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Cross- Sectional Modeling of Agricultural Land Markets- What Can It Tell Us? - South Dakota Case Study Results.

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CROSS-SECTIONAL MODELING OF AGRICULTURAL LAND MARKETS

-What Can It Tell Us?

-South Dakota Case Study Results

by

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CROSS-SECTIONAL MODELING OF AGRICULTURAL LAND MARKETS

INTRODUCTION

Economists have long been interested in determinants of farmland prices. This interest has been heightened by large and contrasting changes in farmland market prices in the 1970's and 1980's. U.S. nominal farmland prices trended steadily upward from 1940-1972, soared upward 1972-1981 and have been declining since then. Percentage declines have been most severe in the Cornbelt and Northern Plains states (USDA, 1985).

Two major econometric approaches (time series and cross-sectional models) have been and continue to be used by economists to analyze farmland price determining factors.

Modern econometric <u>time series</u> analysis of U.S. farmland prices developed in the 1960's with studies by Tweeten and Nelson (1966), Tweeten and Martin (1966), Herdt and Cochrane (1966), and Reynolds and Timmons (1969). Tweeten and associates developed a recursive model and found the main sources of land price increases to be farm enlargement pressures, capitalized benefits of farm programs and capital gains expectations. Herdt and Cochrane, using a simultaneous supply-demand model, found technological advances (productivity increases) as the main source of real price increases over time. Time series results from recursive models developed by Reynolds and Timmons indicate most of the land price variation is explained by expected capital gains, government farm program payments, farm enlargement and rates of return on common stock.

Pope, Cramer, Green and Gardner (1979) reestimated the coefficients for each of these models using a longer and more recent data series and found several structural changes. Klinefelter (1973) developed a simple (single-equation least squares regression) time series model to explain the value of Illinois farmland and improvements from 1951-70. Pope and others (1979) modified the Klinefelter model using national data and found its predictive accuracy equal to or better than results from using more sophisticated (recursive or simultaneous equation) techniques.

Melichar (1979) and Walker (1979) strongly criticized land market research of the 1960's and 1970's that disregarded the central importance over time in the relationship between net returns to farmland and farmland asset values. Walker examined this relationship by comparing USDA cash rent and farmland value series from 1921-1979 for 13 major agricultural states. Melichar contributed improved methodology for estimating current returns and real capital gains to farmland. Phipps (1982) adapted Melichar's approach in his study of the relationship between land prices and farm based returns. Phipps concluded that (1) "farm based returns unidirectionally cause farmland prices" (based on Granger causality methodology), (2) "farmland values are largely determined within the farm sectors" and (3) "lagged values of past farm returns can be successfully used as a proxy for expected returns in structural models of farmland markets" (pp. 427-28).

These examples are representative of contemporary approaches used and issues examined in time series studies of agricultural land markets.

<u>Cross-sectional</u> studies represent another major approach to economic analysis of land markets. As its name suggests, the major purpose of most cross-sectional studies is to explain farmland market price variation at specific points in time.

The major purposes of this report are to examine the contributions and shortcomings of cross-sectional modeling approaches to agricultural land market analyses. Two key questions are addressed in this report:

(1) "What can(have) cross-sectional studies contribute(d) toward an improved understanding of farmland markets?"

(2) "What are some major shortcomings of cross-sectional studies and what (if anything) can be done to overcome the shortcomings?"

This assessment is accomplished by an examination of:

(1) The relationship of cross-sectional modeling to analysis of some major agricultural land market research issues;

(2) Selected cross-sectional studies in terms of issues addressed, methodology used, and specific types of variables selected to explain farmland price behavior.

(3) A South Dakota case study using traditional cross-sectional modeling techniques that illustrates both the potential contribution and limitations of this approach to modeling farmland markets.

CONTEMPORARY RESEARCH ISSUES IN AGRICULTURAL LAND MARKETS

Several important land market research issues have been suggested by Duane Harris (1979), Tim Phipps (1982) and by members of the NCR-123 Research Committee on Agricultural Land Markets. The following list -- whose individual components are not mutually exclusive or exhaustive -- is illustrative:

(1) Development and testing of consistent economic theory based models relative to:
   a. regional or aggregate farmland markets or
   b. individual farm sale tract prices

(2) Effects of international trade and financial markets on agricultural land prices and use

(3) Effects of local, state and national policies on land prices and use:
   a. Fiscal and monetary policies,
   b. Farm credit and taxation policies,
   c. Soil conservation policies, and
   d. Land use planning/zoning;

(4) Relative importance of factors explaining individual farmland tract transfers and sale prices;

(5) Effects of urbanization on local and regional land prices and use;

(6) Development of quality-adjusted price indices for agricultural land; and

(7) Behavioral analysis of land market participants (potential and actual buyers, sellers, creditors, relators).

The first issue is concerned with fundamental economic research on land markets. Time series and, especially, cross-sectional modeling efforts have often been criticized for ad hoc model specifications that are inconsistent with conventional microeconomic theory or do not yield tractable results. Phipps (1982-pp. 62) notes,

> "until recently, most models of the land market were not derived from a theory-based structural model but have instead consisted of ad hoc models relating land price and other dependent variables to fairly long lists of possible explanatory factors,----basing our models upon a theoretical structure has the additional advantage of allowing us to draw implications from the theory that may be tested."

This critical issue is particularly important for making major advances on research issues (2), (3), (5), (6) and (7).

A combination of land market data quality and availability problems and a previous lack of statistical/econometric algorithms have also been major factors limiting past modeling efforts. Data quality and availability in appropriate form remains a major problem, especially at the micro-level.

Recent cross-sectional studies (Chicoine, 1981; Dunford, Marti, Mittelhammer, 1985) and combined cross-sectional time series studies (Chavas and Shumway, 1982; Ziemer and White, 1979) are significant attempts to develop and test internally consistent theoretical models. The Chicoine and Dunford studies incorporate a hedonic price approach in their reports. Palmquist (1984) notes that urban housing demand studies have frequently used a hedonic price modeling approach which should also have significant application to cross-sectional modeling of agricultural land markets. Hedonic price models, using regression techniques, can be used to analyze differentiated product markets by estimating the implicit prices of the underlying product characteristics (attributes). Product attributes comprise elements of a buyers utility function. This approach (hedonic price models) has considerable potential to improving cross-sectional modeling specification of farmland markets.

Analysis of international trade and international capital market impacts on agricultural land markets is critically important. This type of research will likely require aggregate-level data and emphasize changes over time. To the extent that differential regional impacts are important, combined cross-sectional time series models may be a useful tool.

Determining regional distribution impacts of changing state and national policies may lend itself to cross-sectional modeling. Cross-sectional analyses can also be used for analyzing interregional differences in public policies between states. However, other techniques, including econometric simulation models, are likely to be used more.

Cross-sectional models are appropriate tools to examine research issues (4), (5), (6), and (7). Cross-sectional studies commonly involve individual sale tract or aggregate-level (county, regional, state) data, while time series studies are conventionally limited to aggregate-data series, since individual tract sale turnover is infrequent.

Harris (1979, p. 5) indicates that micro-level cross-sectional data are needed to improve our understanding of the impacts of farm enlargement, financing terms and parcel size on farmland prices. Similar statements apply to improved understanding of urbanization impacts and behavior of land market participants.

