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A Stochastic Dominance Analysis of Alternative Land Control Strategies in the Red River Valley

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Selecting a method for control of land is a major decision facing farm operators. Methods of controlling land include ownership, cash, and share renting. Ownership is the most common means farm operators use to control land in North Dakota (10). Advantages of farmland ownership include the potential for price appreciation, the ability to shelter income from taxation, security of tenure, the convenience of having a permanent physical business location, plus numerous other intangible social and family benefits.

However, land ownership exposes farmers with limited equity to substantial financial risk as funds available for debt service are highly variable. To aid beginning farmers with minimal resources state legislatures have initiated programs of direct loans, loan guarantees, and tax incentives to reduce resource control barriers to entry (11).

Both cash and crop-share rental arrangements are popular alternatives to land ownership in North Dakota. Neither rental arrangement involves the large capital outlays and financial risks associated with ownership. Cash renters, like owner/operators or farmland, are completely exposed to business risks arising from viable commodity prices, yields, and input costs. Under a share lease, landlords assume a portion of business risk and participate in managerial decision-making. When cash renting land, operators have almost complete freedom to make optimal production decisions. Main risks associated with renting involve possible termination of the contract and loss of any investments in fertility, conservation, or physical structures.

Choosing between ownership and rental of land is a complex decision involving expected capital costs, commodity prices, input costs, rates of land appreciation and tax rates in the future as well as the farmer's current financial status. Pederson and Apland, Barnes and Justus analyzed farm lease terms under conditions of risk at the enterprise level but did not consider whole-farm tax, government commodity program, insurance, or financing effects.

This paper reports results of a study where the whole-farm financial progress of a representative Red River Valley sugarbeet farm is simulated under varying tenure arrangements and operator financial characteristics. Optimal means of controlling farmland is determined by a stochastic dominance analysis of annual accrual returns to equity after capital gains and contingent tax liabilities. The following sections of the article discuss simulation of the case farm, methods of risk evaluation and results.

Simulation of Alternative Land Control Arrangements

Five land control arrangements are simulated from 1988 to 1991 with the Farm Financial Simulation Model (FFSM) developed by Schnitkey, Barry, and Ellinger. FFSM is a computerized spreadsheet of coordinated financial statements which are capable of modeling the profitability, liquidity, solvency, and financial position of a representative farm over a four-year period.[1] The five alternative land control arrangements considered in this study are full ownership (OWN), half ownership-half cash rent (PARTCASH), full cash rent (CASHRENT), half ownership-half share rent (PARTSHARE), and full share rent (SHARERENT). Information necessary to construct the representative farm was

obtained from averages of individual accounting records maintained by cash grain farmers in the Red River Valley of North Dakota (7).

The simulated farm consists of 1,120 acres and produces 545 acres of wheat, 294 acres of barley, and 280 acres of sugarbeets. Cash operating expenses and capital asset structure reflect farm averages. Input prices are assumed constant over the simulation period. Crop yields are psuedo-random sample observations obtained from multivariate beta distributions which are shown to be representative of the geographic area (13). Multi-peril crop insurance was purchased for all crops.[2]

Given the micro nature of the study and availability of government price support programs, commodity prices are assumed to be independent of yields. Three alternative crop price scenarios were developed and based on a Delphi survey of four agricultural marketing economists familiar with agricultural prices in the region.[3] Participation in government commodity programs occurs when deficiency payments exceed costs of setting aside land.[4]

Current and intermediate assets of the farm total $229,553 and $305,058, respectively for all land control arrangements. All assets are valued on a current market basis. Data on market value changes and tax depreciation of nonreal estate assets was obtained from farm records. Gross investment in nonreal estate assets ($36,275 per year) is based on record information. The simulation farm's land is of average productivity and has a current market value to $800 per acre. Land values change over the simulation period with a one-year lag in direct proportion to variations in net revenue (1, 4). Typical rental arrangements for the Red River Valley are reported by Johnson. Cash rents are assumed to be $50 per acre for small grain acreage and $65 per acre for sugarbeets. Cash rents adjust to net income variations in the same manner as land values. Share rental arrangements reflect a traditional 30/70 split of gross revenue on small grain acreage and a 1/7 split of gross revenue on sugarbeet acreage.[5] Sharerent tenants provide machinery for field crop operations and incur the production costs for all variable inputs.[6] Risks associated with termination of either the cash or share rental lease are not considered in this analysis.[7]

