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Agricultural Land Markets and Soil Erosion:

Policy Relevance and Conceptual Issues

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Land - - Prices

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Farmland values dwarf all other asset values in agricultural production. Therefore understanding the formation and roles of farmland prices should command high research priority. While we have seen some clarification of the pricing of farmland through time from an aggregate perspective, other questions remain enigmas. One is the relationship between land prices, soil erosion and conservation investments. Understanding that relationship is critical to designing effective public soil conservation policy.

In the past, the notion that the farmland market was generally not sensitive to varying erosion conditions was seemingly endorsed without systematic data analysis. Miranowski and Hammes note the paucity of good empirical evidence for testing the effect of erosion on farmland prices. Two probable reasons for this lack of empirical study are worth citing. First, the legitimacy of public soil conservation assistance programs was not challenged then, unlike the present. Thus, there was not a compelling social need to understand whether farmland markets were transmitting "proper" signals to landowners with regard to erosion's effects. Second, thorough and rigorous empirical tests of the relationship between land prices and erosion or conservation conditions are painstakingly detailed work fraught with many conceptual and measurement complications.

This paper has three sections. In the first, the policy context surrounding land prices and soil erosion is discussed. We then report some empirical work on the erosion-land price question with emphasis on specification issues surrounding an implicit price model. Implications for soil conservation policy and further research close the discussion.

Policy Context

A renewed interest in public erosion control policy and programs emerged in the 1970s due to concern over nonpoint water pollution and excessive cropland erosion from the agricultural export boom. Questions were subsequently asked about the efficacy of federal soil conservation programs. Some discussion related to the cost effectiveness of programs in reducing erosion and was carried out primarily in government (e.g., U.S. General Accounting Office).

A second theme emerged from academic writings. The dialogue about private incentives for erosion control turned to a re-examination of the economic rationales for public intervention (Crosson). While there was little debate that public action was justified to reduce Pareto relevant offsite pollution externalities, the need to subsidize farmers to increase onsite productivity benefits from erosion control was questioned. That is, when considering only onsite productivity damages, landowners may already receive adequate incentives through private markets to achieve socially optimal levels of soil conservation.

Consider the discrete case where the landowner is assumed to maximize the present value of net returns from a conservation investment.

$$(1) \quad PV\Delta NR = B_o - C_o + \frac{B_1 - C_1}{1+r} + \ldots + \frac{B_n - C_n}{(1+r)^n} + \frac{SV_n^p}{(1+r)^n}$$

where: $PV\Delta NR$ = present value of the change in net returns; B = benefits of conservation; C = costs of conservation; n = sale date; r =

discount rate, and; SV^p = private salvage value of change in net returns. Salvage value of the conservation investment is calculated as:

$$(2) \quad SV_n^p = \sum_{t=n+1}^{\infty} \frac{B_t - C_t}{(1+r)^{t-n}}$$

A solution which maximizes (1) could range from no conservation to conservation tillage to crop rotation changes to terraces.

Adoption of a practice yields a specific flow of B's and C's through time. Uncertainty associated with projecting the B, C and r will depend upon the length of time, n, the owner retains the land. Both Crosson and Mill conclude that possibilities for significant divergence between private and social B, C and r values from periods 1 to n are not compelling.

To maximize (1), the landowner must also estimate SV_n^p. As shown in (2), the salvage value of the conservation investment to the landowner is simply the expected discounted private net benefits from t=n+1 to infinity. Let $\frac{SV_n^s}{(1+r)^n}$ represent the present value of net onsite control benefits that society will realize from n+1 to infinity. Private owners who sell in period n, in contrast, could realize less, the same, $\frac{SV_n^s}{(1+r)^n}$ or more than depending upon the extent and accuracy of information transmitted to market participants on B, C and r beyond n. Thus, (1) can be rewritten:

$$(3) \quad PV\Delta NR = B_o - C_o = \frac{B_1 - C_1}{1+r} + \dots + \frac{B_n - C_n}{(1+r)^n} + \rho \left[\frac{SV_n^s}{(1+r)^n} \right]$$

where: ρ = percentage of social salvage value received by landowner.

One possible reason for $\rho < 1$ is a lower social discount rate for the period $n + 1$ to infinity than that used in private calculations. Since the focus here is primarily on the role of the land market in measuring B and C beyond n, the discount rate will not be discussed further.

