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ANALYZING TENURE ARRANGEMENTS AND CROP ROTATIONS USING FARM SIMULATION AND PROBIT ANALYSIS

Gregory M. Perry, M. Edward Rister, James W. Richardson, and Warren R. Grant

Abstract

Whole farm simulation analysis and econometric techniques are employed in an analysis of crop rotations and tenure arrangement strategies. The FLIPSIM model is used to analyze a representative Texas Upper Gulf Coast rice and soybean farm. Probit analysis is then used to determine the impact of net cash farm income, land tenure, and crop rotation on probability of survival. Results suggest that, although the simulation model is useful in providing information on the effect at the farm level of following the different strategies, probit results provide greater understanding into the returns and risk inherent to each strategy.

Key words: simulation, survival, probit, risk, rotation, tenure.

Numerous approaches have been used to study crop rotation or land tenure arrangements. Some of the most common methods include whole-farm budgeting (Johnson), linear programming (Heady; Musser et al.), quadratic programming (Freund), and MOTAD (Apland et al.). Despite the proliferation of research in this area, few studies have jointly analyzed both crop rotation and land tenure strategies. Apland et al. as well as Brandao et al. recently conducted joint analyses of these factors using MOTAD as the modelling framework. In both cases, however, the analysis was limited to a single period. In addition, government farm program and income tax considerations for the firm were excluded from the analyses.

Some researchers have also utilized simulation modelling as an approach to analyzing crop rotations and (or) tenure arrangements. A study by Hoskin, for example, applied stochastic dominance decision criteria to rank crop rotations common in the Saginaw Valley of Michigan, assuming a constant tenure arrangement. Pederson, on the other hand, evaluated optimal tenure arrangements and crop rotations for farm operators and landowners in North Dakota. He found farm operators could benefit from more flexible rental arrangements if landowners were willing to negotiate lower base rents in exchange for a share of the gains from price and yield variability. Pederson used a simple accounting approach (i.e., price times yield minus cost), thus ignoring effects of income taxes, government farm programs, and firm financial situation, among other factors.

A detailed whole-farm simulation model represents an approach that is very useful and amenable to simultaneous evaluation of crop rotations and tenure arrangements. In addition, in-depth analysis of such simulation results facilitates identification of preferred rotation-tenure combinations. Use of simulation permits analysis of different crop mixes and tenure arrangements under conditions of price and yield uncertainty and in a multiple-year setting. The impact of rotation and ten-

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ure arrangement on long-term survival and viability of the farm operation can be more clearly analyzed. Effects of government programs, management, financial position, and income tax considerations on the set of strategies under consideration is also more easily identifiable. A detailed whole-farm simulation approach, then, provides information to researchers, extension personnel, and farm operators that cannot be obtained as easily from other approaches.

The Upper Gulf Coast region of Texas was chosen as the setting to demonstrate the usefulness of simulation in analyzing crop rotations and tenure arrangements. This region has traditionally been one of the major rice-producing regions in the United States. The region benefits from level land, a long growing season, close proximity to seaports, and a clay subsoil that is ideally suited for holding irrigation water reserves.

For many years, rice was produced under a government-imposed acreage allotment/marketing quota program. As a result, rice was a low risk, high profit crop. Rice was, in fact, the only crop produced on many Upper Gulf Coast farms.[1] Since suspension of marketing quotas in 1974 and institution of a target price program in 1976, however, the situation has completely changed. Although rice exports have increased since 1973, they have also become more volatile. The combination of a change in government policy and fluctuating export demand has resulted in higher United States rice price volatility. Upper Gulf Coast rice producers are now faced with lower returns and greater risks than they have experienced in several decades. The search for profitable alternative crops and adjustments to existing land tenure arrangements are both receiving widespread attention among Upper Gulf Coast Texas farmers.

