1985

Farm survival under uncertainty

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by

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A Thesis Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

Department: Economics

Major: Agricultural Economics

Signatures have been redacted for privacy

Iowa State University
Ames, Iowa

1985

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CHAPTER 1: INTRODUCTION AND OVERVIEW

Agriculture is an industry which is characterized by rapid and sweeping change, change which can have adverse effects on individual agricultural decision-maker producers who are either unwilling or unable to adapt their firms rapidly enough to accommodate the changes in the economic environment in which they operate. Recent economic events which have caught a number of farmers unaware include a tightened national monetary policy resulting in increasing interest rates and a declining rate of inflation, depressed farm commodity prices as a result of record-breaking levels of production and a decline in export volume, and finally a drop in farmland values (Cox, 1982; Petzinger, 1981; Shellenbarger, 1982). Hence, the wary farmer entering the mid-1980s must carefully evaluate his farm firm's capacity to accommodate change if his firm is to survive the present period of adversity whatever its duration.

The casual observations of a fundamental change in the economic environment in which agricultural production takes place noted above are readily documented more formally. The historical background provided by Hughes (1981) cites five major factors which can be considered to be catalysts for continued rapid change in agriculture:

1) Mechanization of crop production and confinement feeding of livestock have resulted in the substitution of capital inputs for farm labor, a substitution which makes the farmer more dependent on nonfarm produced inputs.

2) Increased returns to fixed factors of production and increased costs of these factors have been generated by increased agricultural exports and certain government agricultural policies.

3) With increased fixed costs and reliance on international trade, net returns before government payments are less stable. In the increasingly risky environment, producers have turned to the government for debt capital rather than curtailing the amount of debt used to finance the farm business.

4) The structural alignment of the farm sector is characterized by farm enlargement resulting in fewer and larger farms. As persons leaving agriculture carry their accumulated wealth with them, those who remain and new entrants must capitalize these sector specific inputs with a greater per capita debt load. An increased debt load removes a layer of the sector's insulation from the rest of the economy.

5) Farmers are no longer self-sufficient; consumption expenditures for farmers are now more rigid.

In a comparable summary, Boehlje (1979, 1981) attributes the changes occurring in agriculture today to the impact of a changing technology on the farmer's production function resulting in the generation of increased output per unit of input, a capital for labor substitution, a greater reliance on purchased inputs, an attendant requirement for a greater supply of funds per farm, and finally, a reduced profit margin. As off-farm inputs were added to the production milieu and increased processing of farm-produced outputs occurred in response to technological developments, profit margins tightened and farmers sought to maintain incomes by expanding in size and scale (Ball and Heady, 1972). Development and adoption of new technologies dictated a greater current capital requirement for the agricultural producton process coupled with increased replacement costs. The net increase in costs of technologically advanced inputs with greater productivity coupled with increasing farmland prices led to a five-fold increase in the agriculture sector's asset base from 1960 to 1983 as shown in Table 1.1.

The major component of the asset base of the agricultural sector is farmland. As shown in Table 1.2, the real estate component of the asset side of agriculture's balance sheet has grown from a 65 percent share of all assets in 1960 to a 76 percent share in 1982 as the relative values of other asset components, especially crop and livestock inventories, financial assets, and household assets, have declined. Though the sector maintains a strong financial position with respect to the appreciation of asset values, the financial position has become increasingly illiquid.

Significant changes have occurred in the liabilities side of the sector's balance sheet over the past two decades as well as displayed in Table 1.3. Debt accumulation exceeded asset accumulation during the decade of the 1960s whereas debts and assets accumulated at approximately the same rate during the decade of the 1970s. In the first two years of the 1980s, however, debt accumulation once again surged ahead of asset accumulation leading to a debt to asset ratio of approximately 18 percent. However, this aggregate debt to asset ratio significantly understates the average debt to asset ratio for farmers who borrow money. Data from the most recent Iowa Farm Finance Survey (Iowa Dept. of Agriculture, 1984)

Table 1.1. Assets of the agricultural sector (including households)[a]

Year	Physical assets: Real estate	Physical assets: Nonreal estate	Financial assets	Total assets
	billion dollars			
1960	137.2	54.8	18.1	210.2
1965	167.5	56.9	19.4	243.8
1970	215.8	76.3	22.8	314.9
1971	223.2	78.8	24.0	326.0
1972	239.6	86.5	25.7	351.8
1973	267.3	99.8	27.8	394.8
1974	327.8	120.9	30.0	478.6
1975	359.7	113.7	29.2	502.6
1976	418.1	126.4	31.8	576.3
1977	496.4	134.2	33.5	664.2
1978	554.7	147.5	34.3	736.3
1979	655.0	180.4	38.0	873.4
1980	755.9	208.8	40.1	1,004.8
1981	830.0	218.9	42.2	1,091.0
1982	823.8	223.2	44.8	1,091.8

[a]From Economic Indicators of the Farm Sector, 1983.

Table 1.2. Balance sheet components for the agricultural sector (including households)[a]

	1960	1970	1980	1981	1982
	Percent				
Assets					
Physical assets					
Real estate	65.3	68.5	75.2	76.1	75.5
Nonreal estate					
Livestock and poultry	7.2	7.5	6.1	5.6	4.9
Machinery and motor vehicles	10.8	10.2	9.7	9.4	10.2
Crops stored on and off farm	3.7	3.5	3.3	3.3	3.4
Household equipment and furniture	4.4	3.0	1.7	1.8	2.0
Financial assets					
Deposits and currency	4.4	3.8	1.6	1.5	1.5
U.S. savings bonds	2.2	1.2	0.4	0.3	0.3
Investments in cooperatives	2.0	2.3	2.0	2.0	2.2
TOTAL	100.0	100.0	100.0	100.0	100.0
Liabilities					
Real estate debt	48.8	55.0	52.2	52.5	52.4
Nonreal estate debt					
Excluding CCC loans	46.5	39.9	44.6	44.6	43.5
CCC loans	4.7	5.1	3.2	2.9	4.1
TOTAL	100.0	100.0	100.0	100.0	100.0

[a] From Economic Indicators of the Farm Sector, 1983.

Table 1.3. Liabilities of the agricultural sector (including households)[a]

Year	Real estate debt	Nonreal estate debt	Total liabilities	Proprietor's equity	Debt-to-asset-ratio
	--------------	billion	dollars	--------------	(percent)
1960	12.1	12.7	24.8	185.4	11.8
1965	18.9	17.9	36.8	207.0	15.1
1970	29.2	23.8	53.0	261.9	16.8
1971	30.3	24.2	54.5	271.5	16.7
1972	32.2	26.9	59.1	292.7	16.8
1973	35.8	29.5	65.3	329.5	16.6
1974	41.3	32.8	74.1	404.4	15.5
1975	46.3	35.5	81.8	420.8	16.3
1976	51.1	39.7	90.8	485.5	15.8
1977	56.6	46.1	102.7	561.6	15.5
1978	63.6	55.7	119.3	617.0	16.2
1979	70.8	65.7	136.5	736.9	15.6
1980	82.7	75.7	158.4	846.4	15.8
1981	92.0	83.2	175.2	915.8	16.1
1982	102.0	92.9	194.9	896.9	17.9

[a] From Economic Indicators of the Farm Sector, 1983.

indicate that 65 percent of the outstanding farm debt in the sample was held by the 28 percent of operators with debt to asset ratios exceeding 40 percent. Moreover, the figures of Table 1.3 are based on market value for assets rather than cost due to the dominant position of a nondepreciable asset, land, in the sector's balance sheet. If the sector's assets were valued at the lesser of cost or market value, agriculture's debt to asset ratio would be much higher in view of the rapid appeciation of farmland value during the past fifteen years.

Hence, a casual observation of agriculture's balance sheet reveals three significant developments:

1) With a debt to asset ratio of less than 20 percent, subject to the comments on the measurement of this ratio mentioned above, agriculture as a sector is in a strong financial position with regard to solvency.

2) The debt to asset ratio has increased by nearly 15 percent in the past three years, a development which merits additional consideration.

3) A disproportionate share of the asset base of agriculture is invested in the most illiquid asset available, real estate.

Capital Gains vs. Current Returns in Agriculture

Inasmuch as such a large share of the sector's asset base is composed of farmland, a closer scrutiny of agricultural land valuation is warranted. Ownership of farm real estate by individuals is limited by the individual's equity and the cash flow generated by the real estate; the income stream from the real estate contributes to equity and/or cash flow depending on the farmer's choices and financial needs. As the price of the asset base is increased, additional credit becomes available to the farmer, but the real capital gains realized on the real estate do not contribute to cash flow. Hence, cash flow requirements become the limiting factor in additional farmland acquisition. Moreover, during periods of cash flow contraction, the financial survival of farmer's who expanded too rapidly is threatened (Plaxico, 1979).

Harris (1979), Melichar (1979), and Reinsel and Reinsel (1979) each use a slightly different form of the asset valuation model (see Van Horne, 1983) to analyze the apparent paradox of the limited cash flow and rising asset values associated with the ownership of real estate. Harris writes the valuation model for a growth stock as shown in equation 1-1.

$$V = R \sum_{i=1}^{n} \left(\frac{1+g}{1+k}\right)^{i} \qquad (1\text{-}1)$$

where V is current value of the asset,

R is current income from the asset,

g is expected rate of growth in R over time,

k is the capitalization rate, and

n is the life of the asset in years.

Assuming an infinite value for n, the asset life, and $k>g$, equation 1-1 simplifies to equation 1-2.

$$V = R \frac{(1+g)}{(k-g)} \qquad (1\text{-}2)$$

Harris defines the capitalization rate as specified in equations 1-3, 1-4, and 1-5.

$$k = w_d k_d + w_e k_e \qquad (1\text{-}3)$$

$$k_d = r_d + {}_d \qquad (1\text{-}4)$$

$$k_e = r_e + {}_e \qquad (1\text{-}5)$$

where w_d, w_e are the respective proportions of debt and equity capital in the asset portforlio,

k_d, k_e are the required rates of return on debt and equity capital,

r_d, r_e are real rates of return on debt and equity capital, and

α_d, α_e are expected rates of inflation for debt and equity holders.