Development of quality-adjusted price indexes is also a challenging task with potential application for many user groups (assessors, other public officials, creditors, realtors, researchers and educators). Price indices, based on actual sales data, suffer from variation in attributes of tracts sold over time especially in "thin" real estate markets. Again, a hedonic pricing approach may have merit here.

In summary, cross-sectional modeling approaches are suitable for examining many agricultural land market research issues, especially at the sale tract level and in conjunction with analysis of different time periods. However, the potential contributions of cross-sectional modeling approaches to improved understanding of international trade, finance and national policy changes on land markets are rather modest.

COMPARISON OF SELECTED CROSS-SECTIONAL STUDIES OF AGRICULTURAL LAND MARKETS

A comparison of completed cross-sectional studies is useful to understanding potential applications and limitations of this approach. Major characteristics from 24 cross-sectional studies published in agricultural economics journals and bulletins from 1958 to 1985 are summarized in Table 1. These studies plus a few others[1] are examined for consistency and divergence in overall approach, problem setting, methodology and estimation procedures, database and selection of independent variables. The list of studies cited is selective, not exhaustive, and represents a wide range of approaches, problem emphases and sophistication levels.

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[1]In the remainder of this section, the term "studies" refers to the 25-30 cross-sectional studies examined and not to the universe of all farmland cross-sectional market studies.

Table 1. Comparison of Cross Sectional Agricultural Land Market Studies[a,b]

First Author, Date Published	Herr 1975	Osburn 1978	Blase 1973	Vollink 1978	Laird 1979	Thompson 1985	Swinson 1984	Carricker 1984
Time Period Studied[c]	1971-73	1975	1970	1975-76	1977	1971-81	1981-82	1978-82
Number of Observations	236	406	63	1321	76	3060	290	6930
Area Studied	SD, IA 32 Counties	SD, IA, NE	MO	NC	AL 11 counties	SC	SD 6 counties	NE
Level of Aggregation	Ind.	Ind.	Ind.	Ind.	Ind.	Ind.	Ind.	Ind.
Dataset	FLB	FLB	Farm Mgt. Assoc.	FLB	Survey	FLB	FLB, Assessors	FLB
Regional/Time Period Comparisons[d]	Region	No	No	Region	No	No	No	Both
Estimation Method and Functional Form[e]	OLS Linear	OLS Linear	OLS, Stepwise Linear	OLS Linear	OLS Linear	Stepwise Linear	OLS Linear	OLS, GLS Linear
R^2	0.49-0.57	0.78	0.86	0.50-0.62	0.89	0.78	0.77-0.85	0.5-0.75
Independent Variables								
Financial								
Lender		D		D*	D	D*	D	
Interest Rate			C			C*	C	
Years to Repay	C	C				C	C	
Percent Borrowed	C	C	C*			C*	C	
Security/Loan	C*							
Buyer-Seller								
Reason for Sale	D*				D		D	
Reason for Purchase	D	D	D*	D*	D		D	
Buyers Financial Condition	C*	C						
Buyers Personal Characteristic		D	C		D, C			
Land/Tract Characteristics								
Size of Tract	C*	C*	C*	C*	C	C*	C	C*
Farm Security/Area Class		D*		D*				D*
Gross/Net Return				C*				
Soil Productivity/Quality	C*						C*	
Principal Products		D*	C	C*			D*	
Percent Cultivated	C*	C*	C*		C*	C*	C*	C*
Other Land Uses[f]		C*			C	C*		C*,D*
Improvements	C*	excl.	C*	excl.	C*	C*	C*	excl.
Distance to Major Cities			C		C*		C	
Distance to Local Markets			C		C		C*	
Road Frontage/Distance			C		D*		D*	
External, Other								
Regional Location		D*					D*	D*
Nonfarm Influence								
Intensity	D*			D*		D*	D*	D*
Specific Factor		D		D*	D			
Community Services					C*			
Population/Farm Density					C			
Date of Sale	C*			C*			C*	C*

Table 1 Continued (2)

First Author, Date Published	Clifton 1983	Pine 1978	Reynolds 1978	Reiss 1980	Chicoine 1981	Burton 1982	Hushak 1979	Dunford 1985
Time Period Studied[c]	1971-79	1975-76	1974-75	1976-78	1970-74	1976-78	1970-74	1978
Number of Observations	24160	1280	255	110	491	?	1840	83
Area Studied	FL, GA, SC, NC	KS	FL 6 counties	IL 2 counties	IL 1 county	OK 3 counties	OH 3 regions	WA 1 county
Level of Aggregation	Ind.	Ind.	Ind.	Ind.	Ind.	Ind.	Ind.	Ind.
Dataset	FLB	Farm Mgt. Assoc.	FLB	FLBA, Assessor	Dept. of Revenue	Assessor	Assessor	Assessor
Regional/Time Period Comparisons[d]	Both	Region	Region	No	No	Region	Region	No
Estimation Method and Functional Form[e]	OLS Linear	OLS Linear	GLS Linear, Nonlinear	OLS Linear	OLS Transcendental	OLS Linear	OLS Transcendental	OLS Exponential
R^2	0.4-0.5	0.30-0.60	0.59	0.56	0.52	0.44-0.46	0.91-0.95	0.63
Independent Variables								
Buyer-Seller								
Reason for Sale								
Reason for Purchase	D*							D*
Buyer Expectation								C*,D*
Buyers Personal Characteristic				D*	D*			D*
Land/Tract Characteristics								
Size of Tract	C*	C*	C*	C*	C*	C*	C*	C*
Farm Security/Area Class	D*							
Gross/Net Return								
Soil Productivity/Quality		D*		C*	C	C		C*
Principal Products								
Percent Cultivated	C*	C*	C*	C*				
Other Land Uses[f]	C*		C*	D				
Improvements	C*	D*	C*	C*		C*		
Distance to Major Cities			C*	C	C*	C*	C*	C*
Distance to Local Markets		C			C*	C*	C*	C*
Road Frontage/Distance		D*	C*		C*,D*		C*	D*,C*
External/Other								
Regional Location		D*					D	D
Nonfarm Influence								
Intensity	D*							
Specific Factor					D*		C*	
Community Services					D*	D*		D*
Population/Farm Density								
Date of Sale	C*			C*	C*	C*		C*
Property Tax Rate							C*	C*

Table 1 Continued (3)

First Author, Date Published	Renshaw 1958	Scharlach 1962	Hammill 1969	Pasour 1973	Drummond 1973	Mundy 1976	Morris 1978	Reynolds 1982
Time Period Studied[c]	1946, 1950	1959	1959, 1964	1969	1969	1969	1969	1978
Number of Observations	30–46	92	68	83	49	95	2952	66
Area Studied	Western U.S.	IN	MN	NC	GA	TN	U.S.	FL
Level of Aggregation	Irrigation District	County	County	County	County	County	County	County
Dataset	Bureau Reclamation	Census	Census	Census Ag. Stat.	Census Assessor	Census	Census	Census
Regional/Time Period Comparisons[d]	No	No	No	No	No	No	Region	No
Estimation Method and Functional Form[e]	OLS Linear	OLS Linear	OLS Linear	OLS Linear	2SLS	OLS Linear	OLS Linear	OLS Linear
R^2	0.6–0.88	0.89	0.71	0.72	0.96–0.97	0.87	0.62–0.69	0.93
Independent Variables								
Gross/Net Income	C*		C*	C*	C*	C*		C*
Selected Farm Expenses		C*					C*	
Productivity/Yield Index		C*						
Percent Cropland	C*		C*	C*		C*		C*
Farm Bldg. Value					C*			
Average Farm Size		C		C*		C*	C*	
Population/Farm Density		C*	C*	C*		C*	C*	C*
Pop./Density							C*	
Distance to Urban Center		C*			C*,D*			
Urbanization			C*			D*		
Regional Location				D*	D*	D		
Property Tax Rate		C*		C*	C*	C*		
Wage Rate		C*						

Table 1 Continued (4)

excl. = Excluded from dataset
C = Continuous variable
D = Binary variable
* = Significant at the 0.05 probability level

[a]Independent variables used for comparison include most but not all variables used in the individual studies. Independent variable descriptions are in general form, each study has specific definitions for variables included in their models. Independent variables left blank were not used in particular studies. Variables denoted by C or D but not including * were not significant at the 0.05 level.