The major objective of this paper is to suggest an approach for identifying crop rotation-tenure strategies that enhance the economic viability of tenant producers. A whole-farm analysis is used in the study. After identifying preferred crop rotation and tenure arrangements from among those examined, the remaining discussion is devoted to identifying the underlying factors influencing preference rankings. Specifically, what influence does expected income and inherent riskiness of each strategy have on the overall ranking of the strategies? For purposes of simplicity, only two major crop rotations and two tenure arrangements are analyzed in this study. The farm is assumed to follow the same crop rotation and tenure arrangement for all farm acreage. The method of analysis is extendable to additional crops and tenure arrangements in Texas and throughout the United States.

STUDY ASSUMPTIONS

The suggested approach involves use of a whole-farm simulation model appropriate for achieving the objectives of this study. An updated and expanded version of the FLIPSIM V model developed by Richardson and Nixon was used to conduct the simulation analyses. The computer model is a firm level, recursive, Monte Carlo simulation model which simulates annual production, farm policy, marketing, management, and income tax parameters of a farm over a specified planning horizon.

To accomplish the objectives of this study, four crop rotation-tenure arrangement strategies were simulated over a 5-year period, 1984-1988. The model recursively simulates the farming operation by using the current year's ending financial position as a beginning financial position for the next year. A total of 50 iterations (or replications) was performed for each strategy simulated.[2]

Two criteria were used to evaluate the different strategies: (a) the probability of survival and (b) the Net Present Value (NPV) of farm earnings over the planning horizon. Probability of survival is the probability that, for each year in the 5-year period, the farm operator will be able to maintain the farm's intermediate and long-term equity ratios at greater than minimum levels established by local financial institutions.

The NPV figure represents the present value of ending net worth for the farm, plus yearly family cash withdrawals discounted to the present, minus beginning net worth and discounted annual off-farm income. A positive NPV is denoted as an economic success since farm income, plus the change in net worth, generated a greater return than an alternative after-tax return available from off-farm investments. A pre-tax discount rate of 11 percent was used in the NPV calculations.

[1]During this period, rice was grown in rotation with pasture.

[2]The initial results were also examined using 100 iterations. No significant difference was observed between the two solutions.

The farm size used in the study was 2,310 acres, of which 2,300 acres were share-leased and 10 acres were used as a farmstead. The representative farm, located in Liberty County, Texas, is larger than the average farm in the county but is typical of the farms controlling most of the farmable acreage.

Crop rotations examined in this study are two of the most common in Liberty County, namely: (a) 2 years of soybeans followed by 1 year of rice (SSR) (i.e., 2/3 of the farm in soybeans and 1/3 in rice each year), and (b) 1 year of soybeans followed by 1 year of rice (SR). The principal advantages of the SSR rotation are the lower incidence of red rice,[3] higher expected rice yields, lower demand for inputs (particularly water and labor), and lower short-term demand for financing. The principal advantage of the SR rotation is the greater acreage of rice, generally the more profitable of the two crops.

Economic theory in the area of tenure arrangements suggests a particular share arrangement is largely determined by the landowner, who lowers his/her share demanded just enough to entice the farmer to rent (Cheung; Sutinen). Actual observation indicates that, although landowners do have a major say in the arrangement chosen, traditional arrangements tend to persist year-after-year in a particular region.

The two crop-share, land rental arrangements analyzed were: (a) 1/2 of the crop to the landowner for rice acreage and 1/7 of the crop to the landowner for soybean acreage and (b) 1/7 of the crop to the landowner for both rice and soybean acreage. The 1/2 share arrangement is the most common for Texas rice acreage (Mullins et al.; Griffin et al.). Under a 1/2 share arrangement, the landowner provides land, water, and seed, and pays 1/2 of the sales commissions and fertilizer, chemical, chemical application, hauling, and drying costs. In return, the landowner receives 1/2 of the harvested crop or equivalent revenue.

The 1/7 share arrangement is the typical tenure arrangement in Liberty County for land in soybean production and is also used for rice production (Boldt). Under the 1/7 share arrangement, the landowner provides only land and pays 1/7 of the drying, hauling, and sales commission costs, receiving in return 1/7 of the harvested crop or equivalent revenue.