Assuming $\alpha_d = \alpha_e = \alpha$, equation 1-2 simplifies to equation 1-6.

$$V = \frac{R(1+g)}{w_d r_d + w_e r_e + \alpha - g} \qquad (1\text{-}6)$$

According to equation 1-6, an increase in the expected rate of inflation α would actually reduce the value of the asset due to its adverse impact on the discounted value of the income stream accruing to the asset. During the 1970s, however, farmland values increased in the face of accelerating inflation indicating that not all other variables in equation 6 were held constant. One could hypothesize that the value of g, the growth rate of the current return to the asset in equation 1-6, increased in response to the increased export demand for farm commodities experienced in the mid-1970s.

Melichar (1979) investigated the validity of this hypothesis and found that real capital gains on farm real estate could be almost completely explained by increased current returns to farm assets appropriately defined. Melichar defines real capital gains as asset appreciation adjusted for increases in the general price level. An "appropriate" definition of current returns to farm assets is derived from the USDA series of net farm income by adding net rental income of landlords and interest paid on farm debt and subtracting returns imputed to equity in farm dwellings and net returns to operator labor and management leaving current returns to farm production assets. Melichar provides data which indicate that the return on farm production assets rose from 3.0 percent in 1955-1959 to 4.2 percent in 1975-1979. Had farm real estate prices not risen significantly in the interim, returns to farm production assets would have approached 12 percent by 1978.

Equation 1-2 may be solved for the capitalization rate k as shown in equation 1-7.

$$k = R/V + g + gR/V \qquad (1-7)$$

Assuming that the third term on the right-hand side is very small, the discount rate is composed of the sum of the rate of current return on the asset value plus the rate of growth of the income stream. At equilibrium the annual rate of increase in the asset price is equal to the growth rate of the annual return, and the discount rate can be seen to be composed of a current return, R/V, and a capital gain, g. Melichar's data indicate that the growth rate of the constant dollar return to farm production assets has averaged approximately 5.0 percent during the 1970s; at a discount rate of 9.0 percent, the underlying assets would be priced to yield a current return of only 4.0 percent on the market value of the assets. In summary Melichar states, "This inescapable consequence is the common root of many of the farming sector's current problems: cash flow difficulties, large increases in debt, troubles of beginning farmers, the attraction of farm real estate for persons of large wealth or high income -- all of these stem from the fact that at such a growth rate, a significant proportion of the total return to farm real estate necessarily takes the form of real capital gains."

Real capital gains are, of course, a form of wealth accumulation and may be as valuable to the farmer in the long run as current returns. A simple numerical example borrowed from Reinsel and Reinsel (1979), however, illustrates the major problem involved with the substitution of capital gains for current returns. Assume that a farmer purchases farmland for \$2000 on terms consisting of a \$400 downpayment with a 25-year mortgage at 10 percent interest providing annual debt service charges of \$176. With a net return above variable costs of \$100, the farmer suffers a net cash flow loss of \$76 in the first year of ownership. If the annual growth rate of the current return is 5 percent, the farmer will experience a positive net return over variable costs and debt service in the thirteenth year $[(1.05)^{12} \text{ X } (100) = \$179]$. The farmer who wishes to maximize his future net worth must first determine a means of surviving an initial period of negative cash flows which fail to provide for consumption expenditures and actually erode the farmer's net worth as well.

The liquidity problems inherent in a balance sheet characterized by a disproportionate share of assets with a low rate of current return are compounded by a sectoral liabilities structure characterized by a shift to shorter term liabilities demanding more immediate pay down as shown in Table 1.2. The sector's liquidity problem is made even more intractable by the fact that farmers are faced with meeting their debt obligations from incomes which have not kept pace with their mounting debt load as shown in Table 1.4.

In summary the decision maker in today's agriculture must cope with a liquidity crisis characterized by a financial statement with a disproportionate share of long-term assets and short-term liabilities, a rising debt-to-asset ratio, and a rising debt-to-income ratio, characteristics precipitated in part by a low rate of current return relative to capital gains on the industry's asset base. Such illiquidity makes the farm business especially vulnerable to periods of contraction in farm income leaving the farmer little margin for error in exercising his managerial functions.

Short- and Long-Run Goals of the Firm

According to Heady (1952), the manager's primary responsibility is the coordination of production activities, a process which includes the formulation of expectations of future events affecting the firm, the planning of production and investment activities in accordance with those expectations, and the implementation of the production plans. In summarizing the plight of the manager functioning in an economic environment with an uncertain future, he states, "The necessity for making subjective forecasts places a limit on the distance into the future for which producers can plan in a meaningful manner. The fact that uncertainty is greater as the time period is extended causes the clear facts of today to shade off into the haze of unknowns which characterize the more distant future." If the manager's expectations about future

Table 1.4. Liabilities, net farm income, and debt-to-income ratios for the agricultural sector[a]

Year	Total liabilities	Net farm income (NFI)	Debt-to-NFI ratio
	----------------billion dollars----------------		
1960	24.8	11.121	2.23
1965	36.8	11.857	3.10
1970	53.0	14.230	3.72
1971	54.5	13.375	4.07
1972	59.1	18.045	3.28
1973	65.3	30.017	2.18
1974	74.1	27.612	2.68
1975	81.8	21.847	3.74
1976	90.8	21.033	4.32
1977	102.7	17.463	5.88
1978	119.3	25.584	4.66
1979	136.5	26.734	5.11
1980	158.4	24.416	6.49
1981	175.2	19.589	8.94

[a]From Economic Indicators of the Farm Sector, 1983.

events are correct, he reaps profits and society gains from an efficient allocation of resources to desired products. If the manager's expectations about the future prove to be incorrect, he will be allowed to continue in his managerial role only until his profits are driven to a sufficiently low level that he can no longer justify managerial effort. Hence, for the farmer as well as other entrepreneurs, the long run becomes relevant only if he can survive the short run.

The objectives of this study are to scrutinize more closely the firm's goals of survival in the short-run and maximization of net worth in the long run and to analyze the impact of certain financial strategies on the attainment of these goals. Chapter 2 defines the forms of risk confronting the agricultural firm, relates those risks to the firm's production, investment, and finance decisions. The model farm analyzed in the empirical portion of this study is described in Chapter 3, and the results and conclusions of this investigation are provided in Chapter 4.

Previous Empirical Studies

Several recent empirical investigations have used different farm modeling approaches to analyze the impacts of different economic scenarios and financial strategies on the growth and survivability of the firm. Mapp et al. (1979) found a baseline, gross-margin maximization, LP solution and two risk- efficient MOTAD (minimization of total absolute deviations) solutions for a 1500-acre southwestern Oklahoma farm. Using a simulation model in which the distribution of gross margin for each activity was assumed triangular, the authors examined the growth and probability of survival of each solution farm during a 20-year simulation period. Regardless of the annual rate of land-value appreciation, seven percent or four percent, no bankruptcies occurred in 100 runs of each model when initial equity was 70 percent of assets, although terminal net worth was reduced when land value appreciation was lower. The impact of a reduction in land value appreciation was much greater when initial equity was only 45 percent; mean terminal net worth fell by 50 percent and the probability of a bankruptcy occurring rose to 20 percent in the baseline (LP solution) scenario.

Held and Helmers (1980) analyzed the effects of alternative initial equity levels of 50, 65, and 80 percent of assets, alternative expansion plans of land purchase, share rent, combination of share rent and land purchase, and no expansion, alternative self-imposed credit limits requiring the maintenance of 45, 50, 55, or 65 percent equity, and alternative rates of annual land value appreciation of zero, four, and eight percent on the growth and survival of a 960-acre Nebraska Panhandle wheat farm. The firm was assumed to have failed whenever equity declined to less than 40 percent of assets.

Under the baseline scenario of 65 percent initial equity and four percent annual increase in land values, gains in terminal net worth when farm expansion occurred by land purchase only were slight relative to other expansion alternatives and came at a great increase in risk of business failure. Low levels of initial equity were accompanied by higher risk of failure due to the pressure placed on the firm's cash flow by greater debt service requirements. High levels of initial equity, however, were accompanied by high rates of survival and rapid accumulation of net worth through the appreciation of owned and purchased land. Self-imposed borrowing constraints enhanced survival with a slight reduction in growth for the highly leveraged firm. The firm which had been conservative in its use of credit, however, realized a larger reduction in growth with only a slight improvement in survival if it curtailed its already limited borrowings. Finally, as the rate of land value appreciation rose from zero to four to eight percent, firm growth and probability of survival increased as increased land values improved owner equity and provided a base for short-term borrowing. The authors did note, however, that under the high rate of land value appreciation substantial net worth accumulation was accompanied by a large amount of short-term debt which could lead to a lender-imposed credit limit even though the firm's equity exceeded the 40 percent minimum.

In a similar simulation study, Richardson et al. (1983) evaluated alternative initial equity levels and methods of financing the acquisition of land and machinery with respect to the survival of new entrants to farming. The model farm was a 640-acre Texas High Plains cotton farm on which annual rates of appreciation of land values and machinery values were assumed to be at 5.7 and 6.2 percent, respectively. For each of ten scenarios which incorporated different initial equity levels and the alternatives of leasing or purchasing all or part of the machinery and land used in the business, the model's ten-year planning horizon was replicated under 50 randomly drawn price and yield combinations. A business failure was assumed to have occurred if the firm's equity level fell below 30 percent of assets.

As in the two studies discussed above, the highest probabilities of surviving the ten-year simulation period were recorded by firm's with the highest initial equity positions. The greatest probability of failure was recorded by the low equity firm which attempted to own a large portion of its land and machinery. Alternatively the low-equity beginning farmer who chose to rent both land and machinery made a much smaller initial capital outlay and recorded a much higher probability of survival. Principal and interest payments on owned land exceeded current returns to land; hence, land ownership did not improve the low equity individual's chances for survival. Similarly, leasing rather than purchasing machinery improved prospects for survival.