The traditional hypothesis seems to have been that $\rho < 1$. Presumably, farmland market participants underestimate the effect of erosion on future productivity and/or input costs. Conditions yielding a $\rho > 1$ are more difficult to envision since farmland productivity has been rising through time and thus possibly masking the effects of erosion. A perfect capital market would yield $\rho = 1$; i.e., the landowner would receive the full social salvage value.

If $\rho < 1$, landowners will not receive the full net social benefits of an erosion control investment. Thus, the traditional argument continues, they will underinvest in erosion control from a social perspective (McConnell). Ergo, a possible rationale emerges for public programs to subsidize actions for control of onsite productivity damages above private levels.

What has been ignored until now it seems are the conditions determining ρ. A naive analysis assumes a perfectly functioning and costless capital market. That is, buyers and sellers have perfect information about future erosion control costs and benefits. But gathering information about any asset's future net returns is not costless. When potential farmland buyers evaluate a parcel, they must hire professional services to evaluate its productivity or spend considerable time themselves. One approach would be to take comprehensive soil samples of all fields. Casual information suggests this is not the usual case, at least in Missouri. A more common method is to project benefits and costs based on average net returns to general soil types, but not conditions in specific fields.

Assessing the future impacts of past erosion or conservation investments is a complicated task. Only in the last decade have scientists begun to quantify the yield impacts of erosion (Larson et al.). Expecting potential buyers to possess that knowledge, especially for small differences in topsoil depth and quality, is unwarranted. Common sense suggests that differing erosion conditions on two otherwise identical soils will lead to different expected net returns due to varying yields and/or input requirements. But sheet and rill erosion is a very gradual process that is difficult to perceive even for current operators. Given the costs of identifying and estimating those differences, one might hypothesize that only those parcels that have been moderately or severely eroded would exhibit discounted market prices. Prices for slightly eroded land may be unaffected although social costs will eventually surface.

The assumption that $\rho < 1$ could be mistakenly characterized as a farmland market failure problem. That is, the farmland market may fail to transmit the correct social signals regarding erosion's effects on future productivity. A more accurate description may be that the farmland market is functioning efficiently given the costs of information discovery.

Market failure is more likely in the social provision of information on the benefits of erosion control. If a good or service is characterized by nonexclusiveness and/or nonrivalry, then private markets may fail to provide the optimal social quantity (Randall). Parcel-specific information on the benefits of erosion control should not suffer nonexclusiveness and/or nonrivalry problems. Thus unaided private markets can be expected to perform that function efficiently. However, a general methodology (algorithm) to calculate parcel-specific erosion control benefits possesses nonrivalry attributes, and may be nonexclusive depending upon the provision mechanism used.

The critical policy question is whether the development and dissemination of a general methodology for estimating erosion control benefits has been at socially optimal levels. Public subsidization of the development and dissemination processes should push ρ toward one, thus reducing the difference between private erosion control actions and socially optimal levels. But information development and dissemination processes cause real social costs. These costs must be compared to the incremental social erosion control benefits including any change in offsite damage that is joint with reduced onsite costs. Avoided offsite costs may be larger than onsite benefits in many situations. The need to include offsite effects also necessitates an examination of the level of public provision of information on offsite damages since those effects are external to private markets. The resulting total benefit-cost comparison for information development and dissemination gives one efficiency measure which should then be compared to alternative public approaches (e.g., taxes) for reducing external onsite and offsite erosion costs.

Formulating an Implicit Price Model of Farmland Price and Erosion

To calculate ρ and draw conclusions about the transmission of erosion-related information through the farmland market requires comparison of the private market effect, SV_n^p, with a comparable social value, SV_n^s, (assuming equal private and social discount rates). This discussion covers private market model specification issues and reports an empirical exercise with Page County, Iowa (PCI) farmland prices. Estimation of the social value is left to future research.

The relevant null hypothesis is: farmland prices do not account for the effects of past erosion or potential erosivity on future net returns to land. That is, SV_n^p is equal to zero. The implicit assumption underlying the alternative hypothesis is that a lower depth of topsoil results in a lower present value of future net returns, ceteris paribus. The lower net returns could stem from irreversible yield damage and/or the need for higher input levels.