Minimum equity levels were set in the model, assuming additional financing could not be obtained if equity fell below 33 percent.[4] This figure represents the minimum equity level allowed by Liberty County banks and is extended only to farmers with an otherwise excellent financial record. Beginning equity position was 60 percent, a typical level for a wholly-leased farm in Liberty County (Jeffrey).

Family living expenses were allowed to vary from $18,000 to $25,000 per year, depending on farm income. The assumed marginal propensity to consume was .45 (Richardson and Nixon). The producer held $20,000 in off-farm investments and also had a $5,000 cash reserve at the beginning of the simulation period. Off-farm income was $16,000 per year.

Key assumptions in the study were the mean annual prices and yields for rice and soybeans over time and the distributions about each mean. Empirical distributions for crop yields were subjectively estimated by farmers and agricultural experts in the Liberty County area. The means of the yield distributions were increased over time based on expectations of agronomists at the Texas Agricultural Experiment Station near Beaumont (Turner; Sij). Price distributions were generated using historical data from the period 1974-1983. Means of the price distributions were changed over time using predictions made by COMGEM (Penson et al.) and by an econometric model developed by Grant et al. Correlations between random variables were estimated using county level historical data.[5] Based on these data, the model generated random values for annual prices and yields from multivariate empirical distributions.

It was assumed the producer participated in government programs for both soybeans and rice. The 1981 Farm Bill target price and loan rate levels for both crops were assumed to be continued in the 1985 Farm Bill. This assumption resulted in a national target price

[3]Red rice is an undomesticated rice variety which, when mixed with domestic rice, lowers the appeal of the rice to consumers. Accordingly, the presence of red rice results in a lower grade and price for the rice lot. In addition, field yield losses are incurred because of the competition for nutrients between the domestic and red rice plants (Diarra et al.).

[4]This required ratio level implies at least one of every 3 dollars of farm assets must be owned by the farm operator. The minimum equity ratio is equivalent to a debt-to-asset ratio of .67 and a leverage ratio of 2.0.

[5]Although combining objective and subjective data in this manner is a violation of Bayes Theorem, the difficulty in eliciting correlation values from farmers necessitates the approach used (Bessler).

TABLE 1. RESULTS FOR SIMULATION OF A 2,300 ACRE LIBERTY COUNTY, TEXAS RICE AND SOYBEAN FARM UNDER ALTERNATIVE LAND TENURE AND CROP ROTATION STRATEGIES

Analysis variables	Rotation and tenure alternative			
	SSR rotation		SR rotation	
	1/2 Share[a]	1/7 Share	1/2 Share[a]	1/7 Share
Probability of survival (%):[b]	50	82	72	78
After-tax net present value ($):[c]				
Mean	−207,167.	−23,183.	−132,641.	−52,266.
Standard deviation	188,318.	213,605.	177,131.	193,744.
Maximum	225,998.	456,226.	250,238.	350,701.
Minimum	−531,767.	−478,900.	−490,366.	−487,218.
Mean annual government payments ($):[d]	29,820.	47,750.	44,003.	56,702.
Mean yearly cash farm income ($):[e]	−25,958.	23,677.	−3,459.	16,536.

[a]Share for rice only; share for soybeans is 1/7th.
[b]Probability of survival is the probability that the farm will maintain its equity ratios at greater than minimum levels established for local financial institutions.
[c]After-tax net present value is the present value of the net annual family withdrawals plus the present value of change in net worth over the 5-year planning horizon.
[d]Total government payments were limited to $100,000 for the farming operation.
[e]Cash farm income is total receipts plus government payments minus all cash production/harvest expenses.

of $11.90/cwt. for rice and national loan rates of $8.00/cwt. and $5.02/bushel for rice and soybeans, respectively, for all years in the study period. Because most farms of the size analyzed involved more than one ASCS approved entity (i.e., it is common for more than one person involved in the farming operation to be eligible for deficiency payments), a $100,000 payment limitation was assumed for the farm unit (Lin et al.).