Each of the three studies discussed above provides definitive documentation of the existence of the trade off which arises between growth and survival in accordance with the principle of increasing risk as the leveraged firm grows in a risky production environment. Boehlje and Eidman (1983) have issued an appeal for investigations that advance beyond the documentation of a growth-survival trade off to consider in greater detail strategies for improving firm survival. In their conceptualization three financial characteristics of farm assets, net income, net cash flow, and capital gains, are typically recognized in farm modeling efforts, while two additional characteristics, collateral value and liquidity value, are seldom if ever recognized. More specifically Boehlje and Eidman perceive a need for farm models which allow the firm to liquidate assets in an effort to avoid failure during periods of financial stress. In addition to typical production and marketing approaches to risk management, these models would include sale-leaseback options for land and machinery as well as asset liquidation as responses to the risk of business failure, and ideally the stochastic nature of asset liquidity value would be recognized as well.

The modeling effort summarized in the following two chapters is closely related to the form followed in the three empirical studies outlined above in that the effects of differing initial equity levels and rates of land-value appreciation on growth and survival are evaluated. Of greater interest, however, are the analyses of three alternative arrangements for financing the acquisition of asset services. The first, the conversion of short-term debt to long-term debt, is fairly traditional, whereas the remaining two, the sale-leaseback of machinery and the sale-leaseback of land represent a first step in the direction outlined by Boehlje and Eidman. The recognition of the stochastic nature of asset liquidity values remains a topic for future research.

CHAPTER 2: RISK AND THE AGRICULTURAL FIRM

The Definition of Risk

Historically a distinction has been maintained in the literature in defining the concepts of risk and uncertainty. Heady (1952) distinguished between the two terms based upon knowledge of the probability distribution underlying the risky or uncertain event or outcome. The term risk was used in reference to the variability of outcomes which could be measured in a statistical sense due to a priori knowledge of the underlying probability distribution or due to a sample of sufficient size to establish the statistical probability of the occurrence of the event in question. An uncertain outcome on the other hand was an outcome for which the probability of occurrence could not be established in a quantitative sense. Hence, the probability assigned to any given uncertain outcome was entirely of a subjective nature.

More recently, however, this sharp distinction between risk and uncertainty has been blurred to the extent that the terms are now used interchangeably. Due to the fact that nearly all the probabilities associated with the decision making process in agriculture are subjective to some extent, little is lost in dropping the distinction between the two terms as will be done in the remainder of this paper.

Analytical clarity is provided, however, in disassociating the risk facing the agricultural decision maker into its component forms. The risks confronting the agricultural firm are customarily classified as:

1) Production or technical risk: That risk arising from the inherent variability in biological systems and weather patterns which produce a

distribution of possible production functions and an uncertain quantity of final product produced.

2) Price or market risk: The risk arising from the variability in the price which the farmer will receive for his final product and the prices he will be required to pay for the inputs required in the production process.

3) Technological risk: Those risks arising from rapid changes in technology which lead to the associated obsolescence of durable factors of production before the end of the economic lives of those factors.

4) Legal and sociological risks: Risks arising from changes in the legal and social setting in which the agricultural firm must operate.

5) Human risks: Risks which arise as a consequence of interpersonal relationships among the individuals associated with the firm.

The analysis and discussion which follows is primarily concerned with the first three forms of risk cited above, production, price, and technological risk, for these are the sources of risk most amenable to the risk management strategies of interest to the agricultural economist. To facilitate an understanding of the impact of these sources of risk on the decisions of the agricultural firm, the risks identified above can be couched in terms relating directly to the firm's primary financial statements, the income statement and the balance sheet. Much of the discussion which follows is based upon the work of Vickers (1968) supplemented from Gabriel and Baker (1980), Baker and Hopkin (1969), and Heady (1952).

The farm firm may be considered to be a collection of assets as displayed in the assets section of the firm's balance sheet which represents the total commitment of resources to the firm. The purpose of these assets is, of course, the generation of a stream of income for the owner's of the firm. Any given structure of the firm's balance sheet displays only one of many different ways in which the firm's investment in assets can be made. That is, a given level of money capital may be divided among assets with differing economic lives and differing income generating properties as shown in the division of assets into current, intermediate, and fixed assets in the firm's balance sheet. The liabilities side of the balance sheet displays the sources of the total money capital invested in the firm's assets and includes the amount of money capital which the firm owners borrowed to finance the purchase of assets and that money capital which the owners contributed themselves as equity capital for the acquisition of assets.

The firm's second financial statement, the income statement, shows in its structure the division of operating costs among the various factors of production of differing durabilities. The residual income remaining after factor costs have been deducted from gross revenues, net operating income, accrues to the providers of money capital to the firm. The residual cash flow remaining after the providers of debt capital have been paid any interest due and after the payment of any tax liabilities, net income, accrues to the providers of equity capital, the owners of the firm. Thus, two residual income streams are identified, net operating income and net income, with net operating income exceeding net income by the amount of interest payable to providers of debt capital. Hence, net operating income is a measure of the true income generating capacity of the firm regardless of the method of finance whereas net income is a measure of the residual income accruing to the firm owners after the payment of the firm's creditors.

In the context of the firm's financial statements as depicted above, the role of the firm's management is two-fold. First, management must make the decisions which are reflected in the structure of the firm's balance sheet. The firm's structural planning consists of solving three interrelated problems, the production problem, the investment problem, and the finance problem. The production problem consists of choosing the optimum level of output and the optimum factor combination to attain that level of output. The managers' decisions regarding the production problem are reflected primarily in the income statement as well as in the assets side of the balance sheet. In making investment decisions, the manager determines the levels of money and real assets required to secure the factor capacities needed to sustain the production levels determined in the solution to the firm's production problem. These decisions are also reflected in the structure of the assets side of the balance sheet. Finally, in the finance decision, management must determine the sources of money capital required for the acquisition of the firm's assets, a determination which is reflected in the liabilities side of the balance sheet.

Once the structural decisions outlined above have been made, the firm's managers assume their second role of managing the short-run operation of the firm. In essence this function consists of the management of the circular transformation of assets from a liquid form, cash accruing from product sales, to a less liquid form, factors of production and inventories, and finally to a liquid form once again, cash from additional product sales. The major objective of Vickers' work is the integration of the theories of production, investment, and finance, and he therefore emphasizes the simultaneity of the solutions to the production, investment, and finance problems. Thus, the managers of the firm are faced with an "enterprise decision nexus" consisting of the interelated structural decisions which Vickers argues, contrary to the traditional logic of profit maximization, are made in a logical sequence from finance to investment to production.

Production, operating, and financial risk

Each of the structural decisions made by the firm's management is in turn associated with a form of risk, production risk, operating risk, and financial risk. Production risk accompanies the firm's production decision and corresponds to the previously described technical and market risks unique to the agricultural firm. Assume the firm's profit function is as specified in equations 2-1 and 2-2.

$$O = R - F - bR \qquad (2\text{-}1)$$

where O is net operating income,

R is total sales revenue,

F is fixed costs of production, and

b is the ratio of variable costs to total revenue.

$$R = P\,Q \qquad (2\text{-}2)$$

where P is the price per unit of final product, and

Q is the amount of final product produced.

Since neither price (P) nor quantity (Q) is known with certainty, variability is induced in net operating income which in turn gives rise to production risk.

Operating risk arises from the firm's investment decision and is a direct result of the presence of fixed factors of production in the transformation process. In this context fixed factors of production are those factors with economic lives exceeding the duration of a single production period. Rearranging equation 2-1 and applying the expected value and variance operators yields equations 2-3, 2-4 and 2-5.

$$E(O) = (1 - b)E(R) - F \tag{2-3}$$

$$Var(O) = (1 - b)^2 Var(R) \tag{2-4}$$

$$SD_0 = (1 - b)\ SD_R \tag{2-5}$$

Equations 2-6, 2-7, and 2-8 are derived by using the coefficient of variation as a relative measure of risk (Van Horne, 1983).

$$CV_0 = SD_0/E(O) = \frac{(1 - b)SD_R}{(1 - b)E(R) - F} \tag{2-6}$$

$$CV_R = SD_R/E(R) \tag{2-7}$$

$$CV_0/CV_R = \frac{(1 - b)E(R)}{(1 - b)E(R) - F} > 1 \tag{2-8}$$

Hence, as shown in equation 2-5, the absolute variability of net operating income increases as the proportion of costs attributable to fixed factors of production (1 - b) increases. Equation 2-8 dictates that the relative variability in net operating income exceeds the relative variability of sales revenue whenever fixed factors of production are involved in the production process. The intuitive explanation for this magnification of production risk in operating risk is the inflexibility introduced into the production process by the presence of fixed factors of production; costs associated with fixed factors accrue regardless of changes in the level of the firm's output and gross revenue.

In a manner directly analogous to the development of the concept of operating risk above, financial risk arises from the firm's finance decision and is the result of fixed finance charges which do not vary with variations in the level of the firm's output. The interposition of fixed finance charges between net operating income and net income magnifies the fluctuations in net operating income. Equations 2-9, 2-10, 2-11, and 2-12 define net income (N) as the residual remaining after fixed debt service charges (M) are deducted from net operating income and derive its expected value, variance, and standard deviation.

$$N = O - M \tag{2-9}$$

$$E(N) = E(O) - M \tag{2-10}$$

$$Var(N) = Var(O) \tag{2-11}$$

$$SD_N = SD_0 \tag{2-12}$$

As shown in equations 2-11 and 2-12, the variability in net operating income and net income are identical in absolute terms, but the relative variation in net income exceeds that of net operating income due to the presence of fixed debt service obligations (M) as shown in equation 2-15.

$$CV_0 = SD_0/E(O) \tag{2-13}$$

$$CV_N = SD_N/E(N) = \frac{SD_0}{E(O) - M} \tag{2-14}$$

$$CV_N/CV_0 = \frac{E(O)}{E(O) - M} > 1 \qquad (2\text{-}15)$$

Gabriel and Baker (1980) define financial risk as the difference between the relative variability in net operating income and net income as shown in equations 16 and 17 in which the notation of Vickers has been substituted to maintain continuity in the presentation.

$$F.R. = \frac{SD_N}{E(O) - M} - \frac{SD_0}{E(O)} \qquad (2\text{-}16)$$

$$F.R. = \frac{SD_0}{E(O)} - \frac{M}{E(O) - M} = \frac{CV_0 \cdot M}{E(O) - M} \qquad (2\text{-}17)$$

This formulation of financial risk provides a more lucid picture of the magnifying effect of fixed finance charges M on the relative variation of net operating income; financial risk increases from zero as debt service charges are incurred.