One estimation procedure for testing the null hypothesis is the hedonic or implicit price approach (Rosen). Under that theory, farmland prices are the composite result of buyers' and sellers' attempts to maximize their welfares by purchasing and selling farmland characteristics. Stated mathematically,

(4) $P(q_i) = P(q_1, q_2, \ldots, q_n)$

where: $P(q_i)$ = farmland price

q_i = farmland characteristic, $i=1,\ldots,n$.

Note that only farmland characteristics are to be included, not buyer/seller personal factors. If buyer/seller characteristics are included, the model yields uncertain theoretical implications.

Specification begins with the appropriate dependent variable. Preference should be given to individual parcel transaction prices because of their precision. Use of average land value estimates over a geographic area lacks the detail necessary to identify the often differential economic impacts of erosion over parcels. The reported price should be adjusted for special provisions agreed to by the buyer and seller which alter the effective price, e.g., concessionary financing terms. The PCI study used transaction price per acre from all valid, arms-length, non-family sales of farmland 40 acres or larger during 1976-78 (Mill). Prices were corrected for special contract financing terms which altered the reported price.

Assuming farmland has no significant consumptive attributes, the relevant independent variables include any factor that affects the marginal productivity, output price or input cost. Initially, consider the characteristics unrelated to erosion. In the PCI study, transaction sale date, parcel size, building assessed value, percentage of tilled land and distance to market were included. The list for other empirical studies may vary due to special land market conditions.

The possible erosion-related effects on farmland prices require specification and measurement of several variables. First, a measure of the uneroded productivity of the parcel's soils is necessary. A productivity index which incorporates all important soil characteristics affecting productivity such as pH level, organic matter and water holding capacity is desirable. This variable then establishes the base level of net returns without erosion. The PCI study used a corn suitability rating not adjusted for erosion or slope characteristics.

A second variable can then be used to capture the effect of past erosion. Ideally, this measure should capture the differential damages across soils rather than produce a constant damage effect for all soils. Since that type of soil-specific damage data are not common, other surrogates are used. Miranowski and Hammes used average depth of topsoil. Lacking individual parcel topsoil depth data, the PCI study measured the percentages of a parcel eroded to phase 2 (mixing of topsoil and subsoil) over favorable and unfavorable subsoils.

Note again that two variables are specified to separate the effect of a parcel's basic productivity from the impact of past erosion. If variation in productivity is not fully accounted for, then effects of productivity and erosion may become intertwined in the parameter estimate of the variable measuring past erosion damages, e.g., topsoil depth (Miranowski and Hammes). That is, soils with deeper topsoils may also have greater base productivities; thus topsoil depth captures some productivity and past erosion influences.

The third erosion-related variable measures the effect of future potential erosion damages. Again, values should differ across soils to capture variances in potential onsite costs across soils. Miranowski and Hammes use the product of R, K and LS in the universal soil loss equation, representing rainfall intensity, soil particle erodibility and slope length and percentage, respectively. The PCI study used average parcel slope which is less precise than RKLS.

Finally, the potential impact of any conservation structures on future net returns should be measured, if not captured in the potential erosion damage variable. For example, does the existence of terraces affect a parcel's potential net returns and thus sale price? The answer, of course, depends upon whether the benefits of the terraces outweigh the added costs to the buyer. If terraces are predominantly built on more productive soils because of greater potential benefits, then inclusion of a terracing explanatory variable may give simultaneity problems. The PCI study used percentage of the parcel acres terraced of the total recommended for terraces by the Soil Conservation Service. This variable was not highly correlated with parcel productivity, thus eliminating simultaneity concerns.

Table 1 gives the estimated regression coefficients for the PCI hedonic farmland price model. A linear form was assumed when preliminary tests did not reveal curvilinear relationships. Recall that all qualified farmland transactions during 1976-78 were included thus capturing the population in that county not a sample. If the estimated coefficients are interpreted as population parameters, then conventional tests of significance (T values) do not apply and standard errors (SE) only portray dispersion of population relationships.