RESULTS AND ANALYSIS

Simulation Analysis

Simulation results for the four crop rotation-tenure arrangement strategies considered are summarized in Table 1. The soybean-soybean-rice rotation with a 1/7 crop-share arrangement (SSR-1/7) offered the highest probability of survival (82 percent) for the four strategies examined. The soybean-rice rotation under a 1/7 crop-share arrangement (SR-1/7) offered a 78 percent probability of survival, highest for the two soybean-rice rotation strategies. The SR 1/2 strategy offered a higher probability of survival than the SSR 1/2 strategy. All four strategies exhibited a 50 percent or greater probability of survival.

Average after-tax net present value (NPV) was also highest for the SSR 1/7 strategy. The discount rate used in calculating NPV represents the after-tax return obtained if the value of assets and debt level held by the farmer were in a low-risk, off-farm investment. Interest expense associated with debt caused returns to be taxed at a lower rate than if no debt were held, resulting in a higher after-tax discount rate than occurs in a no-debt situation. Results imply the farm operator would, on average, receive a higher return to his off-farm investment than the return generated by the farm investment.

These negative NPV results do not necessarily imply the farmer's long-run probability of survival approaches zero. If the farmer has little or no debt and is willing to accept a lower return than the after-tax discount rate assumed (varying according to the debt level, related interest expense, and associated income tax bracket), he may continue in farming for many years. Off-farm income, which is not included in the NPV results, may be sufficently large to offset farm losses.

One approach frequently used in identifying preferences among stochastic outcomes is stochastic dominance (Hadar and Russell). First-degree and second-degree stochastic dominance were used to rank the NPV cumulative distributions for the strategies examined. Results indicated the SSR 1/7 and SR 1/7 strategies were first-degree co-dominant over the two 1/2 crop-share strategies. The SSR 1/7 strategy dominated the other three strategies under second-degree stochastic dominance criteria. The two SR rotation strategies, in turn, were second-degree co-dominant over the SSR 1/2 strategy.

Major factors influencing the general superiority of the SSR 1/7 strategy in farm survival, NPV, and stochastic dominance analyses were assumptions regarding the price discount for red rice, high intermediate-term financial demands, rental arrangements, differences in yields, and the value of diversification. The SSR rotation benefited from higher rice prices because of the lower incidence of red rice. Expected yields for rice were also about 4 cwt. (8 percent) per acre higher under the SSR rotation. The result was a bonus of $.27/cwt. for rice and a approximate $.60/cwt. (or 5 percent) reduction in production costs.

Government deficiency payments to the tenant were much higher for the 1/7 share strategy, resulting in more cash income. Under the 1/2 share arrangement, 1/2 of all government payments went to the landowner. The results, thus, were higher per acre rents and lower net returns for the 1/2 share operators. The government program basically protected all strategies from price risk, although the payment limitation was reached in some years under the SR 1/7 strategy.[6]

Producers operating under all four strategies had to meet high levels of principal and interest payments, particularly for farm machinery and equipment loans. Under the 1/2 share arrangements, there apparently was not enough profit generated to meet these high fixed cost cash flows during a bad year. The government program provided more protection against large losses in low price years for the 1/7 share producer, while still allowing the producer to receive most of the benefits from a good year. Years of high prices and (or) yields tended to generate enough surplus income to meet financial obligations during adverse years. Also, in several instances, insolvency occurred for the SSR 1/2 strategy as a result of bad soybean prices and (or) yields, even when rice prices and (or) yields were excellent. Because the tenant gave the landowner 50 percent of the rice crop, soybeans were the principal crop in the SSR 1/2 and SR 1/2 strategies. The 1/2 share arrangement, then, seemed to offset the principal benefit of crop diversification, i.e., risk reduction.