[b]All models used price or value per acre as the dependent variable. Two studies (Kaiser and Thompson; Burton and Nelson) used deflated price as the dependent variable. Three studies (Chicoine; Dunford, Marti and Mittelhammer; Hushak and Sadr) used logarithm of per acre price as the dependent variable.

[c]A few studies are time series-cross sectional (Clifton and Spurlock; Thompson and Kaiser) and some other studies have cross-sectional data of 4 years or more.

[d]Several studies applied similar/same model specifications to different regions and/or time periods and compared results. These studies are noted here.

[e]A "linear" function form infers that most independent variables are linear continuous or binary variables. A few variables, such as tract size may be specified as a linear, reciprocal, square root or squared function.

[f]Other land uses includes pasture, forest, wasteland or irrigation.

General Observations

Most of these studies involve cross-sectional models with a single equation OLS estimation approach and a potpourri list of independent variables.

Only two studies (Reynolds and Timmons, 1969; Drummond and White, 1973) have used recursive or simultaneous equation estimation techniques. Reynolds and Timmons, using state-level data, estimated voluntary transfers of farmland per 1000 farms with expected net farm income, government payments, expected capital gains, rate of return on common stock and increase in farm size as exogenous variables. Drummond and White used a simultaneous equation system to jointly estimate county average values of forest land and farmland.

Selection of explanatory variables is conditioned by data availability and level of aggregation. Agricultural production, land use and location variables are included in almost all studies. Nonfarm influences on farmland markets are included in fewer studies. Even fewer studies use estimated revenue and expense variables, which are most readily obtained for county or state level datasets. Buyer-seller characteristics have been used as explanatory variables in many studies using individual sale tract data, but in only one study cited (Dunford, Marti and Mittlehammer, 1985) are buyer's expectation variables used.

Financial variables are widely used in maximum bid price models to determine how much one can afford to pay for farmland (Lee and Rask, 1976; Kletke and Plaxico, 1978). However the importance (or lack thereof) of financial/credit variables on farmland price levels has been investigated in relatively few cross-sectional studies.

The growing interest in examining financial variables and the use of large-scale datasets has been stimulated by development of computerized farmland sales databases by Federal Land Banks. The Third Farm Credit District (located in Columbia, SC) was the first Federal Land Bank to encourage/ permit Land Grant

University researchers in their region to use their dataset for research purposes.

My own experience with a large scale farmland sale tract dataset from the Federal Land Bank of Omaha indicates (1) some tradeoffs between using a large scale dataset versus obtaining added information on selected variables (e.g. soil productivity, buyer expectations) for smaller datasets, and (2) researchers should become thoroughly acquainted with the definition and specification of variables included in their dataset, and the continuity of these variables over time.

Dependent Variable

Selection of the dependent variable (price or value) is strongly influenced by the level of data aggregation. Actual sale price per acre is generally used with individual sale tract datasets. Estimated value per acre is normally used with aggregate-level datasets (county, region or state). Values are estimated by producer-respondents in U.S. Census of Agriculture datasets and by survey respondents (lender, farmers, realtors and others) in states using their own land value series (Minnesota, Iowa, Nebraska are examples).

Changing rates of general price inflation during the 1970's have led some researchers to use deflated price series in cross-sectional studies (Burton and Nelson, 1982) and cross-sectional time series studies (Thompson and Kaiser, 1985).

Specific Sets of Explanatory Variables

Tract/Farm Size

Tract size or average farm size (for aggregate-level datasets) is the only variable included in all studies examined. This variable has been frequently suggested from the appraisal literature. A linear relationship has generally been examined and the coefficient has usually been negative and significant.

Carricker, Curtis and Johnson (1984) have critically examined--theoretically and empirically--alternative functional forms of tract size. Their findings suggest the functional form: price = f (acres + acres squared) has the best properties for consistent estimates of price per acre and total sale price. Hushak (1979) suggests a transcendental function yields consistent results across different datasets.

Agriculture Productivity/Returns

Data limitations usually preclude direct estimation of a major explanatory variable - net returns per acre. Consequently, proxy variables anticipated to be highly correlated with net returns per acre are substituted. Proxy variables include soil productivity, principal crops produced, crop yield, gross sales and percent cropland, pasture or forest.

Percent cropland and/or principal crops have been the most widely used proxy variables in sale tract studies, while some measure of gross sales and percent cropland have been most widely used in aggregate-level data studies. Coefficients for these proxy variables are significant in most studies - except where urbanization is the predominant factor (Chicoine, 1981).

Soil productivity rating variables have received considerable use in soil conservation and property tax literature but lesser use in farmland market studies. Proper specification depends on how the productivity rating variables are constructed. Recent work at South Dakota suggests a nonlinear positive relationship of soil productivity rating to per acre price (Swinson, 1984). A possibly improved specification would require conversion of soil productivity ratings to 'economic value' indices that could directly use product price trends or expectations.

Land Improvements

The impact of land improvements on farmland price has been handled by:

(1) including the estimated (appraised) value of improvements as an explanatory variable;

(2) including a binary variable for presence/absence of improvements;

(3) estimating a bareland price (exclusive of estimated value of improvements); or

(4) deleting tracts with buildings and other improvements from the dataset.

None of these approaches are very satisfactory because the values of bareland and improvements are jointly determined. The first approach permits one to estimate a contributory percentage of appraised value and for this reason may be preferred by a researcher (Hushak, 1979).

The growing practice of separate sales of building sites from cropland or pasture also has implications for land market analysis. It is important to specify whether a dataset includes(excludes) this phenomenon. For example, Federal Land Bank farmland sales tract datasets in some districts exclude tracts below a specified acreage. These excluded tracts frequently are building sites.

Location Factors, Nonfarm Influences

Location factors and nonfarm influences have been incorporated into most cross-sectional studies examined. Coefficients for both sets of variables have usually been significant.

Location theory is the framework for a 1962 study of county farmland values in Indiana. Nonfarm factors were found to influence farmland prices through four variables: population density, transportation costs, property taxes and rural wages (Scharlach and Schuh). Pasour (1973) and Drummond-White (1973) show similar findings for impacts of density, transport costs and property taxes on county farmland value.