Note that the model explained 63 percent of the farmland price variation, a respectable cross-sectional analysis performance. Inspection of residuals did not indicate omitted variables or mis-specified functional

TABLE 1

Farmland Hedonic Price Model, Page County, Iowa, 1976-78

Variable	Coefficient	Standard Error
	($/acre/unit)	
Intercept	-934.21	484.44
Saledate (month of sale, 1-36)	8.21	1.91
Size (acres)	0.58	.34
Buildings' assessed value ($/acre)	2.79	.50
Percentage of tilled land	3.80	1.25
Base soil productivity index (without slope and erosion adjustments)	17.35	5.57
Slope percentage	-21.99	18.32
Percentage in erosion phase II over favorable subsoil (FS)	2.63	1.39
Percentage in erosion phase II over unfavorable subsoil (US)	-0.48	1.39
Percentage terraced (of total recommended for terraces)	0.38	.77
Distance to market (miles)	-17.69	8.06

n = 101 R^2 = .63 F = 15.36

form. Only the erosion-related coefficients are discussed due to space limitations.

The base productivity index coefficient (without slope and erosion adjustments) is large with a relatively small SE. In contrast, the slope coefficient, presumably reflecting potential future erosion damages is large but with a large SE indicating less precision over the population. The variables intended to measure past erosion damages show mixed results. Percentage of the parcel eroded to phase II over favorable subsoils (FS) shows a surprising positive coefficient with a relatively small SE. Percentage in phase II over unfavorable subsoil (US) has a negative, but very small coefficient with a large SE. Finally, the percentage of the parcel terraced has a positive coefficient but a large SE.

The unexpected FS coefficient requires further comment. Upon further investigation, the observations with high FS levels were located predominantly in the western part of the county where soils are mostly in the Marshall association. Thus increasing levels of FS reflect increasing levels of Marshall soils. Two possible explanations may underlie the positive coefficient. First the base productivity index may not fully capture the potential net returns to Marshall soils including less risk and/or lower production costs. Second, the percentage tilled variable used 1973 data and may not capture differential rates of permanent cover conversion during the 1973-78 period. If Marshall soils were converted more rapidly to crop production, the FS variable may capture that effect. Substitution of an instrumental variable measuring tilled percentage rank did not change the results, however. One conclusion seems warranted: the group of variables measuring past and future erosion damages and conservation structures did not exhibit large and precise effects.

Summary and Policy Implications

The notion of failure of the farmland market to transmit appropriate signals on erosion's effects may be inaccurate. Farmland market participants will incorporate past and future erosion impacts dependent upon the availability and cost of appropriate information. The market failure, if it exists, is more likely in the acquisition of information relating erosion to yield impacts and associated production costs. Because that information is likely a nonrival, and perhaps a nonexclusive good, public provision may be necessary to approximate socially optimal levels. Unless such information is available at low cost to farmland buyers and sellers, we should not expect farmland prices to fully incorporate theoretical effects of erosion on yields and costs.

Carefully specified tests of the relationship between erosion and land prices are a first step to judge the degree to which private market participants approximate social values for erosion control. These social values should be estimated separately from dynamic optimization models reflecting full information on the impact of past and future erosion onsite damages. Only with accurate social values can the important question of whether the costs of providing such information outweigh the increased social benefits associated with its use be answered. In that regard, avoided offsite damages stemming from increased erosion control need to be added to onsite benefits to make a proper social benefit-cost comparison.

References

Crosson, Pierre. "Diverging Interests in Soil Conservation and Water Quality: Society vs. the Farmer." Paper presented at symposium entitled "Perceptions, Attitudes, Risks: Overlooked Variables in Formulating Public Policy on Soil Conservation and Water Quality." At annual meeting of AAEA, Clemson University, 27 July 1981.

Larson, W.E., F.J. Pierce, and R.H. Dowdy. "The Threat of Soil Erosion to Long-Term Crop Production." Science 219(1983): 458-65.

McConnell, Kenneth E. "An Economic Model of Soil Conservation." Amer. J. Agr. Econ. 65(1983): 83-89.

Mill, John W. "The Impact of Soil Conservation on Land Prices: An Empirical Investigation." Unpublished MS Thesis, University of Missouri-Columbia, July 1984.

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

Rosen, Sherwin. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." J. Pol. Econ. 82(1974): 34-55.

Randall, Alan. "The Problem of Market Failure." Natural Resources Journal 23(1983): 131-48.

U.S. General Accounting Office. Agriculture's Soil Conservation Programs Miss Full Potential in the Fight Against Soil Erosion. Washington, DC, 1983.