Probit Analysis

An advantage in using Monte Carlo models such as FLIPSIM is in the evaluation of returns and riskiness of returns in a multi-year setting. Yet, the complexity of the model often makes it difficult to fully understand why particular results were obtained. Geoffrion suggests the primary purpose of programming models (and, one could add, simulation models) is to gain insight into the particular questions being evaluated; that is, to spur the researcher into an investigation of the results that ultimately will yield further understanding of the factors involved and their interactions.

One common method of gaining further insight is through perturbing the important parameters of the model and observing the results, i.e., sensitivity analyses. This approach was used extensively in this particular study and subsequent results are given further treatment elsewhere (Perry et al.). Nevertheless, sensitivity analyses do not always provide all information sought by the researcher(s). Consider as an example the probability of survival generated for each strategy. Although many reasons were given to explain the relative rankings of the probabilities of survival for the different strategies, all were related to expected returns and (or) variability of returns for each strategy.

The survivability figure reflects the combined effects of returns and risk (or variability of returns) on farm survival. It is not clear from the results, however, what part returns and risk each played in generating the final survivability value. Does the SSR 1/7 strategy, for example, dominate the other three strategies because it generates a much higher return, or alternatively, because returns are less variable? An analysis which is able to separate risk and income factors influencing simulation results could provide further information about the different strategies and suggest how they could be altered to enhance the probability of survival.

If average net returns across the 5-year period were the same for all strategies, the riskiness of each strategy could be more readily identified. The strategy with the highest probability of survival at a given average income level could be termed the least risky at that income level. This measure of risk could more properly be labelled the inherent risk level, because it reflects the structural or built-in risk associated with each strategy's particular combination of price and yield distributions. As will be demonstrated later, a direct relationship exists between inherent risk and risk premiums. Holding income or probability of survival constant across all strategies would be a difficult task to perform

[6]Although per acre government payments were less under the SR rotations, the larger amount of rice acreage caused the operator using the 1/7 share arrangement to have more total government payments and thus reach the payment limitation more often than for other strategies.

using standard sensitivity analyses. For this reason, econometric techniques were utilized to conduct the analysis.

In the simulation analyses previously discussed, a set of prices and yields were generated for each year, for each of 50 iterations. FLIPSIM then simulated operation of the farm for the entire 5-year period, following the specified crop rotation-tenure arrangement strategy. If farm equity remained above the minimum level during each of the 5 years simulated, the farm operation was declared to have survived in that iteration. When particular combinations of factors occurred such that the credit criterion was violated, the operation was declared insolvent. For convenience in presentation, the variable Y_{it} is created to represent the numerous factors affecting farm survival, such as gross income, beginning debt, costs of production, etc. Further, a dichotomous variable Z_{it} can also be created and represented mathematically as:

$$(1)\quad Z_{it} = \begin{cases} 0 \text{ if } Y_{it} < Y_t^* \\ 1 \text{ if } Y_{it} \geq Y_t^*, \end{cases}$$

where Y_t^* is the particular combination of factors needed by the t^{th} strategy to survive and Y_{it} is the actual combination of factors realized in the i^{it} iteration by the t^{th} strategy. If Y_t^* is the same for all strategies, all have the same inherent level of risk. If Y_t^* differs between strategies, the difference can be defined as a pseudo-risk premium. Traditionally, the risk premium concept has been used to equate in utility values a risky prospect with a certainty equivalent (Anderson et al.). In the present study, however, the pseudo-risk premium represents additional compensation needed to equate (in terms of farm survival) two strategies having unequal risk levels.

Extending the analysis further, one can identify lower Y_t^* levels at which a probability (S_{it}) exists such that Z_{it} equals 1. That is,

$$(2)\quad S_{it} = P(Z_{it}=1) = F[H(X_{it};\beta)],$$

where P represents probability, F is a cumulative standard normal distribution function, H is the standard deviation unit (or Z value), X_{it} is a set of explanatory variables, and β is a vector of parameters estimated using a maximum likelihood probit model (Amemiya).