Transportation access, distance to urban centers, neighboring land uses and other location attributes overshadowed farmland productivity variables in explaining farmland sale prices in the Chicago SMSA region (Chicoine, 1981). Similar results, using considerably different model specifications, are found in studies of urban fringe farmland markets in Florida, Oklahoma, and Washington (Burton and Nelson, 1982; Reynolds and Tower, 1982; Dunford, Marti and Mittlehammer, 1985).

Agricultural productivity variables are generally the most important price determining factors found in farmland market studies of more rural/agricultural regions. However, coefficients for location, distance and nonfarm influence variables are usually significant ($p = 0.05$) in these studies (Swinson, 1984; Carricker, 1984; Laird, 1979 are examples).

Functional specification of location/distance variables (linear, reciprocal, logarithmic and other) has not been resolved in the empirical studies.

The trend toward using large-scale computerized datasets has led researchers to specify location and nonfarm influences in binary form, often at a highly aggregated level (e.g. "residential influence", "moderate to high degree of urban influence"). This tendency illustrates a classic tradeoff between using larger datasets with some missing variables versus costs of obtaining the necessary information for more complete model specification.

Buyer-Seller Characteristics

Buyer and/or seller characteristics are included in a majority of tract sale studies. However, there is little consistency in variables selected or their functional form. Sets of binary variables describing "reason for sale" and "reason for purchase" are most widely used. These variables are convenient proxies for underlying characteristics such as financial position or future expectations of buyers.

In some respects, analysis of objective buyer-seller characteristics should be considered in a broader context of changing land ownership, tenure and resource control. It may also be useful to compare the changing distribution of potential/actual buyers at different points in time. However, the limited empirical evidence suggests these are not major factors explaining price variations at a point in time. On the other hand, detailed studies of expectations of land market participants may contribute to improved models (Dunford, Marti and Mittlehammer, 1985).

Financial/Credit Variables

The inclusion of financial/credit variables in cross-sectional studies represents growing interest in estimating financial impacts on farmland values. A traditional view of financial impacts is that availability of credit financing converts potential demand into effective demand for farmland but has little if any influence on observed cross-sectional price variation. Alternative views, based on examination of maximum bid price literature, suggest that major differences in financing terms impact relative prices paid.

The impacts of financial variables on farmland prices in Iowa, Nebraska or South Dakota during the early and mid-1970's are analyzed in two studies (Herr, 1975; Osburn and Johnson, 1978). Results from both studies indicate that financial variables do not significantly explain variations in farmland price level. The same conclusion is reached in a more recent study of two South Dakota regions during a period of declining land prices and rapidly changing financial terms (Swinson, 1984).

Thompson and Kaiser, (1985) using a cross-sectional time series approach for a longer period of rising land prices, 1971-1981, report coefficients for "real" interest rates and percent borrowed to be significant and negative. In the same study, the deflated price per acre is significantly higher for seller financed tracts than for mortgage financed tracts by Federal Land Banks or other institutional lenders.

The major issues concerning the use of financial/credit explanatory variables are:

(1) The length of time necessary to examine in a farmland market study to capture the impacts of financial variables;

(2) The use and interpretation of nominal and deflated interest rates and prices;

(3) The need for more theoretically complete and consistent models to specifically test traditional and alternative views of impacts of financial variables on farmland prices; and

(4) Data availability for selected financial variables. The major data deficiencies are specific terms on seller financing such as the use of fixed or variable interest rates and structure of balloon payments. As land financing arrangements become more complex and variable, this issue may assume greater importance.

This review of studies has shown a variety of approaches, datasets and variables used in cross-sectional modeling of agricultural land markets. A recent case study from South Dakota is now presented to further illustrate the contribution and limitations of this approach to modeling farmland markets.

CASE STUDY OF SOUTH DAKOTA FARMLAND PRICES-A CROSS-SECTIONAL ANALYSIS, 1979-1983

Objectives

The importance of agricultural productivity, location, financial and other variables in explaining variation in farmland sale price per acre during periods of rising and declining farmland values is examined in this case study. Both nominal and deflated prices per acre are examined as dependent variables. Specific hypotheses tested are:

1) Agricultural productivity and tract location variables significantly explain per acre price variation while financial variables do not; and

2) Coefficients of estimated equations are stable between periods of rising and declining land prices.

Procedures and Data Sources

Credit-financed sales of agricultural land from 1979-1983 in four South Dakota counties are examined. The analysis is conducted for sales during a period of rising agricultural land prices (1979-1981½) and a period when farmland prices peaked and started to sharply decline (1981½-1983). Turner and Yankton counties are selected as representative of the cornbelt region in southeastern South Dakota, while Edmunds and McPherson counties are selected as representative of the wheat, corn and small grains region of north central South Dakota. The per acre sale prices and agricultural productivity of tracts vary greatly within each region and between regions.

Data on the 382 sales of agricultural land used in this study were obtained from the Federal Land Bank of Omaha (FLB).[1] The FLB data were supplemented with information obtained from local county courthouse offices, soil maps and county road maps.

Multiple linear regression (OLS) techniques are used to estimate the cross-sectional farmland price models (SAS, 1982, pp. 39-83). Two multiple regression equations, nominal and deflated per acre price, are used to estimate parameters for each time period, 1979-1981½ and 1981½-1983. For each equation, restricted and unrestricted models are tested to determine if the set of financial variables significantly added to the explanation of variation in price per acre (Johnston, 1972, pp. 192-199). The stability of regression coefficients across time periods is examined by use of the Chow test (Maddala, 1977, pp. 198-199). Details of both F-tests are available in Appendix 1.

Model Specifications

Nominal and deflated price per acre are the dependent variables in alternate equations. The GNP-PCE deflator (1972=100)[2] is used to adjust price per acre for the deflated price series. The explanatory variables used in the regression equations are in three general groups: 1) agricultural productivity variables, 2) location and other tract related variables, and 3) financial variables. The definition and description of each variable are given in Table 2.

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[1]The Federal Land Bank of Omaha obtains information on bonafide farmland tract sales of 40 acres or more, regardless of financing source. A total of 382 sale tracts were included in the four-county dataset from 1979-1983. A total of 100 sale tracts were equity-financed and were therefore excluded from this case study.

[2]The GNP implicit deflator for personal Consumption Expenditures (GNP-PCE) is a measure of inflation rates in the private sector. It is a variable weight index since price level and expenditure patterns are allowed to vary over time.