Of the three types of risks associated with the structural decisions facing the firm's decision makers, only financial risk can practicably be reduced to a zero level. Production or technological risk is an inherent part of the biological systems integrated into the transformation processes of agriculture, and though certain strategies can be developed to minimize this form of risk as will be discussed in a subsequent paragraph, the manager of a farm firm must always be willing to accept some level of production risk. Similarly, some level of operating risk is also inherent in production processes of agriculture; an agricultural production function in which all factors of production are variable is difficult to imagine. Indeed, recent technological advances have increased rather than diminished the importance of fixed factors of production in agriculture and have contributed markedly to gains in agricultural production. However, to the extent that production can occur with different combinations of fixed and variable factors of production, the farm manager has a degree of control over the level of operating risk the firm will incur. One can hypothesize, however, that a trade off will develop between the manager's desire to minimize operating risk and the firm's capacity to generate an income stream for its owners with a paltry capital investment. Hence, a problem in economic optimization, the investment problem, is identified.

Finally, by reducing the amount of debt capital M in equation 2-17 to zero, the firm's financial risk can be eliminated entirely. The firm would then be forced to finance the acquisition of its productive assets entirely from equity capital. Such a structural decision would not curtail production entirely, but one could reasonably expect that the scale of operations would be reduced compared to a firm operating with the same level of equity capital combined with some level of debt capital. Again one could hypothesize a trade off between the level of income the firm can generate for its owners with a given structure in the liabilities side of the balance sheet and the level of financial risk the firm's managers are willing to accept. Thus, a second problem in economic optimization, the finance problem, is identified.

Leveraged firm growth and increasing risk

The solution to the firm's finance problem relates directly to the concept of financial leverage. The return on the firm's assets in excess of the rate of interest charged for the use of debt capital accrues to the owner's of the firm as a higher rate of return on equity capital. Hence, the combination of debt capital with the owners' equity provides a "lever" for increasing the earning power of the firm's equity capital. Baker and Hopkin (1969) provide a simple model of the levered growth of the firm. Leverage may be defined as the ratio of debt capital to equity capital as in equation 2-18.

$$L = D/E = D/(A - D) \quad (2\text{-}18)$$

where D is debt capital,

E is equity capital, and

A is total assets.

The annual growth in the equity of the firm owners is given by equation 2-19.

$$g = (rA - iD)(1 - t)(1 - c) \quad (2\text{-}19)$$

where g is the annual increment in the firm's equity capital,

r is the rate of return on the firm's assets,

i is the rate of interest charged on the firm's debt capital,

t is the tax rate, and

c is the rate of consumption of after tax earnings.

Defining g' as the annual percentage growth rate in the firm's equity, equation 2-19 reduces to equation 2-20.

$$g' = g/E = [L(r - i) + r]K \quad (2\text{-}20)$$

where K is $(1 - t)(1 - c)$.

Note that when r, the rate of return on the firm's assets, exceeds i, the rate of interest charged against debt capital, g' increases with L, the leverage reflected in the structure of the liabilities side of the balance sheet. Conversely, when the rate of return on the firm's assets falls below the rate of interest due on debt, g' falls in direct proportion to L. The phenomenon modeled above in which the firm's equity base is exposed to increasingly rapid rates of erosion with increased financial leverage has been called the principle of increasing risk. Given an agricultural sector characterized by sole proprietorships with limited equity capital, Heady (1952) concluded that the specter of vanishing equity capital in accordance with the principle of increasing risk served as a definite constraint on the expansion of farms through the use of debt capital.

The finance decision in the theory of the firm

The firm's finance decision as presented above has been integrated into the microeconomic theory of the firm by Baker (1968, 1969) as well as Vickers. Baker's analysis emphasizes the impact of differential money capital costs caused by lender preferences and the entrepreneur's perception of those preferences on the production organization of the firm. Given a production function of the form

$$y = f(x_1, x_2 / x_f) \tag{2-21}$$

and the cost function

$$C = r_1x_1 + r_2x_2 + F \tag{2-22}$$

the firm in Baker's model seeks to maximize production subject to a cost constraint as given by the Lagrangian function of equation 2-23.

$$L = f(x_1, x_2 / x_f) + u(C - r_1x_1 - r_2x_2 - F) \tag{2-23}$$

where y is final product,

x_1, x_2 are variable factors of production,

r_1, r_2 are variable factors costs,

x_f are fixed factors of production,

F is fixed costs, and

u is the Lagrangian multiplier.

The familiar first order conditions for least cost production are given by the equation of the marginal rate of technical substitution between the variable factors and the factor price ratio.

$$dx_2/dx_1 = -r_1/r_2 \tag{2-24}$$

If the cost constraint is relaxed incrementally, the firm's expansion path is traced. If, however, the marginal costs of financing the purchase of the different variable factors differ due to lender preferences, the incorporation of these differential costs of finance in the model above will result in the firm's being forced onto a new expansion path, each point of which will in general represent a different optimal production organization as given by equation 2-25.

$$-dx_2/dx_1 = (r_1 + d_1)/(r_2 + d_2),\ d_1/d_2 \neq r_1/r_2 \tag{2-25}$$

where d_1 and d_2 are marginal factor costs associated with lender preferences.

Baker employs identical logic to illustrate the impact of the finance decision on the optimal mix of final products as given by the equation of the marginal rate of transformation between final products and the product price ratio.

$$-dy_2/dy_1 = (p_1 - L_1)/(p_2 - L_2),\ L_1/L_2 \neq p_1/p_2 \tag{2-26}$$

where y_1, y_2 are final products,

p_1, p_2 are final product prices, and

L_1, L_2 are marginal costs associated with the finance of y_1 and y_2 based on lender preferences.

In the product-product relationship, finance decisions based on lender preferences result in an alteration of the mix of final products as specified in equation 2-26. In conclusion, Baker argues, "In choices related to growth, consequences of financial alternatives are likely to be at least as important as those of production alternatives. Moreover, and more important still, production and financial alternatives are interrelated."

Although Baker's model does succeed in incorporating the finance decision in the theory of the firm, the *ad hoc* addition of variables representing lender preferences is not conceptually appealing. The model developed by Vickers provides a more comprehensive integration of the theories of production, investment, and finance and thus an intuitively and theoretically more elegant analysis of the theory of the firm. Vickers maintains that the objective of the owners of the firm is the maximization of the economic value of the firm as specified in equation 2-27.

$$V = \pi / p(D) \qquad (2\text{-}27)$$

where V is the economic value of the firm to its owners,

π is the residual income stream accruing to the owners,

p(D) is the capitalization rate function applied to equity capital, and

D is debt capital, an argument of the capitalization function.

The cornerstone of Vickers' approach is the inclusion of money capital as a constraint in the optimization of the economic value of the firm rather than as an argument in the firm's production function. Finally, Vickers argues that consideration of any of the firm's structural decisions alone is merely partial equilibrium analysis; the true solutions to the firm's production, investment, and finance problems are provided by the general equilibrium analysis specified in equations 2-28 and 2-29.

$$L = \pi/p(D) + u[K + D - g(Q) - ax - by] \quad (2\text{-}28)$$

$$\pi = P(Q)f(x,y) - v_1x - v_2y - r(D)D \quad (2\text{-}29)$$

where L is the Lagrangian function,

u is the Lagrangian multiplier,

K is the fixed quantity of equity capital available,

D is debt capital employed by the firm,

x is a unit of variable factor capacity,

y is a unit of fixed factor capacity,

a,b are money capital outlays required to secure a unit of factor capacity,

Q is final product related to factors x and y through f(x,y), the production function,

g(Q) is the working capital requirement function,

P(Q) is the final output price function,

v_1,v_2 are direct cash costs associated with factors x,y, and r(D) is the interest cost of debt function.

The first order conditions for the optimization of the economic value of the firm for its providers of equity capital are stated in equations 2-30, 2-31, and 2-32.

$$dL/dx = (1/p)[(P + QdP/dQ)f_x - v_1] - u[g'(Q)f_x + a] = 0 \quad (2\text{-}30)$$

$$dL/dy = (1/p)[(P + QdP/dQ)f_y - v_2] - u[g'(Q)f_y + b] = 0 \quad (2\text{-}31)$$

$$dL/dD = -(1/p)[r + Ddr/dD] - (\pi/p2)dp/dD + u = 0 \quad (2\text{-}32)$$

Recognizing the term P + QdP/dQ in equations 2-30 and 2-31 as marginal revenue for the firm in an imperfectly competitive industry, the first term in square brackets in both equations is the excess marginal revenue product over direct factor cost. The second term in square brackets is the marginal money capital requirement of the factor in question. Hence, equations 30 and 31 dictate that at the optimum the capitalized value of the excess marginal revenue product of each factor of production is equal to the factor's marginal money capital requirement multiplied by the Lagrangian multiplier u. Rearranging equations 2-30 and 2-31 and taking the ratio of the two provides equation 2-33.

$$MRTS = f_x/f_y = (v_1/p + ua)/(v_2/p + ub) \quad (2\text{-}33)$$

Because value rather than profit was the maximand in this problem the equity capitalization rate p appears in the first order condition of equation 2-33. The appearance of the terms a and b is accounted for by the constraint on the optimization of economic value imposed by a limited supply of money capital given by the sum of debt D and equity capital K. Remarkably the form of equation 2-33 is identical to that of equation 2-25, the first order condition for efficiency in production derived in the model of Baker, in spite of the differences in the logic upon which the two models are based.