Quantal response models are commonly used by biometricians and econometricians when conducting analyses of univariate dichotomous models. Amemiya, in an extensive discussion of quantal response models, identifies three types commonly used in research: (a) linear probability models, (b) probit models, and (c) logit models. With data constrained to lie between 0 and 1, the linear model has the defect that kinks must be introduced into the functional form to prevent values above 1 or below 0. With regard to the other two models, Amemiya concludes that, "Because of the close similarity of the two distributions [upon which the models are based], it is difficult to distinguish between them statistically unless one has an extremely large number of observations." (p. 1,487). Hanushek and Jackson add that "Since the logistic estimator is very similar to the probit estimator, the choice between logit and probit is largely one of the convenience and program availability." (p. 204). In keeping with this advice, the probit model was used in the analysis.

The explanatory variables included in the probability of survival equation are income, rotation, and tenure arrangement. The income variable used (NETINC) is average net cash farm income (in thousand dollars) simulated for the 1984-1988 period.[7] Net cash farm income is calculated in the model as total cash receipts plus government payments minus all cash production and harvest expenses. Rotation and tenure arrangement are represented using shift variables. A value of 1 for ROTATION indicates a SSR rotation, with a 0 representing the SR rotation. A value of 1 for RENT dictates a 1/2 share arrangement, with a 0 value representing the 1/7 share arrangement. The estimated probit model is:

$$(3)\quad H(X_{it};\beta) = \underset{(1.07)}{3.6758} + \underset{(.062)}{0.1965}\,\text{NETINC} + \underset{(.89)}{1.2138}\,\text{RENT} + \underset{(.92)}{1.4685}\,\text{ROTATION}$$

Standard errors are given in parentheses; however, they should not be used for variable selectivity because the data used to estimate lation model data (Candler and Cartwright).

[7]Net cash farm income and NPV were highly correlated in the study results. In fact, stochastic dominance results using net cash farm income were virtually identical to stochastic dominance results for NPV.

As a method of evaluating the probit model, the percent of correct forecasts was estimated. The percent of correct forecasts (C) is defined as:

$$(4)\ C = \left(1 - \frac{\sum_{i=1}^{n} (Z_{it} - \tilde{Z}_{it})^2}{n}\right) \bullet 100,$$

where:

$$(5)\ \tilde{Z}_{it} = \begin{cases} 0 \text{ if } \tilde{S}_{it} \leq .5 \\ 1 \text{ if } \tilde{S}_{it} > .5, \end{cases}$$

$\tilde{S}_{it}$ is the estimated probability from equation (2), and n is the number of observations. The probit model had 98 percent correct forecasts.

RENT has a positive coefficient in equation (3), indicating that, when NETINC and ROTATION are held constant, the farm operator with a 1/2 share rental arrangement has a higher probability of survival than under the 1/7 share arrangement. The positive coefficient for ROTATION suggests producers following the SSR rotation have a higher probability for survival than do those producers who follow the SR rotation, when NETINC and RENT are held constant.

Perhaps the best way to understand the probit results is by means of a graphic illustration. Predicted probabilities of survival at different income levels are presented in Figure 1 for the four strategies considered. When the figure is first examined, it may seem odd that the farmer can generate an average annual loss for the farming operation and still guarantee survival through 1988. The beginning equity position (60 percent) for the farm was somewhat higher than the minimum equity level (33 percent) needed to continue farming and off-farm income more or less offsets family living expenses. Because of these two factors, the farm operation could generate a small annual loss and yet not be in serious danger of financial insolvency.[8]