Table 2. Definition of Variables Used in Analyzing Per Acre Price

Variable[a]	Type	Expected Sign	Definition
Dependent Variable:			
PRICE	C		Sales price per acre
DPRICE[b]	C		Sales price per acre adjusted by GNP deflator for personal consumption expenditures (GNP-PCE, 1982 = 100)
Agricultural Productivity Variables:			
SPR	C	–	Average soil productivity rating
SPRSQ	C	+	Soil productivity rating squared
CVSPR	C	–	Coefficient of variation of soil productivity rating
PCTCULT	C	+	Percent of tract cultivated
PCTIRR	C	+	Percent of tract irrigated
PGRAIN	D	–	Principal product is wheat or small grains
Location and Other Nonfinancial Variables:			
SOUTHEAST	D	+	Located in southeastern region
LMKT	C	–	Distance in miles to local market
RMKT	C	–	Estimated distance in miles to regional market
GROAD	D	+	Road surface of road bordering tract
PROAD	D	+	where: PROAD = paved GROAD = gravel
NONFARM	D	+	Non-farm influence is present
EXPAND	D	+	Reason for purchase is expansion
BVPA[b]	C	+	Building value per acre
DBVPA[b]	C	+	Building value per acre adjusted by implicit GNP deflator for personal consumption expenditures (GNP-PCE, 1982 = 100)
ACREPRCH	C	–	Total acres purchased
Financial Variables:			
PCTFIN	C	+	Percent of purchase price financed
TERM	C	+	Years to repay on mortgage or land contract
PCTCSR	C	–	Percent of purchase price seller received upon settlement
INTEREST[b]	C	–	Interest rate on mortgage or land contract
REALINT[b]	C	–	Contract interest rate minus the annual rate of inflation for previous 12 months as measured by rate of change in GNP-PCE deflator

Variable[a]	Type	Expected Sign	Definition
LFLB	D	n	Primary lender where:
LFMHA	D	n	LFLB=FLBA, LFMHA=FmHA
LCOMM	D	n	LCOMM = All other institutional lenders; includes commercial banks, insurance companies and PCA

Type of variable:
C = Continuous variable
D = Binary variable

Expected sign of beta coefficient:
+ = Positive
− = Negative
n = No prior expectation

[a]Each equation includes an intercept term which incorporates an omitted variable from each set of binary variables. Omitted variables included in the intercept are:

PCORN = Principal product is corn or soybeans
NORTH = Located in North Central region
DROAD = Dirt road or no road borders tract
FARM = Nonfarm influence is not present
REASON = Reason for purchase is to establish a farm or invest, not to expand an existing farm
LSELL = Tract was seller financed with a contract for deed or mortgage

[b]For nominal price equations, the variable PRICE is the dependent variable while BVPA and INTEREST are included as dependent variables. For deflated price equations, the variable DPRICE is substituted for PRICE as the dependent variable while DBVPA and REALINT are substituted for BVPA and INTEREST. All other independent variables are included in both the nominal and deflated price equations.

Agricultural Productivity Variables

Agricultural productivity variables include land use and other variables that are related to expected physical productivity of each tract. Physical productivity, in turn, is highly correlated to estimated net returns from land. The latter economic variable could not be directly estimated from available data. The productivity variables are expected to have a major impact on price per acre.

The average soil productivity rating (SPR) for each tract is calculated from soil classification data using the methodology developed by the Plant Science Department at South Dakota State University (Malo and Westin, 1978). The soils of South Dakota are given a percentage productivity rating (0-100%) based on expected yields of suitable crops and forages under non-irrigated "good" management conditions. For each tract, SPR is found by weighting the soil productivity rating of each soil type in the tract by its number of acres and dividing the sum by total tract acres.

Soil productivity rating, which is an expected yield index, and gross income per acre is expected to have a linear relationship for a given cropping pattern and time period. However, crop production expense is expected to have a nonlinear relationship to soil productivity with expenses increasing at a decreasing rate as the soil productivity rating increases. Consequently, as the tract soil productivity rating increases, net returns and price per acre would be expected to increase at a faster rate (Scott and Chicoine, 1982). A squared term (SPRSQ) for soil productivity rating is included to reflect an expected positive nonlinear relationship to per acre sales prices.

The coefficient of variation in tract soil productivity (CVSPR) is included to examine whether increased within-tract variability in productivity has a discount (negative) effect on average price per acre.

The present agricultural land uses of a tract also affect its expected net return and sale price. In any time period, agricultural land use patterns reflect economic outlook (expectations) for different uses, landowner and/or farm operator risk/return preferences and technical constraints (soil type, productivity and relative capacity for producing various crops and forages).

The percentages of tract cultivated (PCTCULT) or irrigated (PCTIRR) are indicators of expected increases in per acre net returns and sale price. Cropland primarily used to produce wheat and small grains (PGRAIN) is expected to have lower net returns and sale prices than cropland used to produce corn or soybeans.

Location and Other Nonfinancial Variables

Location and other nonfinance explanatory variables can also influence per acre sales price.

The variable SOUTHEAST is included to account for regional variation in per acre sales price that other location, land use and productivity variables are not able to capture. This variable reflects regional differences in population density, infrastructure and agglomeration factors that indirectly affect per acre price. Farmland price per acre is generally higher in the southeast region than in the north central region.

Increased distance to market, either local or regional market centers (LMKT and RMKT) increases transportation costs which reduces net returns and per acre sale price. The variable LMKT is the distance in miles to the nearest village or town while RMKT is the distance to the nearest regional trade center with a 1980 population exceeding 10,000. The trade center for the north central region is Aberdeen. The closest trade centers for the southeast region are Sioux Falls and Yankton.

Both gravel and paved roads (GROAD and PROAD) are expected to have a postive influence on sale price compared to no roads or a dirt road bordering the tract.

Two binary variables, NONFARM and EXPAND, are expected to have a positive correlation with per acre sale price.

The NONFARM variable represents those cases where the farmland tract sale price is directly influenced by residential, commercial, industrial, highway or recreational development. Farmland with conversion potential to these uses in the near future generally sells for a higher price.

The EXPAND binary variable represents the influence on sale price of existing farm operators purchasing tracts to expand their farm operation. Since the mid-1950's, farm expansion has been the major reason for farmland tract purchases in South Dakota and many other states (USDA, Farm Real Estate Market Developments, various issues). It is hypothesized that farm expansion pressures increases per acre price because per acre net returns have increased from an add-on farm unit which allows fuller utilization of labor and larger machinery. Farm expansion is the primary reported reason for purchase of 70% of farmland tracts sold in the four counties from 1979-1983.

The dependent variable, per acre price, includes the value of buildings on the tract. Building values are estimated by Federal Land Bank loan officers using a replacement cost (less depreciation) approach. The dominance of farm expansion buyers may cause many buyers to place a lower valuation on farm building sites. Building value is included on a per acre basis (BVPA) to determine the proportion of estimated building value recaptured. Building value per acre (DBVPA) is adjusted by the GNP-PCE deflator for the deflated price models. The beta coefficient is expected to be positive in each model.

The total number of acres in each sale tract (ACREPRCH) is expected to be negatively correlated to price per acre. Credit limits per buyer and increased parcelization (less than whole-farm units) of farmland sale tracts are two reasons for expecting a "discount" in the per acre price as the number of acres sold increases.

Financial Variables

The financial terms of a sale may also affect the per acre price (Thompson and Kaiser, 1985). Percent of purchase price financed (PCTFIN), years to repay (TERM), percent cash seller received upon settlement (PCTCSR) and primary lender (LFMHA, LFLB, LCOMM) are included in all equations. Nominal (contract) interest rate (INTEREST) and real (inflation adjusted) interest rates (REALINT) are respectively included in the nominal and deflated price models.

PCTFIN and TERM are included to test if lower downpayment and longer repayment periods affect price per acre. Both of these financial variables affect cash flow feasibility of farmland purchases and are generally believed to affect marketability of tracts, but their significance in affecting per acre price is less certain.