Equation 2-34 is derived by solving equations 2-30 and 2-31 for u.

$$u = (M_x/p)/C_x = (M_y/p)/C_y \qquad (2\text{-}34)$$

where M_x, M_y are excess marginal revenue products for factors x and y, and

C_x, C_y are money capital requirements for factors x,y.

Thus, at the optimum the marginal value contributions per dollar of money capital employed are equal for all factors of production. Closer scrutiny of equation 2-32 facilitates a firmer understanding of the meaning of the term u and its relationship to the firm's structural decisions. The value of u, the Lagrangian multiplier of the money capital constraint and thus the marginal value productivity of money capital, is given by equation 35.

$$u = (1/p)[r + Ddr/dD + Vdp/dD] \qquad (2\text{-}35)$$

The first two terms in the square brackets represent the total direct costs of borrowing money capital including a term providing for the increase in the interest rate as lenders require compensation for incurring greater risk as the firm's debt burden increases. Similarly the last term in square brackets represents the impact of a rising debt load on the risks borne by the providers of the firm's equity capital and the attendant change in the equity capitalization rate. Thus, the term in square brackets represents the total marginal cost of debt capital. At the optimum the marginal value productivity of money capital, u, is equal to the marginal cost of debt capital capitalized at the equity capitalization rate p.

Equations 2-34 and 2-35 are especially useful in gaining insights into the manner in which the firm solves its production, investment, and finance problems to maximize the value of the firm for its owners. If the value of u in equation 2-34 exceeds unity, the contribution of the last unit of factor capacity to the value of the firm exceeds the costs incurred in acquiring that factor of production. Obviously additional units of factor capacity should be acquired until the value of u is driven to unity. Simultaneously, a value of u greater than unity in equation 2-35 indicates that the marginal cost of debt given by the term in square brackets exceeds the marginal cost of equity given by the equity capitalization rate p. Therefore, the additional units of factor capacity acquired to drive u toward unity in equation 2-34 would be financed with an increase in the level of equity capital commited to the firm driving the value of u toward unity in equation 2-35. With each increment in equity capital which the firm owners commit to the firm, the model must be solved again, and the point which Vickers calls the firm's "optimum optimorum" will eventually be attained.

The preceding discussion may be summarized in the following principal elements which will form a foundation for the subsequent discussion and empirical investigations of this study:

1) The agricultural firm is exposed to production risks inextricably related to the biological processes and competitive pricing system inherent in agricultural production. Production risk is in turn magnified

in operating risk due to the presence of production costs attributable to fixed factors of production in the production milieu, costs which are invariate regardless of the level of output of the firm. To the extent that production may proceed with different combinations of factors of production of differing durabilities, the firm manager may control the level of operating risk to which the firm is exposed by maintaining some optimal mix of variable and fixed factors of production. Hence, the structure of the asset side of the firm's balance sheet will reflect the level of operating risk to which the firm is exposed and the manager's response to that risk. As the manager's aversion to risk increases, the level of fixed factors of production in the production process decreases, and the asset side of the firm's balance sheet is characterized by a greater degree of liquidity.

2) In a manner exactly analogous to the magnification of production risk in operating risk, operating risk is magnified in financial risk due to the incurrence of fixed financing charges as the firm uses debt capital to acquire productive capacity. Assuming that the cost of debt capital is less than the rate of return accruing to the firm's assets, the firm is able to attain higher levels of net income and growth in owner equity as the firm's leverage ratio, the ratio of debt to equity capital displayed in the liabilities side of the firm's balance sheet, increases. Concurrently, however, the firm incurs greater exposure to financial risk as the amount of debt capital and the leverage ratio increase.

3) The firm's response to financial risk is reflected in its finance decision, a decision which also affects the firm's production decision.

However, the impact of the finance decision on the firm's production processes is more subtle than is the impact of the firm's investment decision as discussed above. The model developed by Baker suggests that lender preferences with regard to specific productive activities are reflected in the relative costs associated with the debt financing of those activities, and that those relative costs in turn determine the firm's expansion path. A similar result was derived from the more general model developed by Vickers. In Vickers' model differential money capital outlays required for the acquisition of factor capacity determine the position of the firm's expansion path when money capital, the sum of debt and equity capital available to the firm, is constrained at some fixed level. Moreover, the attitudes of the firm's owners and lenders towards risk as reflected in the equity capitalization rate $\rho(D)$ and the interest rate $r(D)$, respectively, are determinants of the relative amounts of debt and equity capital committed to the firm. As the firm's debt load and the attendant financial risk increase, the cost of committing additional money capital to the firm increases as the firm's owners and lenders increase the rates of return required on the capital they have committed to the firm as compensation for the additional risks they are assuming.

4) The model of the firm proposed by Vickers is complete in that it addresses the firm's simultaneous production, investment, and finance decisions and the risks associated with each. Vickers' analysis of the finance decision is in accordance with the objective of maximizing the value of the firm to its owners and focuses on the choice of an optimal combination of debt and equity capital used to acquire the firm's

productive assets while giving due regard to the risk preferences of the firm's owners and lenders. In this study, however, the objective of the owners of the firm is assumed to be the survival of the firm during contractions in operating income in the short run. Survival of the firm in the short run ensures that the firm will be in existence to reap the rewards of the optimal production, investment, and finance decisions in the longer run. As discussed in Chapter One, a major problem confronting many farm firms today is the maintenance of positive cash flows in the presence of a high debt load arising from the debt financing of farm real estate which realizes a low rate of current return relative to long run capital gains. With respect to the issue of the short run survival of the firm, the term structure of the firm's debt obligations is of critical importance. A loan structure which requires rapid amortization will restrict the firm's cash flow and in the extreme could result in the forced liquidation of the firm's assets during a period of contraction in the firm's operating income. Hence, this study must proceed a step beyond Vickers' analysis of the firm's finance decision in order to investigate the effects of the liquidity characteristics of the liabilities side of the balance sheet on the short-run survival of the firm.

CHAPTER 3: METHODS

The Empirical Model

The model used to study the effectiveness of the restructuring of the liability side of the balance sheet as a risk management strategy is the Iowa State Universtiy Business and Financial Planner. In brief the model estimates net operating income, cash fixed operating costs, and depreciation as a function of 1) the assets used in the business and 2) the time trend. These estimates feed into the remaining equations of the model which provide for the payment of all financial obligations of the firm including purchase of new assets, service of all outstanding debt, payment of income taxes and family living expenses, and the distribution of the residual net income stream to the holders of equity capital throughout the model period. For a complete specification of the model, see the work of Reinders (1983).

Three major alterations were made in the ISU Business and Financial Planner to make it conform to the current economic environment and the objectives of this study. First, the tax laws embodied in the Economic Recovery and Tax Act of 1981 were incorporated in the updated version of the model. Second, the consumption function upon which expenditures for family living requirements are based was changed to that identified by Brake (1968). Third, actual farm data obtained from the Iowa Farm Business Association and used to estimate net operating income, cash fixed operating expense, and depreciation were disaggregated by enterprise as well as farm size to improve the model's performance. The equations estimated for net operating income, cash fixed operating expense, and depreciation for Class 4 cash grain farms are given in equations 3-1, 3-2, and 3-3, respectively.

$$NOI = 27{,}998.1 + 1.103CA - 0.037(IA + FA) - 279.40(YR) \quad (3\text{-}1)$$

$$CFOC = 6328.8 + 0.005(IA + FA) - 132.78(YR) \quad (3\text{-}2)$$

$$DEPR = -27{,}776.8 + 0.005(IA + FA) + 472.68(YR) \quad (3\text{-}3)$$

where NOI is net operating income in year t,

CFOC is cash fixed operating expense,

DEPR is depreciation,

CA is the value of current assets,

IA is the value of intermediate assets,

and FA is the value of fixed assets.

NOI, CFOC, and DEPR were not statistically identified when IA and FA were included as separate regressors in equations 3-1 to 3-3. Summing IA and FA provided for the identification of each dependent variable at the 5 percent confidence level.

The model farm

The typical Class 4 cash grain farm modeled in this study is a unit of 438 acres with the asset structure shown in Table 3.1. The Class 4 cash grain farm was chosen as the subject of this analysis because larger cash-grain farms in Iowa are highly specialized usually producing only two crops, corn and soybeans, on an asset base of which land is the major component. According to the discussion of Chapters 1 and 2, such farms run the greatest risk of facing a liquidity crisis during an economic contraction in the agricultural sector. Another suitable subject for this study is the Class 5 cash grain farm which contains a larger real estate land value than does the Class 4 farm; however, all of the data required for the following analyses were not available for class 5 farms when this study was begun.

Table 3.1. Assets of the Model Class 4 Cash Grain Farm

Current Business Assets			
Grain Inventory	$87,614		
Livestock inventory	9,554		
Total		97,168	
Intermediate Business Assets			
Machinery inventory		42,797	
Fixed Business Assets			
Land and improvements		761,409	
Total assets used in business			901,374

The farm family operating the model farm consists of a husband, wife, and one child each of whom shares equally the financial burdens of the farm's debt obligations as well as the residual net income from the farm's operation. A total of 16 different scenarios are modeled, the scenarios being distinguished by 1) the method of financing the acquisition of assets used in the business, 2) the equity ratio at the beginning of the planning horizon, and/or 3) the annual rate of appreciation of the value of fixed assets controlled by the firm as shown in Table 3.2. All loans in each of the scenarios are initiated at the beginning of the firm's 10-year planning horizon on January 1, 1981.