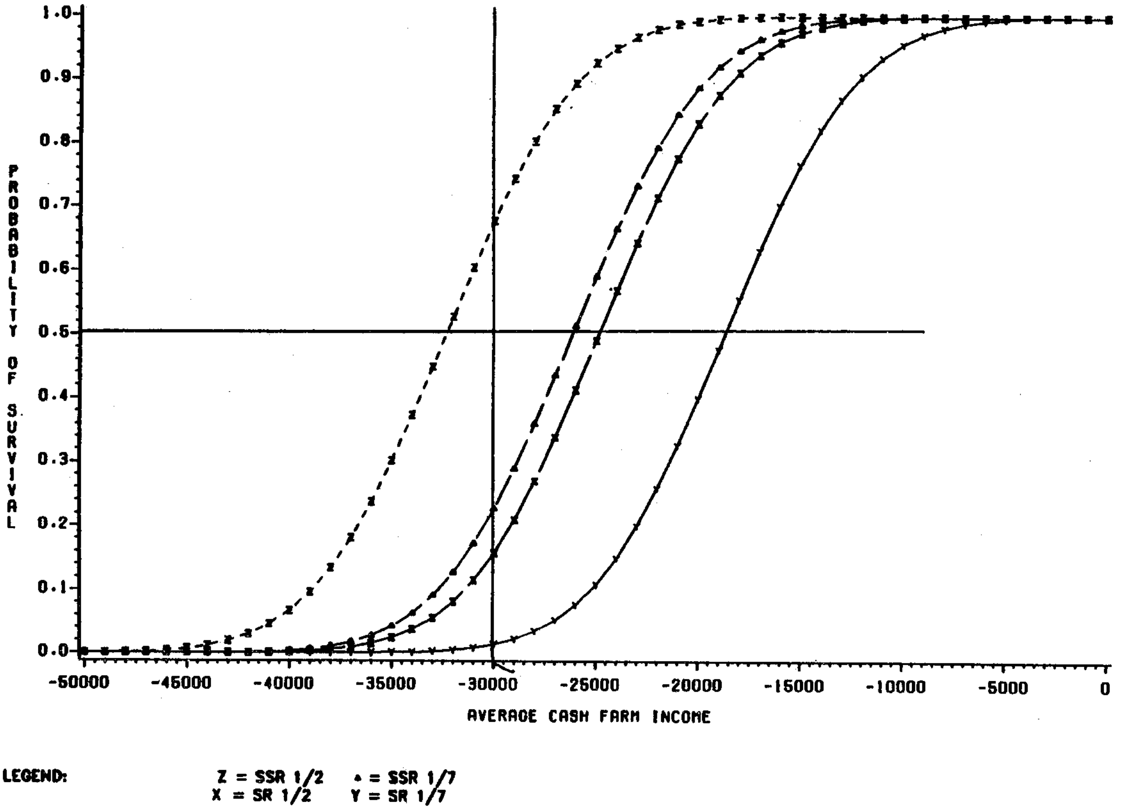

Figure 1. Probabilities of Survival for Each Strategy with Changes in Net Cash Farm Income.

[8]Although the results in Figure 1 appear very amenable to analysis using stochastic dominance, such is not the case. Stochastic dominance is used to analyze cumulative density functions representing probability of occurrence rather than probability of survival.

The inherent riskiness of each strategy relative to the other strategies is calculated as the difference in survival probabilities between strategies at a given income level. At average net cash income levels of \$−50,000 or less, all strategies offer essentially a zero probability of survival. Similarly, at average cash income levels above zero, all strategies offer essentially a 100 percent chance of survival. At a average income of \$−30,000, however, the inherent riskiness of each strategy is clear. The SSR 1/2 strategy represents the least risky strategy with a predicted probability of survival equal to 68 percent. At the other extreme, the SR 1/7 strategy offers only a 1 percent probability of survival at the \$−30,000 income level. The SSR 1/7 and SR 1/2 strategies are quite similar, generating survival probabilities of 23 and 16 percent, respectively, at the \$−30,000 income level.

The psuedo-risk premium (as indicated in Figure 1) is the horizontal difference between strategies at a given probability of survival. At a 50 percent probability of survival, psuedo-risk premiums of \$14,000 for the SR 1/7, \$8,000 for the SR 1/2, and \$7,000 for the SSR 1/7 are required to equate these strategies with the SSR 1/2.