In a capital budgeting framework, the expected sign of both coefficients depends on the relationship between the buyer's after tax loan interest rate (ATLIR) and after tax required rate of return (RRR) on investment. If ATLIR exceeds RRR then PCTFIN and TERM are expected to have negative coefficients. If RRR exceeds ATLIR then PCTFIN and TERM are expected to have positive coefficients (Lins, Harl and Frey, pp. 121-128). As the percent of purchase price financed (PCTFIN) increases, the lower required downpayment may encourage a buyer to pay a higher per acre price if the buyer perceives his discount rate as higher than the ATLIR. In these circumstances, longer repayment periods decrease annual payment and allow the buyer to pay a higher per acre price.

However, buyers' willingness to pay more due to these financing terms may not be observed in actual sales transfer data if the level of buyer competition for the tract makes it unnecessary to pay the maximum bid price. Furthermore, a buyer's RRR and marginal tax rate are not observed variables which implies the expected sign of both coefficients cannot be determined, apriori.

The proportion of cash received by the seller at time of settlement, PCTCSR, may also affect per acre sale price because of possible risk and income/capital gains tax implications for the seller. A negative coefficient is expected because of the impact of progressive marginal tax rates on major increases in annual income. Also, risk averse sellers (in contract for deed sales) during periods of financial stress may settle for a lower per acre price in exchange for a higher initial cash payment because of possible buyer default risk.

Price per acre is expected to decrease whenever the contract interest rate (INTEREST) increases due to increased total financing cost over the loan life. However, the nominal (contract) interest rate is also very highly correlated with the inflation rate and may not exhibit its expected sign.

The real interest rate (REALINT) variable is defined as the contract interest minus the inflation rate for the previous 12 months (Thompson and Kaiser, 1985). The previous inflation rate is a proxy for the expected future inflation rate. A negative relationship is expected between positive real interest rates and per acre sale price.

The type of lender (LFLB, LFmHA, LCOMM) who financed the sale is included to account for differences in financing terms by lender that are not incorporated into other financial variables. Sales financed by sellers are left in the intercept.

Empirical Results

Four equations explaining farmland price variation are presented in Tables 3 and 4. The major differences in equations between tables are choice of dependent variable - nominal vs. deflated price - and selected independent variables - nominal vs. real interest rates and building value per acre. Mean values of dependent and explanatory variables are presented in Table 5.

A relatively high percentage ($R^2 > 0.81$) of price variation is explained in each time period by both equations. Findings are discussed by major sets of variables across both periods.

Agricultural Productivity Variables

The analysis indicates that agricultural productivity variables had a major impact on per acre sales price in both time periods.

Soil productivity rating (SPR and SPRSQ) has a strong nonlinear relationship to per acre sale price. The coefficient for SPRSQ is positive and highly significant ($p = .01$) in all equations. The combined effect of the negative SPR and the positive SPRSQ coefficient indicates that, above a minimum soil productivity rating, per acre farmland sale price is an increasing positive function of soil productivity rating. Very few tracts have average soil ratings below the minimum level.

The proportion of cultivated acres (PCTCULT) is significantly and positively correlated with per acre sales price in both periods, while the coefficient for wheat-small grain production (PGRAIN) is negative and significant in the earlier time period. In both regions, cropland generally sells for a higher price per acre than pastureland and farmland typically used to produce wheat or small grains sells for a lower price per acre than corn-soybean tracts. The proportion of irrigated acres is also positively correlated with per acre sales price.

Table 3. Explanation of Nominal Per Acre Sale Price, 1979-1983

Variable	Jan. 1979 - June 1981 Beta	Jan. 1979 - June 1981 Std. Error	July 1981 - Dec. 1983 Beta	July 1981 - Dec. 1983 Std. Error
Intercept	870.942	280.227***	765.625***	343.322
Agricultural Productivity Variables				
SPR	- 20.641	8.112**	-24.131	9.917**
SPRSQ	0.201	0.064***	0.273	0.072***
CVSPR	- 1.201	1.446	- 1.572	1.578
PCTCULT	2.864	0.562***	2.133	0.745***
PCTIRR	3.994	1.373***	8.262	1.072***
PGRAIN	-103.214	37.315***	-40.489	54.649
Location/Other Variables				
SOUTHEAST	344.938	69.121***	273.326	96.692***
LMKT	- 8.980	2.592***	- 7.379	1.955***
RMKT	- 2.413	1.300*	- 0.167	1.402
GROAD	- 2.477	40.952	55.749	41.958
PROAD	8.253	44.544	18.332	42.899
NONFARM	73.903	67.068	252.384	97.540**
EXPAND	69.132	30.907**	18.361	28.517
BVPA	0.764	0.132***	0.842	0.119***
ACREPRCH	0.038	0.044	0.033	0.060
Financial Variables				
PCTFIN	- 0.802	0.944	- 0.328	0.794
TERM	- 1.326	2.035	- 0.765	1.783
PCTCSR	- 1.351	0.725*	- 1.428	0.754*
INTEREST	12.023	8.526	8.353	9.808
LFLB	83.342	59.489	36.056	53.667
LFMHA	123.132	74.840	95.369	73.908
LCOMM	63.738	119.998	43.581	90.378

Summary Statistics		Summary Statistics	
R^2	= 0.819	R^2	= 0.874
Adj. R^2	= 0.798	Adj. R^2	= 0.855
F-value	= 39.01***	F-value	= 46.10***
RMS	= 183.21	RMS	= 151.54
Dep. Mean	= 600.38	Dep. Mean	= 722.25
N	= 213	N	= 169

Coefficient is significant at:
*** 0.01 probability level
** 0.05 probability level
* 0.10 probability level

Table 4. Explanation of Deflated Per Acre Sale Price, 1979-1983[a]

Variable	Jan. 1979 - June 1981 Beta	Jan. 1979 - June 1981 Std. Error	July 1981 - Dec. 1983 Beta	July 1981 - Dec. 1983 Std. Error
Intercept	1180.459	294.670***	941.460	320.311***
Agricultural Productivity Variables				
SPR	- 26.285	8.725***	-25.108	9.805***
SPRSQ	0.264	0.068***	0.280	0.072***
CVSPR	- 1.000	1.561	- 1.231	1.583
PCTCULT	3.035	0.605***	2.101	0.742***
PCTIRR	4.479	1.477***	8.543	1.074***
PGRAIN	-112.206	40.136***	-47.707	54.575
Location/Other Variables				
SOUTHEAST	366.778	74.236***	238.901	96.723**
LMKT	- 10.618	2.789***	- 7.286	1.957***
RMKT	- 3.203	1.398**	- 0.272	1.390
GROAD	- 6.153	44.098	68.832	41.969
PROAD	11.537	47.926	25.740	42.909
NONFARM	122.505	72.251*	267.322	97.600***
EXPAND	66.170	33.381**	16.490	28.528
DBVPA	0.742	0.124***	0.843	0.122***
ACREPRCH	0.039	0.047	- 0.016	0.789
Financial Variables				
PCTFIN	- 0.868	1.015	0.112	0.795
TERM	- 0.455	2.188	- 0.679	1.784
PCTCSR	- 1.463	0.780*	- 0.646	0.760
REALINT	4.754	9.195	-22.885	6.430***
LFLB	80.387	63.619	56.748	52.948
LFMHA	115.022	80.540	49.106	75.818
LCOMM	117.539	129.581	146.231	83.289*

Summary Statistics (Jan. 1979 - June 1981)		Summary Statistics (July 1981 - Dec. 1983)	
R^2	= 0.838	R^2	= 0.874
Adj. R^2	= 0.819	Adj. R^2	= 0.855
F-Value	= 44.55***	F-value	= 45.97***
RMS	= 197.17	RMS	= 151.68
Dep. Mean	= 691.70	Dep. Mean	= 713.50
N	= 213	N	= 169

Coefficient is significant at:
*** 0.01 probability level
** 0.05 probability level
* 0.10 probability level

[a]Per acre sale price is deflated by the GNP-deflator for Personal Consumption Expenditures (GNP-PCE) with a base year of 1982.