In each of the first four models displayed in Table 3.2, Series 450, 50 percent of the firm's assets are financed with equity capital. Moreover, the equity ratio in the current, intermediate, and fixed asset

Table 3.2. Summary of sixteen financial scenarios analyzed

Model	Debt Asset Ratio(%)	Rate of Asset Appreciation(%) CA	IA	FA	Debt Structure CURRENT	INTERM.	FIXED
SERIES 450							
FAST450B	50	4.4	6.3	7.6	1 yr. @ 14%	1 yr. @ 14%	25 yr. @ 12%
REFI450B	50	4.4	6.3	7.6	25 yr. @ 12%	25 yr. @ 12%	25 yr. @ 12%
LESM450B	50	4.4	6.3	7.6	1 yr. @ 14%	LEASED	25 yr. @ 12%
LESLF450	50	4.4	6.3	7.6	1 yr. @ 14%	1 yr. @ 14%	LEASED
SERIES 453							
FAST453B	50	4.4	6.3	1.9	1 yr. @ 14%	1 yr. @ 14%	25 yr. @ 12%
REFI453B	50	4.4	6.3	1.9	25 yr. @ 12%	25 yr. @ 12%	25 yr. @ 12%
LESM453B	50	4.4	6.3	1.9	1 yr. @ 14%	LEASED	25 yr. @ 12%
LESLF453	50	4.4	6.3	1.9	1 yr. @ 14%	1 yr. @ 14%	LEASED
SERIES 470							
FAST470B	70	4.4	6.3	7.6	1 yr. @ 14%	1 yr. @ 14%	25 yr. @ 12%
REFI470B	70	4.4	6.3	7.6	25 yr. @ 12%	25 yr. @ 12%	25 yr. @ 12%
LESM470B	70	4.4	6.3	7.6	1 yr. @ 14%	LEASED	25 yr. @ 12%
LESLF470	70	4.4	6.3	7.6	1 yr. @ 14%	1 yr. @ 14%	LEASED
SERIES 473							
FAST473B	70	4.4	6.3	1.9	1 yr. @ 14%	1 yr. @ 14%	25 yr. @ 12%
REFI473B	70	4.4	6.3	1.9	25 yr. @ 12%	25 yr. @ 12%	25 yr. @ 12%
LESM473B	70	4.4	6.3	1.9	1 yr. @ 14%	LEASED	25 yr. @ 12%
LESLF473	70	4.4	6.3	1.9	1 yr. @ 14%	1 yr. @ 14%	LEASED

categories is assumed to be uniformly 50 percent at the beginning of the planning horizon. The term structure of the firm's debt in model FAST450B includes one-year repayment of current and intermediate liabilities at 14 percent interest and 25 year repayment of long-term liabilities at 12 percent interest, loan terms consistent with average rates and maturities offered across all banks for the past six to ten years (Melichar and Balides, 1983). Amortization of the long-term liability is based upon constant annual principal payment with interest due annually on the outstanding balance. Model REFI450B is identical to model FAST450B with the exception that the firm is provided the opportunity to restructure its liabilities by incorporating all initial current and intermediate debt into a single 25-year obligation at 12 percent interest. Hence, the firm's entire 50 percent debt burden becomes a long-term obligation as if the firm were allowed to secure additional debt funds with the firm's owned land, funds which are then used to reduce its shorter term obligations to the zero level.

Model LESM450B is a variation of model FAST450B in that the portion of the firm's complement of machinery purchased with borrowed funds is sold and then leased from the purchaser thus eliminating the firm's intermediate-term debt. Hence, the firm in this model operates with a line of machinery half of which is purchased with equity funds and half of which is leased. The machinery lease is a financial lease the terms of which specify five annual payments of 22 percent of the value of the leased asset and a sixth payment of 20 percent of the asset's value after which the lessee owns the asset. This leasing arrangement is an industry standard (Wickham, 1984), and provides the lessor with an internal rate of return of 12.1 percent.

The final model of Series 450, LESLF450, is similar to model LESM450B, but in this case the firm's indebted land rather than machinery is sold and leased from the purchaser. Land in this model is assumed to be rented for cash with the annual rental rate equal to 5.8 percent of the land's value, the ten-year average annual rental rate for cropland rented for cash (Farm Real Estate and Market Development, 1983).

The financial arrangements of the next four models of Table 3.2, Series 453, are identical to the corresponding models of Series 450 as described above. The feature which distinguishes the models of Series 453 from their counterparts in Series 450 is the rate of appreciation of the value of fixed assets consisting of farmland and fixed improvements. In Series 450 the annual rate of appreciation for current assets (4.4 percent), intermediate assets (6.3 percent), and fixed assets (7.6 percent), is the 30-year trend rate as calculated from the USDA Index of All Commodities, Interest, Taxes, and Wage Rates, the Index of Prices Paid for Tractors and Self-Propelled Machinery, and Farm Real Estate Values, respectively. The models of Series 453, however, employ a rate of fixed asset value appreciation (1.9 percent) designed to offset as nearly as possible depreciation in the value of fixed improvements which occurs over the 10-year planning horizon. The result is a zero net rate of fixed asset appreciation.

The thrust of the models of Series 453 is to mimic the situation existing in agriculture today in which the farmer can no longer anticipate substantial accumulation of net worth through appreciation in the value of owned land. Indeed, given the existing environment a strong case can be made for reducing fixed asset appreciation to negative values in these models. However, the sign of the coefficient of fixed and intermediate assets in the NOI structural equation (equation 3-1) is negative; as fixed assets decline in value, NOI actually increases. Since NOI is the residual income stream after deducting factor costs but before deducting interest expense and taxes from total revenues, one would expect this measure of income to increase as firm size and thus the quantity of fixed assets employed increased. However, for a firm of constant size with a value of fixed assets appreciating over time and with operating costs rising faster than total revenues, the relationship between net operating income and fixed assets over time would be negative. In fact, the data used in estimating equation 3-1 were gathered during a period of rapidly appreciating land values; the assumption of a relatively large, negative value for the rate of appreciation of land values in effect extrapolates beyond the data over which equation 3-1 is estimated. Hence, the lower limit on the rate of fixed asset appreciation is set at zero.

One could also argue that the rate of appreciation of the value of farm machinery should be treated in an identical fashion inasmuch as used machinery has definitely declined in value or has at least ceased to appreciate in value at the rate which prevailed in years past. However, the specification of a trend rate of intermediate asset appreciation in this model emphasizes the fact that the price of machinery--especially new machinery--is determined by forces beyond the farm gate including costs of steel and labor used in manufacturing, factors which are best reflected in the long-term trend. Inasmuch as land comprises approximately 84 percent of the value of the firm's assets and machinery only five percent, the assumption regarding the appreciation of land values is of far greater importance than that regarding machinery values with respect to the validity of the results of this modeling experiment.

The last eight models of Table 3.2, Series 470 and Series 473, are identical to the corresponding models described above with the exception that the firm in each of these models is more highly leveraged at the initiation of the planning horizon. Whereas the initial debt to asset ratio in Series 450 and Series 453 is 50 percent, the initial debt to asset ratio in Series 470 and Series 473 is 70 percent.

The identification of a liquidity crisis

The value of NOI as specified in equation 1 is assumed to be known with certainty in each year of the 10-year model period in an initial deterministic run of each of the 16 models specified in Table 3.2. In 50 additional runs of each model, NOI in each year of the model period was made stochastic to simulate the production risk facing the farm manager. The stochastic nature of NOI was modeled through the incorporation of a Monte Carlo routine as discussed in a following section of this chapter.

Balance sheet and income statement data for each year of the planning horizon for the single deterministic and 50 stochastic runs of each of the 16 models are provided in the program output. The objective of the farm family is assumed to be the maximization of its terminal net worth;

however, in focusing on terminal net worth, the family cannot disregard the risk of business failure in the shorter run. An existence-threatening financial crisis arises whenever the firm's cash flow is insufficient to meet its financial obligations. In such a situation the firm must be able to obtain funds from an external source if the firm is to continue in business in an unaltered state if at all. The models of this analysis allow the firm to accumulate short-term debt on terms of one-year repayment at 14 percent interest whenever the firm's NOI is insufficient to provide for the payment of debt service obligations, income taxes, and family living expenses.

Accumulation of additional short-term debt erodes the firm's equity position as defined by the equity ratio (equity as a percentage of total assets) and the firm's liquidity position as defined by the current ratio (current assets divided by current liabilities) as well as the lender's confidence in the firm as a viable entity. In a study of the viability of Nebraska wheat farms reviewed earlier, Held and Helmers (1980) employed an equity ratio falling below 40 percent as suggested by Penson and Lins (1980) as the criterion for determining business failure under the assumption that the firm's lenders would no longer be willing to provide additional funds to the firm at that point. Because the problem facing many producers in the agricultural sector today is one of liquidity rather than solvency per se as discussed in Chapter 1, the survival criterion specified in this analysis is based upon the current ratio. Current assets, the numerator of the current ratio, are those assets, inventories of grain and livestock, which will be converted to cash in the next 12 months. Similarly, the denominator of the current ratio, current liabilities, represents the firm's known cash obligations of the next 12 months. These obligations include the repayment of short-term debt and the portion of intermediate- and long-term debt due that year, rent due on leased machinery and land, and the year's income tax liability.

In general a current ratio falling below a value of two is viewed with alarm by agricultural lenders, although financially sound, larger farms often do not meet this criterion (Lee, Boehlje, Nelson, and Murray, 1980). However, credit evaluations in the field of agricultural finance are based upon numerous other criteria including subjective evaluations of borrower credit worthiness. Lenders might readily apply a less stringent current ratio criterion in evaluating credit requests from borrowers in a favorable equity position experiencing temporary contractions in liquidity. Therefore, alternative threshold values of 2.0, 1.5, and 1.0 are considered as the limiting values of the current ratio below which the firm's lender will refuse requests for additional credit, and an existence-threatening liquidity crisis is assumed to occur whenever the firm's current ratio falls below the lender specified critical value at any time during the ten-year planning horizon. The discussion of the initial deterministic run of each of the models of Series 450 and Series 453 is based upon the assumption that the firm must maintain a current ratio of 1.5 or greater.