Production of sugarbeets requires ownership or rental of cooperative stock in a sugarbeet processing plant. At the present, sugarbeet stock can be purchased for $650 per share (9). One share is necessary for each 1.1 acres of production. Farmland owners in the simulation are assumed to possess the necessary number of shares. Cash renters must rent stock at the prevailing rate of $80 per share. Sharerent tenants must also cash rent stock because landlords typically do not own sugarbeet stock. The value of stock is assumed to adjust over time in reponse to changes in net revenue.

In addition to five land control arrangements, the financial performance of the case farm was evaluated at four initial debt-to-asset positions (0, 20, 40, and 60 percent) for each tenure pattern. Levels of current, intermediate, and long-term debt vary with indebtedness. Higher levels of indebtedness reflect more recent purchases of farmland by owners. Hence, outstanding mortgage balances are larger and repayment periods longer (i.e., 0, 10, 15, and 20 years for each debt-to-asset ratio, respectively). All current, intermediate, and long-term loans

are financed at prevailing 1988 North Dakota Farm Credit System variable interest rates.[8] Asset values are the same for all leverage positions.

The farm household is assumed to consist of four members and requires $22,715 per year for family living expenditures (7). Residual farm profits are taxed at both federal and state levels according to 1988 provisions. After-tax earnings are first used to pay down debt and then invest in market securities earning 8 percent interest annually.

The five land control methods and four respective levels of financing yield twenty management options. Each option is simulated under twelve alternative commodity yield and price environments. The twelve environments represent unique draws from the multivariate yield distributions. One of the three commodity price scenarios is then randomly assigned to each environment so as to determine government commodity program participation and gross revenues.

Risk Analysis

Risk attitudes appear to differ considerably among farmers but they are generally considered to be risk averse (14). This implies farmers are sensitive to both the variability and level of income arising from alternative tenure and financial arrangements.

Stochastic dominance (SD) was chosen to select the optimal means of controlling land because it does not require normality of the underlying distribution of income (16). SD selects the most risk-efficient strategy by comparing the cumulative probability distributions of possible returns from each activity under consideration[9]. As crop yields, and therefore returns, are assumed to be non-normal, SD is more flexible than traditional mean-variance analysis. Further, SD is consistent with the expected utility hypothesis but does not require specification of a utility function.

Optimal land control strategies are evaluated on the basis of rates of return to equity (RRE) over the simulation period. RRE provided by FFSM are based on accrual accounting and include effects of contingent tax liabilities and capital gains. RRE account for financing effects and facilitate performance comparisons of farm operators with differing levels of equity.

McCarl et al. indicate problems with the stochastic dominance criteria can arise if the alternatives are not mutually exclusive but can be used to form portfolio strategies. They state the original alternatives may be compared as long as the correlation coefficient exceeds the ratio of standard errors less a potential correction for the difference between the means. Further, they state their decision rule is highly reliable but conservative.

This study compares the performance of three tenure situations--full ownership, partial ownership, and full rental of farmland. Obviously, these are not mutually exclusive alternatives as convex combinations of the tenure arrangements are theoretically possible and empirically observed. Identification of an optimal combination is impractical and beyond the scope of this study. Nevertheless, McCarl et al.'s criterion will be employed to test membership of the risk efficient set of optimal tenure arrangements. If convex combinations cannot be eliminated, decision makers must be aware of the resulting portfolio implications and consider diversification.

Results

Means and standard deviations of returns to equity from the alternative land control arrangement/financing combinations are shown in Table 1. OWN00 refers to the farm situation of 100 percent land ownership and no debt financing. Likewise, PARTCASH20 refers to the farm situation where one half of the cropland is owned and the rest cash rented and 20 percent of the assets are debt financed. The remaining variables are similarly defined.

In all cases, returns to equity increase directly with usage of debt capital. Cash and share renting have both the highest level and greatest variability of returns. Farmland ownership provides the lowest level of returns but least amount of variability.

