential bias of this estimator can be reduced by using $\exp[\hat{\beta} - 1/2V(\hat{\beta})] - 1$ where $V(\hat{\beta})$ is the variance of $\hat{\beta}$ (Kennedy,1981). For discrete changes in a continuous variable, a consistent estimate of the relative effect is given by $\exp(\beta\Delta N)-1$ where $\Delta N$ is the change in the variable. For small samples a better estimator is $\exp[(\hat{\beta}\Delta N)-1/2(\Delta N)^2 V(\hat{\beta})]-1$ (Palmquist, 1982). The interpretation of the results makes use of the two small sample estimators.

8. All prices based on the estimates will be in 1980 dollars.

9. Personal communication, Rick Hamilton, Extension Forestry, N.C.S.U.

## REFERENCES


Alston, Julian M. "An Analysis of Growth of U.S. Farmland Prices, 1963-82." Amer. J. Agr. Econ. 68(1986):1-9.

Barnes, Steve. "Agricultural Adaptability of Wet Soils of the North CarolinaCoastal Plain," in Pocosin Wetlands: An Integrated Analysis of Coastal Plain Freshwater Bogs in North Carolina, Curtis J. Richardson, ed.,Stroudsburg: Hutchison Ross Publishing Company, 1981

Bartik, Timothy J. "Can Hedonic Demand Parameters Be Estimated Using Single Market Data?" Working paper, Vanderbilt University (1985).

Burt, Oscar R. "Econometric Modeling of the Capitalization Formula for Farmland Prices." Amer. J. Agr. Econ. 68(1986):10-26.

Chicoine, D. L. "Farmland Values at the Urban Fringe: An Analysis of Sale Prices." Land Econ. 57(1981):353-62.

Danielson, Leon E. "The Rural Real Estate Market in North Carolina." Economics Information Report No. 66, Department of Economics and Business, North Carolina State University, 1981.

Ervin, David E. and John W. Mill. "Agricultural Land Markets and Soil Erosion: Policy Relevance and Conceptual Issues." Amer. J. Agr. Econ. 67(1985):938-42.

Freeman, A. Myrick. "Spatial Equilibrium, the Theory of Rents, and the Measurement of Benefits from Public Programs: A Comment." Quarterly Journal of Economics. 88(1975): 470-473.

Gardner, Kent and Richard Barrows. "The Impact of Soil Conservation Investments on Land Prices." Amer. J. Agr. Econ. 67(1985):943-47.

Halvorsen, Robert, and Raymond Palmquist. "The Interpretation of Dummy Variables in Semilogarithmic Equations." American Economic Review. 70(1980):474-475.

Hertzler, Greg, Carlos A. Ibañez-Meier, and Robert W. Jolly. "User Costs of Soil Erosion and Their Effect on Agricultural Land Prices: Costate Variables and Capitalized Hamiltonians." Amer. J. Agr. Econ. 67(1985): 948-953

Kennedy, Peter E. "Estimation with Correctly Interpreted Dummy Variables in Semilogarithmic Equations." American Economic Review. 71(1981):801.

Lind, Robert C. Spatial Equilibrium, the Theory of Rents and the Measurement of the Benefits from Public Programs: A Reply." Quarterly Journal of Economics. 88(1975): 474-476.

Miranowski, John A. and Brian D. Hammes. "Implicit Prices of Soil Characteristics for Farmland in Iowa." Amer. J. Agr. Econ. 66(1984): 745-49.

Palmquist, Raymond B. "Measuring Environmental Effects on Property Values without Hedonic Regressions." Journal of Urban Economics. 11(1982):333-347.

Palmquist, Raymond B. "Land as a Differentiated Factor of Production: An Hedonic Model and its Implications for Welfare Measurement." North Carolina State University (1987).

Pierce, F. J., R. H. Dowdy, W. E. Larson, and W. A. P. Graham. "Soil Productivity in the Corn Belt: An Assessment of Erosion's Long-Term Effects." Jour. of Soil and Water Conservation. 39(1984):131-136.

Pope, C. Arden, III. "Agricultural Production and Consumptive Use Components of Rural Land Values in Texas." Amer. J. Agr. Econ. 67(1985):81-86.

Pugh, Charles R., and Dale M. Hoover. "Lease Rates in North Carolina Counties under the Program for Flue-Cured Tobacco," presented at the 29th Tobacco Workers Conference, Lexington Kentucky, January 19-22, 1981.

Rosen, Sherwin. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." Journal of Political Economy. 82(1974):34-55.

Seagraves, J. A., and Fred E. Williamson. "Returns to Investors in Flue-Cured Tobacco Allotments 1975-1980." Economics Research Report No. 42, Department of Economics and Business, North Carolina State University, Raleigh (1981).

Skaggs, R. W., and A. Nassehzadeh-Tabrizi. "Optimum Drainage for Corn Production," North Carolina Agricultural Research Service, Technical Bulletin 274, North Carolina State University, June 1983.

Soil Conservation Policy Task Force, "Soil Erosion and Soil Conservation Policyin the United States," American Agricultural Economics Association, January 1986.

United States Department of Agriculture. Soil Productivity Groups in North Carolina: Supplemental Economics Base Information, Economic Research Service, Soil Conservation Service and Forest Service, Raleigh, North Carolina, April 1975.

United States Department of Agriculture. Outlook and Situation Summary: Farm Real Estate, Economic Research Service, Washington, D.C., May 1984.

Walker, David J. "A Damage Function to Evaluate Erosion Control Economics." Amer. J. Agr. Econ. 64(1982):690-98.