The models of Series 470 and 473 reflect a higher initial leverage position and lower initial current ratios than the corresponding models of Series 450 and 453. It is assumed for the sake of these analyses, however, that the firm's lenders are willing to apply a less stringent failure criterion in the scenarios of Series 470 and 473 than in those scenarios modeled in Series 450 and 453. The basis for this assumption is that the firm's lender has presumably provided credit to the model firm up to the beginning of the planning horizon, and it is assumed that the lender would continue to do so provided that some minimum criterion is met. Alternatively one could view the highly leveraged farmer in the models of Series 470 and 473 as a young farmer eligible for credit by some government agency such as the Farmers Home Administration which places less stingent requirements on its borrowers. In either case the failure criterion specified throughout the analysis and discussion of the deterministic run of each of the scenarios of Series 470 and 473 is a minimum value of unity for the firm's current ratio throughout the firm's planning horizon. If the current ratio falls below a value of unity in any year of the planning horizon, the firm is assumed to have suffered an existence-threatening liquidity crisis.

Of greater interest to this study is the probability of the firm's experiencing an existence-threatening liquidity crisis under each of the 16 scenarios considered. This issue is resolved through the analysis of the results of the 50 stochastic simulations of each scenario. The firm in each of the 50 simulations of each model is assumed to have encountered a liquidity crisis if:

1) the firm's current ratio at the beginning of the planning horizon meets the lender specified critical value but falls below that critical value at some point during the ten-year planning horizon, or

2) the firm's initial current ratio is below the lender specified minimum and fails to improve by the end of the first year of the planning horizon, meet or exceed the lender specified critical value by the end of the second year, and maintain a value at least as large as the critical value to the end of the planning horizon.

All three alternative critical values of the current ratio, 1.0, 1.5, and 2.0, are considered in the analysis of the stochastic simulations of all models.

The Monte Carlo Routine of the ISU Business and Financial Planner

The objective of the Monte Carlo routine of the ISU Business and Financial Planner is the simulation of the stochastic nature of net operating income (NOI). As discussed previously, variability in net operating income arises from variability in price and quantity of the firm's output, the source of production risk, the first of the three forms of risk confronting the farm firm, which is in turn magnified in the two remaining forms of risk, investment risk and financial risk. The levels of investment and financial risk to which the firm is exposed are determined to a degree by the firm's manager as the investment and finance decisions are made. Similarly in this model designed to simulate the economic environment in which the firm's manager must make his production, investment, and finance decisions, the results of the investment and finance decisions are determined exogenously. That is, the investment decision is embodied in an exogenously specified asset structure and the finance decision is embodied in an exogenously specified liability structure in the firm's balance sheet.

Due to the inherent variability in the quantity and price of output produced by the farm firm, net operating income, the result of the firm's production decision, is stochastic in nature and cannot be controlled by the firm's management. In similar fashion, NOI is determined endogenously in the model through the use of the Monte Carlo routine which removes exact specification of NOI from the modeler's control.

The stochastic nature of NOI and, thus, production risk is incorporated in the model through the specification of a pseudo-random Monte Carlo variate which is used as a factor in the calculation of actual NOI from that estimated in equation 3-1 as specified below in equation 3-4.

$$NOI' = xNOI \qquad (3\text{-}4)$$

where NOI is predicted net operating income from equation 3-1,

NOI' is actual net operating income,

and x is the Monte Carlo variate.

Determination of the value of the Monte Carlo variate

The first step in the determination of the value of x, the Monte Carlo variate, is the assumption of a distribution of net operating income. Though the true distribution of NOI is unknown, the modeler can specify with reasonable accuracy the lowest, highest, and most likely values for NOI. Desirable properties of the distribution assumed for NOI for the determination of the Monte Carlo variate include simple mathematical specification of the probability density function f(X), the cumulative distribution function F(X), and the inverse of the cumulative distribution function where X is used to denote NOI. A distribution which meets each of these requirements and is completely specified by the lowest (a), highest (b), and most likely or modal (m) value of NOI is the triangular distribution, a distribution often chosen for use in applied economic research (Reinders, 1983; Sprow, 1967).

Table 3.3. Statistics of the distribution of observed NOI (deflated) and of the Monte Carlo variate x

Value of Deflated NOI		Distribution of the Variate, x	
		Statistic	Value
Mode	1200.00	M	0.8809
Lowest	909.11	A	0.5140
Highest	1913.38	B	1.4859
Mean	1362.22	Mean	1.0000
St.Dev.	337.77		
C.V.	.2480		

The values a, b, and m of the triangular distribution of NOI for Class 4 cash grain farms in Iowa were determined by first deflating the time series (15 observations) of NOI by the USDA Index of Prices Received for Feed Grains and Hay to eliminate the impact of general price inflation during the observation period. The mode of the distribution of deflated NOI was then determined by constructing frequency histograms and choosing that region of deflated NOI containing the largest number of observations. The lowest, highest, and modal values of deflated NOI are used to calculate the parameters of the assumed triangular distribution of NOI and the distribution of the Monte Carlo variate x (Table 3.3). Once the values of a, b, and m are specified, the probability density function (PDF), cumulative distribution function (CDF), and the inverse of the CDF for the Monte Carlo variate x are readily determined algebraically as follows:

1) Choose the lowest value of NOI and the highest value of NOI so that the triangular distribution will include 95 percent of all observations of NOI as if the true distribution of NOI were actually normal. Thus,

$$a = \bar{X} - 1.96SD_x$$

$$b = \bar{X} + 1.96SD_x$$

where $\bar{X}$ is the mean of the observed values of NOI,

SD_x is the standard deviation of NOI, and

1.96 is chosen from the tables of the standard normal distribution. and

2) Standardize the resulting distribution so that the mean of the random variable x is 1:

$$A = a/\bar{X} = 1 - 1.96CV_x$$

$$B = b/\bar{X} = 1 + 1.96CV_x$$

where A is the lowest value of the random variable x,

B is the highest value of the random variable x, and

CV_x is the coefficient of variation of NOI.

3) Determine the equation of the PDF of the Monte Carlo variate x using the definition of PDF and the formula for the area of a triangle:

$$\int_A^B f(x)dx = 1 = (B - A)f(M)/2$$

$$f(M) = 2/(B - A)$$

For $A < x < M$, $f(x) = 2(x - A)/(B - A)(M - A)$.

For $M < x < B$, $f(x) = 2(B - x)/(B - A)(B - M)$.

4) Determine the CDF of x:

For $A < x < M$, $F(x) = \int_A^x f(x)dx$

$$= (x - A)^2/(B - A)(M - A)$$

For $M < x < B$, $F(x) = \int_A^M f(x)dx + \int_M^x f(x)dx$

$$= [(B-A)(B-M) - (B-x)^2]/(B-A)(B-M)$$

And at $x = M$, $F(x) = (M-A)/(B-A)$

5) Determine the inverse of the CDF of x. Given a value of $F(x) = u$, find $x = v$:

For $0 < u < (M-A)/(B-A)$, $u = (v-a)^2/(B-A)(M-A)$

$$v = A + [u(B-A)(M-A)]^{1/2}$$

For $(M-A)/(B-A) < u < 1$, $u = [(B-M)(B-A) - (B-v)^2]/(B-A)(B-M)$

$$v = B-[(1-u)(B-M)(B-A)]^{1/2}$$

Given the mathematical specification of the PDF, CDF, and the inverse CDF of the Monte Carlo variate x, the Monte Carlo routine of the ISU Business and Financial Planner models the stochastic character of NOI. A random number generator chooses a value of u, $0 < u < 1$, which is mapped onto the CDF to determine a value v of the Monte Carlo variate x the mean value of which is 1. If the value of x chosen by the Monte Carlo procedure exceeds 1, then actual NOI exceeds predicted NOI and conversely.

That is,

$$\text{for } x > 1,\ NOI' > NOI$$

$$\text{for } x < 1,\ NOI' < NOI$$

One run of the entire simulation model complete with the pseudo-random determination of NOI according to NOI'= xNOI provides one point on the probability distribution of terminal net worth for the exogenously specified investment and finance strategy under consideration. Additional runs of the model allowing only the Monte Carlo variate x and thus NOI' to vary provide additional points on the distribution of terminal net worth until the distribution is approximated to the desired degree of accuracy. The CDF of terminal net worth is determined from n runs of the model by ranking in ascending order the values of terminal net worth obtained, assigning a probability of 1/n to each, and summing the probabilities cumulatively. Repeating the entire procedure for a different investment or finance strategy determines another CDF of terminal net worth. The CDFs obtained can then be used to evaluate the relative merits of the strategies under consideration by using the theorems of stochastic dominance as discussed in Anderson et al. (1977) and reviewed by Reinders (1983).

The number of runs of the model required to adequately approximate the distribution of terminal net worth depends in part upon the level of accuracy desired by the modeler. Brooks (1958, 1959) has shown that the number of random observations n required to ensure a probability P of obtaining at least one observation from the subset B of optimal or near-optimal values of the decision variables which comprises a proportion b of the entire decision space is given by:

$$n = \log (1-P)/\log (1-b)$$

If five percent of all possible solutions are optimal or near-optimal (b = 0.05) and a confidence level of 90 percent (P = 0.90) is specified as the probability of observing at least one of these solutions, then the model must be run 45 times (n = 45, rounding to the nearest integer).

CHAPTER 4: RESULTS AND DISCUSSION

Deterministic Runs

The initial simulation of each of the 16 farm models included in this study were run with the Monte Carlo variate fixed at its mean value of unity. Thus, these initial deterministic models simulate a world in which prices and quantities and therefore net operating income are known with certainty. The model solutions gained from this abstraction of the real world are useful in providing insight into the impact of changes in the exogenously specified variables of interest in the average year.