Table 5. Mean Values of Selected Variables by Time Period

Dependent Variables		Jan. 1979 - June 1981	July 1981 - Dec. 1983
Deflated Price		691.70	713.50
Nominal Price		600.38	722.25
Explanatory Variables	Type		
Agricultural Productivity Variables			
SPR	C	57.80	62.90
CVSPR	C	19.14	15.61
PCTCULT	C	62.10	73.05
PCTIRR	C	1.31	2.44
PGRAIN	D	0.37	0.24
Location/Other Variables			
SOUTHEAST	D	0.46	0.62
LMKT	C	9.38	10.28
RMKT	C	28.70	26.76
GROAD	D	0.50	0.50
PROAD	D	0.33	0.38
NONFARM	D	0.05	0.02
EXPAND	D	0.69	0.74
BVPA	C	47.13	43.85
DBVPA	C	54.16	43.00
ACREPRCH	C	253.48	218.60
Financial Variables			
PCTFIN	C	82.38	77.07
TERM	C	18.13	17.03
INTEREST	C	8.98	10.91
REALINT	C	- 0.13	5.00
PCTCSR	C	54.27	54.97
LFLB	D	0.27	0.32
LFMHA	D	0.11	0.08
LCOMM	D	0.02	0.04

C = continuous variable
D = binary (0,1) dummy variable

Intra-tract variation in soil productivity (CVSPR) is negatively related to per acre price but is not significant in either time period (p = .10).

Location and Other Nonfinancial Variables

Region (SOUTHEAST) is the most important location related variable in all equations. The SOUTHEAST coefficient is considerably higher during 1979-1981½ period when land prices were rising than during the latter period when farmland prices peaked and began declining. The lower regional difference in 1981½-1983 coincides with the fact farmland sale prices declined first and more rapidly in southeastern South Dakota than elsewhere in the state (Janssen, 1985).

Increased distance from local and regional market centers has a negative impact on per acre sale price. The coefficient for local market (LMKT) is highly significant (p = 0.01) in both periods, while the regional market coefficient is significant only in the 1979-1981½ period. The nearest local market center is an average of 9-10 miles from the tract while the regional market is 26-28 miles away.

Sale tracts adjacent to gravel or paved roads do not have statistically significant coefficients in either time period. The coefficient for paved roads has a positive sign in both periods while the coefficient for gravel roads is unstable in sign.

The coefficient for local non-farm influence (NONFARM) is positive and highly significant in 1981½-1983 but not significant or weakly significant (p = .10) in the 1979-1981½ period. However, local nonfarm factors only influence the sale price of about 2-5% of sale tracts (Table 5).

Buyers expanding farm operations (EXPAND) have a statistically significant (p = .03) upward impact on per acre sale price during the period of rising prices but are not a significant factor during the initial period of declining prices. These buyers purchase more than two-thirds of farmland tracts sold in each period.

Farm buildings (BVPA or DBVPA) significantly added contributory value to per acre sales price in both periods. The beta value indicates that buildings recaptured 74-76% of their value in 1979-1981½ compared to 84% in the latter period.

No premium or discount in per acre sales price is associated with tract size (ACREPRCH), even though tract size varied from 40 acres to 3600 acres. This finding does not conform with results in most other cross-sectional studies examined where a negative and significant coefficient was usually present. Other functional specifications of tract size as suggested in the literature, were also examined and none were statistically significant (p=.05).

Financial Variables

Financial variables show little significance in explaining per acre sale price variation in either equation or time period. Only one financial variable, PCTCSR, has a significant coefficient (p=.10) in the 1979-1981½ period of rising farmland prices. The coefficient for PCTCSR is also negative and significant in the latter period in the model with nominal farmland prices.

The coefficient for real interest rate is negative and highly significant (p=.01) in the 1981½-1983 period when real interest rates exceeded 5% (Tables 4 and 5). In the earlier period when real interest rates approach zero (-0.13) the coefficient is positive and nonsignificant.

The coefficients for LFLB, LFmHA and LCOMM are positive but usually nonsignificant in both equations and time periods indicating no significant differences between the sale prices mortgage financed tracts and seller financed tracts. Credit information on seller financed sales did not specify if repayment terms were partially or fully amortized or whether interest rates were fixed or variable. The lower price of seller financed tracts may reflect these factors.

Credit terms are often considered important variables influencing farmland market prices. Approximately 80% of farmland sales in each period are credit financed and wide variations in interest rates (nominal or real), years to repay and percent of purchase price borrowed existed within each period. However, few of these variables are significantly related to per acre sale price in either time period.

A statistical test (restricted vs. unrestricted models) was applied to both equations in each time period to determine if the set of financial variables significantly added to the explanation of per acre price variation. The null hypothesis is that the set of financial variables is not significant. The calculated F-values for 1979-1981½ are 0.80 for the deflated price equation and 1.12 for the nominal price equation. For 1981½-1983, the calculated F-values are 3.13 for the deflated price equation and 1.26 for the nominal price equation. The critical value for the test statistic at $p = 0.05$ and $p = 0.01$ are approximately 2.08 and 2.77 respectively. The null hypothesis is not rejected for the nominal price equation in either time period. For the deflated price equation, the null hypothesis is not rejected in the 1979-81½ period of rising land prices and very low real interest rate. However, the null hypothesis is rejected ($p=.01$) in the latter 1981½-1983 period when real interest rates increased to above 5% and farmland prices began declining.

Stability of Coefficients Across Time Periods

A Chow test was conducted to determine if the coefficients are stable between time periods of rising and declining land prices for the equations including financial variables. The null hypothesis is that the coefficients are stable between the two time periods. The alternative hypothesis is that some coefficients significantly varied between the two time periods. In this example, the critical value of the Chow statistic for equations including financial variables (Tables 3 and 4) is approximately 1.58 for $p = 0.05$ and 1.92 for $p = 0.01$. The calculated value of the Chow statistic for the nominal price equations is 0.95 indicating the null hypothesis is not rejected at the 5% probability level. However, the calculated value of the Chow statistic for the deflated price equation is 1.63 indicating the null hypothesis is rejected at the 5% probability level.

The structural change inferred for the deflated price equations may be accounted for by rapid charges in and different significance levels of real interest rates between the two time periods. The real interest rate variable, REALINT, increased from -0.13% in the 1979-1981½ period to 5.0% in the 1981½-1983 period. Nominal interest rates continued to increase during both periods but the inflation rate, as measured by the GNP-deflator, increased throughout 1979 and 1980 and declined sharply from mid 1981-1983.

Case Study - Summary and Implications

In this case study of farmland sales from four South Dakota counties, the importance of agricultural productivity, location, financial and selected other variables in explaining variation in per acre farmland sale price during periods of rising and initially declining farmland prices is examined.