Results of the stochastic dominance analysis are shown in Table 2. Based on McCarl et al.'s conservative criterion, 30 percent (16/54) of the convex combinations can be eliminated. They state if the population correlation coefficient (p) between the two activities is 1, then combinations of the two are dominated. If p is negative, then the combinations cannot be eliminated and diversification should be considered. In this study, all of the correlation coefficients exceeded .94. Thus, even though the land control arrangements considered in this study are not mutually exclusive, it is unlikely alternative combinations of the activities will be significantly more risk efficient.

Under the second-degree stochastic dominance criterion, land control arrangements involving rental land dominate those of greater land ownership. Part ownership of land generally dominates full land ownership strategies with similar levels of debt financing. These strategies are in turn dominated by full rental arrangements.

Farmland ownership is unfavorable given current rental rates and values of land. The simulation analysis permitted full capitalization of revenue increases into the value of farm real estate, albeit with a one period lag. As farmers in the Red River Valley continue to purchase farmland, either current market conditions are out of equilibrium, farmland owners expect future price appreciation to be greater than levels permitted by the model, or the intangible benefits of farmland ownership are significant.

Trade-offs between business risk and financial risk are evident in the results. For example, CASHRENT20 dominates SHARERENT40. The former involves lower financial risk due to less usage of debt capital while share renting reduces business risk because the tenant's land rental payments vary directly with levels of gross revenue. Likewise, SHARERENT20 dominates OWN00. Ownership of farmland entails greater business risk but SHARERENT20 results in higher financial risk due to debt financing.

The risk efficient means of controlling farmland is more sensitive to the method of land control than the level of financing. In only one instance, SHARERENT20 and SHARERENT00, did one level of financing dominate another when methods of land control were held constant. Hence, relative and not absolute levels of debt affect the rates and variability of returns as highly leveraged tenant farmers faced financial risks similar to those experienced by farmland owners with significant amounts of debt.

In contrast to results of previous studies, cash renting generally dominated share renting in this analysis. Results of this study coincide with farmers' actual practices as 73 percent of all farmland leases in the Red River Valley are on a cash basis (8). Downside business risks associated with cash renting are reduced in the analysis because of the effects of taxation, government programs, price supports, crop insurance, and flexible rental rates.

However, the desirability of share renting is highly contingent on the relative returns to and contributions of tenants and landlords. In the simulations above, landlords made no contribution to production costs, which again is common practice in the area. Farm operations in the Red River Valley are of considerable acreage. It is not uncommon for a tenant farmer to rent land from three or more landlords. Hence, allocating expenses and obtaining collections from numerous landlords would be a considerable task.

To test the sensitivity of the share rental arrangement to expense contributions, the above simulations were replicated with share rent landlords incurring 30 percent of all seed, fertilizer, and chemical expenses. The average rate of return to tenant farmer's equity increased and arrangements involving share rent dominated both cash rental and ownership of farmland. Rate of return to equity under SHARERENT00, 20, 40, and 60 averaged may be the risk preferred method of controlling farmland as long as landlords make a contribution to expenses and costs of recordkeeping do not become prohibitive.

Conclusion

This study identifies conditions under which alternative land control methods are preferred by farmers in the Red River Valley of North Dakota. A tenant farmer's preference for a cash versus share rental arrangement is highly contingent on the terms of each arrangement. These results are consistent with observed management behavior and differ from those of past studies where share renting was the sole risk preferred means of controlling land. The willingness of tenants to incur all expenses limits the profitability of share renting while government commodity programs, multi-peril crop insurance, and current tax provisions reduce business risks associated with cash renting. In all cases, cash rental, share rental, and partial ownership strategies were preferred to full ownership of farmland. Price appreciation of the asset did not offset either the opportunity or financial costs of ownership. Intangible benefits of farmland ownership were not included in the analysis. Additional research could evaluate the importance of these benefits.

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FOOTNOTES

1. Barry describes the application of FFSM to thirteen alternative farm situations across the United States, including North Dakota.

2. Crop insurance was purchased by the majority of farmers in the farm record program who either raised sugarbeets or used debt capital.