It is not surprising that the 1/2 share arrangement is less risky than the 1/7 arrangement. The purpose of using the 1/2 arrangement is to permit the landowner to share in the production risk in exchange for a higher proportion of the crop. The poor performance for the 1/2 share strategies (particularly the SSR 1/2) in the simulation results reported in Table 1 suggests the need for landowners to make adjustments in rental arrangements so returns to the tenant are more in line with risk shared.[9]

The lower inherent risk level of the SSR versus SR rotation is somewhat more surprising, given the current farm program for rice and the high level of management used by farmers to reduce production uncertainty. These factors would suggest rotations containing a greater proportion of rice would be less risky. Per acre costs of production, however, are much higher for rice than soybeans. In fact, even under the 1/2 share arrangement, where many costs are paid by the landowner, the remaining per acre production costs paid by the farmer to produce an acre of rice are nearly twice those incurred for an acre of soybeans. These higher costs can result in large losses during years of low rice prices and (or) yields. Rice production, then, is the more important source of risk to the farmer. Because rice also generates a much higher expected return than soybeans, however, the net effect of rice acreage is to improve probabilities of survival for the SR rotational strategies.

The probit results initially appear contradictory to the stochastic dominance results presented earlier; however, this is not the case. Stochastic dominance rankings demonstrated the combined influence of returns and risk on preferences for different strategies. Use of the probit model provided additional insight by separating the income and risk components influencing the simulation and stochastic dominance results.

SUMMARY AND CONCLUSIONS

The purpose of this paper was to suggest an approach for evaluating crop rotations and tenure arrangements. A representative farm in the Upper Gulf Coast region of Texas was used in the analysis. The FLIPSIM model was used to conduct the analysis for the 1984-1988 study period.

Simulation results suggest that the preferred crop rotation between rice (R) and soybeans (S) strategy depends on the tenure arrangements under which the farmer is operating. If a 1/2 share arrangement is used for rice, SR is the preferred rotation; if the 1/7 arrangement is in effect for rice, SSR is the preferred rotation. The government farm program, higher yields for rice, and lower incidence of red rice all contribute to the dominance of the SSR rotation under a 1/7 share arrangement. Regardless of the rotation, the tenant would prefer the 1/7 share arrangement.

Probit analysis facilitated separation of income and risk factors influencing the simulation results. Probit results suggest poor performance for the SSR 1/2 strategy and strong performance of the SR 1/7 strategy

[9]The downturn in the agricultural economy has, in fact, caused some movement away from traditional arrangements. Several farmers in the study area reported they have received major concessions from the landowners during the last few years (Dishman).

and largely tied to level of annual income. The SSR 1/2 stragety was inherently the least risky strategy but also had the lowest expected income, while income generated by the SR 1/7 strategy was much more volatile. Adjusting share arrangements to increase the portion of the crop going to the tenant, while maintaining the same cost-share arrangement, could well make the SSR 1/2 the predominant strategy.

The results provide a basis for determining how tenure arrangements might be renegotiated to enhance producer's chances for future survival. Strategies in which income levels are a hinderance to tenants' survival could be improved by reducing the landowner's share of the crop. When riskiness of income under a strategy is judged excessive, the proportion of production costs borne by the landowner could be increased. As the results suggest, rotational preferences differ with tenure arrangements and vice versa. An attempt to create crop rotation-tenure arrangement strategies that are of equal utility to producers may require crop-share arrangements that change with changes in crop rotation.

Probit results may also suggest why some persons exhibit risk aversion behavior and others attempt to maximize profits. At high income levels, the inherent riskiness of each strategy has no effect on survival of the farm, thus allowing the producer to select a strategy which maximizes profits. At lower income levels, however, inherent riskiness becomes a factor in survival and individuals give it consideration in deciding which cropping and tenure strategy to follow. The influence of risk in farmer's decisions then depends on what influence risk has on continued farm survival.

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