Multiple regression results confirm that agricultural productivity and location variables are important explanatory variables while most financial variables (except real interest rate) are not important. Over 80% of per acre price variation is explained in both periods. Per acre sale price is an increasing positive function (non-linear) of soil productivity. Percent of cultivated acres, percent of irrigated acres, building value per acre, region and distance to local markets are also significant variables in all models.

A major implication is that traditional explanations of cross sectional farmland per acre price variation based on agricultural productivity and location variables are largely confirmed. At a minimum, it is very important to include variables that are closely correlated to physical productivity, if direct measures of net returns per tract are not available. Soil productivity indices are useful proxy measures of physical productivity but more investigation of its functional form relationship to per acre price is warranted.

The agricultural land markets in the case study counties are generally not subject to direct influences of major recreational areas or metropolitan areas. It would be useful to land market researchers to conduct a systematic study classifying local agricultural land markets by proportion of influence from agricultural and nonagricultural factors.

A second implication is that inferences concerning structural changes in coefficients can be affected by selection of dependent variable - nominal or deflated price per acre - and corresponding explanatory variables. The time periods examined in this case study included rapid changes in and reversal of inflation rates and real interest rates. These influences are captured in the deflated price equation and contribute to structural changes between time periods. Deflated price equations are generally used in time series econometric models but are also appropriate to use in cross-sectional models when inflation rates are rapidly changing.

Finally, financial and credit terms (except real interest rates) may not contribute much to an explanation of cross sectional farmland price variation even during periods of volatile change. It is likely that a longer term analysis of farmland markets is necessary to assess impacts of financial variables. These findings are in general agreement with those in the Herr (1975), Osburn and Johnson (1978) and Thompson-Kaiser (1985) studies. At first glance, it may seem these results conflict with Kaiser and Thompson findings that lender, real interest rate, percent credit financed are significantly related to price per acre. However, their overall model is specified for a longer time period, 1971-1981. Further analyses of the impact of financing terms on farmland prices, both cross-sectional and time series, is warranted.

CONCLUDING REMARKS

Cross sectional studies represent one major approach to analysis of agricultural land markets. The major purpose of these studies is to explain farmland price variation at specific points in time.

The main issues addressed in this paper are the contribution of and major shortcomings of cross-sectional studies toward an improved understanding of farmland markets. This preliminary assessment is accomplished by 1) examining the relationship of cross-sectional methods to major land market research issues, 2) review of selected cross-sectional studies, and 3) a case study of farmland prices in four South Dakota counties, 1979-1983.

The cross sectional method is best suited for

(1) examining the importance of factors explaining individual tract sale prices;

(2) investigating the effects of urbanization on farmland sale prices; and

(3) classifying of land markets and/or developing quality-adjusted price indices

It is less suited for analyzing effects of international trade, international financial markets and national economic policies on regional or local farmland markets.

Both cross-sectional and time series studies have been frequently criticized for ad hoc model specifications that do not allow appropriate testing of theoretical issues. A combination of land market data quality and availability problems have been major factors limiting modeling efforts. The development of large-scale datasets of individual sale tract information from the Federal Land Banks (or other sources) has greatly standardized data quality and reduced data availability problems. However, several explanatory variables are often not included in these data sources.

General findings from review of previous case studies and the South Dakota case study are:

(1) Tract size, location and agricultural land use/productivity measures are included as explanatory variables in almost all studies. Specific definitions and functional forms vary considerably between studies, but coefficients of these variables are generally significant in the studies examined.

(2) The income capitalization approach has provided the basic analytical framework for most farmland market studies. The lack of current net return measures has led researchers to specify many land use/productivity proxy measures for net returns. Soil productivity ratings, when used along with land use variables have been highly correlated with per acre price except where urban influences are predominant. Proper specification and functional form of soil productivity and many other variables has not been fully resolved in the empirical literature.

(3) The impact of nonfarm/urban influences on farmland prices has been demonstrated in studies of metropolitan/ urban fringe areas. However the impact of urbanization across large geographic region (states) has been investigated in few studies.

(4) Buyer-seller objective characteristics have been included in a wide variety of forms and often found nonsignificant. Analysis of buyer expectations may be a fruitful avenue of inquiry in future studies.

(5) The impact of financing/credit terms has been investigated in relatively few cross-sectional studies. Several issues remain concerning proper analysis of these variables. For example, deflated price equations are appropriate specifications of cross-sectional models when inflation rates are rapidly changing. Real interest rates become a significant explanatory variable in these conditions. Most empirical cross-sectional studies have not found other financial/credit terms to be significant variables explaining per acre price variation.

(6) Hedonic price modeling approaches have been used in many urban housing demand studies. This approach may have significant potential for agricultural land market analysis, provided adequate data are available in terms of variable selection and quality. Hedonic price models can be used to analyze differentiated product markets by estimating the implicit prices of underlying product characteristics.

The availability of large-scale datasets and greater attention to theory-based modeling approaches will likely lead to continued use of cross-sectional studies as a major approach to agricultural land market analysis.

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APPENDIX 1
STATISTICAL TESTS OF SIGNIFICANCE FOR ADDED VARIABLES AND FOR STABILITY OF COEFFICIENTS

Added Financial/Credit Variables

The collective contribution of added financial/credit variables is examined by using an "added variables" F-test. This approach permits testing a subgroup of coefficients in a model and their collective added explanation of variance in the dependent variable. The statistical equation used to perform the F-test for added financial/credit variables is:

$$\text{Calculated F-value} = \frac{(RSSE - USSE) / k}{USSE \ / (n - p - 1)} \quad \text{(Johnston, pp. 192-199)}$$

where RSSE = restricted error sum of squares for equation excluding financial/credit variables;

USSE = unrestricted error sum of squares for equation with added financial/credit variables;

k = number of added parameters (financial/credit variables);

p = number of explanatory variables in unrestricted equation; and

n = number of tract sales (observations).

The denominator of this equation is equivalent to the unrestricted mean square error. The equation is tested for a critical value of $F\alpha = 0.05$, with k degrees of freedom in the numerator and $n - p - 1$ degress of freedom in the denominator.

Stability of Coefficients

Another objective in the case study involves testing for structural charges in farmland markets by testing for stability of coefficients across time periods of rising price and initially declining farmland prices.

The statistical equation used to conduct an F-test (Chow test) for this purpose is:

$$\text{Calculated F-value} = \frac{SSE_T - (SSE_1 + SSE_2)\ /k}{(SSE_1 + SSE_2)\ /(n + m - 2k)}$$ (adapted from Maddala, pp. 198-201)

Where SSE_T = error sum of squares in entire time period (1979-1983);

SSE_1 = error sum of squares in first time period (1979-1981½);

SSE_2 = error sum of squares in last time period (1981½-1983);

k = number of parameters including intercept;

n = number of observations(sales) in first time period; and

m = number of observations(sales) in second time period.

This equation is tested for a critical value $F\alpha = 0.05$ with k degrees of freedom in the numerator and $n + m - 2k$ degrees of freedom in the denominator. In essence, the F-test compares the unexplained variables of each model for the entire time period to the sum of unexplained variance for the individual time periods. The null hypothesis of no structural change is rejected at a specified probability level of α, if the test statistic is significant. Rejection of the null hypothesis implies that parameter estimates have changed significantly between time periods.