3. Two public and two private economists were asked to specify potential low, medium, and high prices for each crop over the four year simulation period assuming each crop price scenario was equally probable.

4. Set-aside requirements for wheat and barley are 27.5 percent and 20 percent, respectively, in 1988 and 10 percent for all crops in 1989 based on government commodity program provisions. Set-aside costs involve land rental and establishment of a cover crop which is assumed to be $20 per acre.

5. Terms of the share rental arrangement were obtained from unpublished cost of production survey data obtained from Red River Valley farmers and a telephone survey of three farm and trust managers at financial institutions in the Red River Valley who were considered knowledgeable on current practices in the geographic area of interest.

6. This situation is unique in that landlord input cost participation is irrelevant. A reviewer of the article indicates that in most midwest areas, share arrangements in which the landlord pays part of the production costs are quite common, particularly if the land is managed by a professional firm.

7. Termination of a rental contract is an important source of risk in some geographic areas. In the Midwest, most farmland is leased on an annual basis--longer term leases are rare.

8. Variable interest rates in this analysis are risk adjusted according to a borrower's financial position as represented by their debt-to-asset ratio. The following interest rate schedule on nonreal estate and real estate loans is an abstraction of a local Farm Credit System association's loan pricing practices:

Borrowers Debt-to-Asset Ratio (percent)	Nonreal Estate Interest Rate (percent)	Real Estate Interest Rate (percent)
.0 - .199	11.5	10.5
.200 - .399	12.5	11.5
.400 - .599	13.5	12.5
.600+	14.5	13.5

9. The micro-computer program used to evaluate stochastic dominance was SARA (6).

TABLE 1. STATISTICAL ANALYSIS RETURNS TO EQUITY FROM ALTERNATIVE LAND CONTROL/FINANCING ARRANGEMENTS

Arrangement	Sample Mean	Standard Deviation
OWN00	.0796	.0280
OWN20	.0818	.0362
OWN40	.0887	.0488
OWN60	.0917	.0798
PARTCASH00	.0848	.0344
PARTCASH20	.0935	.0420
PARTCASH40	.1055	.0553
PARTCASH60	.1133	.1014
CASHRENT00	.1104	.0459
CASHRENT20	.1270	.0564
CASHRENT40	.1434	.0820
CASHRENT60	.1706	.1576
PARTSHARE00	.0802	.0300
PARTSHARE20	.0870	.0387
PARTSHARE40	.0973	.0512
PARTSHARE60	.0967	.0978
SHARERENT00	.0937	.0370
SHARERENT20	.0989	.0616
SHARERENT40	.1158	.0679
SHARERENT60	.1261	.1452

TABLE 2. STOCHASTIC DOMINANCE RESULTS OF ALTERNATIVE NORTH DAKOTA LAND CONTROL ARRANGEMENTS*

Superior Activities	Dominating Inferior Activities
Own00	none
Own20	none
Own40	none
Own60	none
Partcash00	Own20*
Partcash20	Own20 Own40* Own60 Partshare20
Partcash40	Own40 Own60 Partshare40 Partshare60
Partcash60	Partshare60
Cashrent00	Own00 Own20 Own40* Own60* Partcash00 Partcash20 Partcash40* Partshare00 Partshare20 Partshare40* Partshare60 Sharerent00 Sharerent20*
Cashrent20	Own00 Own20 Own40 Own60* Partcash00 Partcash20 Partcash40 Partcash60 Partshare00 Partshare20 Partshare40 Partshare60* Sharerent40 Sharerent60
Cashrent40	Own60 Partcash60* Partshare60* Sharerent40 Sharerent60
Cashrent60	Sharerent60
Partshare00	Own00
Partshare20	none
Partshare40	Own40 Own60
Partshare60	none
Sharerent00	Own00 Own20 Own40* Own60 Partcash00 Partcash20* Partshare00 Partshare20*
Sharerent20	Own00 Own20 Own40* Own60 Partcash00 Partcash20* Partcash40 Partshare00 Partshare20* Partshare40 Partshare60 Sharerent00
Sharerent40	Own60* Partcash60 Partshare60*
Sharerent60	none

*Denotes convex combinations of the two activities can be disregarded according to McCarl et al.'s criterion.