Model Series 450

Relevant balance sheet and income data generated from the deterministic solutions to the four models of Series 450, those models characterized by an initial debt-to-asset ratio of 50 percent and trend rate of fixed asset appreciation, are presented in Tables 4.1 to 4.4. Table 4.1, the deterministic results from model FAST450B, indicates that on average the farmer who has attained an equity level of 50 percent in his business fares well with respect to accumulation of net worth over the ten year planning horizon modeled. Income net of all production expenses and interest on outstanding loans builds from $18,857 to $56,492 as the firm's equity nearly triples to $1,322,308 sustaining an annual growth in equity ranging from 14 to 9.4 percent and a terminal equity ratio of nearly 80 percent. As specified earlier, however, the firm's initial current ratio of 1.14 is unacceptable to the firm's lenders and is indicative of liquidity problems. Indeed the firm does manage to generate sufficient net income to cover interest due on outstanding loans, but

Table 4.1. Results of the deterministic run of Model FAST450B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	18,857	97,168	69,984	0	85,212	380,698	450,682	1.14
1982	22,715	101,443	72,408	474	88,110	365,473	437,881	1.15
1983	26,758	105,906	73,856	1,665	10,749	350,245	424,101	1.17
1984	30,896	110,566	74,871	3,009	93,108	335,020	409,891	1.19
1985	35,128	115,431	75,491	4,825	95,544	819,791	395,282	1.21
1986	39,409	120,510	74,963	6,085	97,276	304,562	380,525	1.24
1987	43,739	125,812	76,278	7,889	99,395	289,333	365,611	1.27
1988	48,051	131,348	76,814	9,317	101,359	274,105	350,919	1.30
1989	52,320	137,127	77,705	10,892	103,825	258,878	336,583	1.32
1990	56,492	143,161	79,279	12,516	107,023	243,650	322,929	1.34

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	450,687	5.58	14.00	50.00
1982	951,675	513,794	5.71	13.26	53.99
1983	1,006,034	581,933	5.84	12.54	57.84
1984	1,064,780	654,889	5.96	11.93	61.50
1985	1,128,271	732,989	6.08	11.38	64.97
1986	1,196,893	816,368	6.20	10.91	68.21
1987	1,271,060	905,449	6.31	10.48	71.24
1988	1,351,217	1,000,298	6.41	10.09	74.03
1989	1,437,842	1,101,259	6.51	9.74	76.59
1990	1,531,448	1,208,519	6.60	9.42	78.91
1991	1,632,588	1,322,308			

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.2. Results of the deterministic run of Model REFI450B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	20,258	97,168	0	0	18,027	450,681	450,681	5.39
1982	24,104	101,443	4,911	682	23,620	432,655	437,566	4.29
1983	28,139	105,906	8,792	1,926	28,745	414,629	423,421	3.68
1984	32,273	110,566	12,260	3,339	33,626	396,603	408,863	3.29
1985	36,493	115,431	15,358	5,245	38,630	378,576	393,934	2.99
1986	40,758	120,510	18,355	6,898	43,280	360,549	378,904	2.78
1987	45,048	125,812	21,328	8,321	47,676	342,522	363,850	2.64
1988	49,337	131,348	24,426	9,742	52,195	324,495	348,921	2.52
1989	53,580	137,127	27,908	11,371	57,306	306,467	334,375	2.39
1990	57,718	143,161	32,120	12,982	63,129	288,439	320,559	2.27

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	450,688	5.58	14.07	50.00
1982	951,675	514,109	5.71	13.32	54.02
1983	1,006,034	582,613	5.84	12.58	57.91
1984	1,064,780	655,917	5.96	11.96	61.60
1985	1,128,271	734,337	6.08	11.39	65.09
1986	1,196,893	817,989	6.20	10.91	68.34
1987	1,271,060	907,210	6.31	10.48	71.37
1988	1,351,217	1,002,296	6.41	10.09	74.18
1989	1,437,842	1,103,467	6.51	9.73	76.74
1990	1,531,448	1,210,889	6.60	9.41	79.07

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.3. Results of the deterministic run of Model LESM450B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	17,147	97,168	48,584	69	65,450	398,811	447,395	1.48
1982	20,763	101,443	52,734	823	70,354	381,411	434,145	1.44
1983	24,731	105,906	54,712	1,836	73,345	363,708	418,420	1.44
1984	28,791	110,566	56,282	2,899	75,978	345,660	401,942	1.46
1985	32,950	115,431	57,426	4,321	78,544	327,214	384,640	1.47
1986	41,879	120,510	58,325	5,525	80,505	308,317	366,642	1.50
1987	45,752	125,812	61,902	8,553	85,683	289,333	351,235	1.47
1988	50,111	131,348	62,101	10,031	87,360	274,105	336,206	1.50
1989	54,425	137,127	62,669	11,692	89,589	258,878	321,547	1.53
1990	58,635	143,161	63,968	13,330	92,526	243,650	307,618	1.55

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	879,971	21,399	901,370	453,975	5.58	14.00	50.36
1982	929,315	22,360	951,675	517,530	5.71	13.54	54.38
1983	982,647	23,388	1,006,035	587,615	5.84	12.80	58.41
1984	1,040,294	24,486	1,064,780	662,838	5.96	12.19	62.25
1985	1,102,610	25,661	1,128,271	743,631	6.08	11.65	65.91
1986	1,196,894	0	1,196,894	803,252	6.20	10.79	69.37
1987	1,271,061	0	1,271,061	919,826	6.31	10.35	72.37
1988	1,351,219	0	1,351,219	1,015,013	6.41	9.98	75.12
1989	1,437,844	0	1,437,844	1,116,297	6.51	9.63	77.64
1990	1,531,450	0	1,531,450	1,223,832	6.60	9.32	79.91

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.4. Results of the deterministic run of Model LESLF450

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Current Ratio
	$	$	$	$	$	
1981	46,460	97,168	69,984	4,446	96,511	1.01
1982	50,095	101,443	48,529	6,960	77,570	1.31
1983	53,609	105,906	27,311	9,259	58,651	1.81
1984	56,824	110,566	7,493	11,489	41,063	2.69
1985	60,020	117,445	0	13,392	35,473	3.31
1986	63,230	125,878	0	14,218	36,299	3.47
1987	66,241	134,507	0	15,723	37,804	3.56
1988	68,917	143,213	0	16,888	38,969	3.68
1989	71,193	151,961	0	17,948	40,029	3.80
1990	72,982	160,690	0	18,791	40,872	3.93

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	$	%	%	%
1981	520,667	380,702	901,369	450,683	6.34	11.03	86.56
1982	548,919	409,635	958,554	500,390	6.43	10.33	91.16
1983	579,409	440,767	1,020,176	552,098	6.51	9.55	95.29
1984	612,324	474,264	1,086,588	604,831	7.60	8.93	98.78
1985	658,859	510,308	1,169,167	658,859	8.20	8.66	100.00
1986	715,943	549,091	1,265,034	715,943	8.08	8.45	100.00
1987	776,462	590,882	1,367,284	776,462	7.93	8.18	100.00
1988	839,965	635,724	1,475,689	839,965	7.78	7.92	100.00
1989	906,455	684,038	1,590,493	906,455	7.63	7.65	100.00
1990	975,790	736,025	1,711,815	975,790	7.48	7.38	100.00

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

principal payment obligations are not met as shown by the gradual increase in current borrowing throughout the planning horizon. Although the rate of appreciation of the firm's current assets does exceed the rate of accumulation of current debt resulting in an improving current ratio over time, the firm's initial outstanding obligations are too great to allow the firm to attain a current ratio which exceeds the lender-specified threshold value of 1.5.

Restructuring the firm's balance sheet so that all initial debt is long-term debt as in model REFI450B (Table 4.2) leaves the firm's accumulation of equity nearly unchanged relative to that of model FAST450B. Net income net of production and interest expense is improved relative to that of model FAST450B by the amount of the reduction in annual interest payments due as the firm receives the more favorable 12 percent interest rate on its entire initial debt load compared to the 14 percent rate on the shorter term obligations. Nonetheless the firm's income is unable to meet all annual principal obligations resulting in accumulating current debt and a declining current ratio. However, in this instance the disparity between the rate of appreciation of current assets and the rate of accumulation of current debt is sufficient to maintain a current ratio well in excess of the threshold value of 1.5. Given the growth in the firm's equity in addition to the favorable liquidity position, the firm's lenders are assumed to continue to react favorably to its credit needs throughout the ten-year model period. Hence, the liquidity crisis which beset the firm of model FAST450B is successfully averted.

The second proposed method of restructuring the firm's liabilities is to finance the acquisition of the nonequity portion of the firm's machinery with a five-year financial lease rather than a one-year loan as specified in model LESM450B (Table 4.3). The firm's rate of equity accumulation is slightly improved over that attained in the previous two models, and the firm again attains a terminal equity ratio of nearly 80 percent. Initially the firm's net income after payment of interest and its annual lease obligation is reduced by the amount that the 22 percent lease payment in model LESM450B exceeds the 14 percent interest payment of model FAST450B which amounts to $1710. This deleterious impact on net income persists until the end of the lease period in 1986. The firm's annual current borrowing grows very gradually throughout the planning horizon maintaining a level intermediate to that of models FAST450B and REFI450B. Initially the firm's fixed liabilities are greater than in FAST450B due to the presence of the five-year lease obligation, but following the end of the machinery lease period the firms of FAST450B and LESM450B have identical fixed obligations associated with the outstanding real estate debt.

Of particultar interest in this case is the improvement in the firm's current ratio relative to that of FAST450B throughout the entire planning horizon. Neither firm is successful in generating sufficient net income to fully cover all annual principal payments. However, the firm of LESM450B maintains a lower level of current liabilities during the first five years of the planning horizon by shifting its machinery debt obligation into the fixed obligation column thereby maintaining a current ratio of nearly 1.5. After the termination of the machinery lease the appreciation of the firm's current assets outpaces the accumulation of current debt, and the current ratio improves through the remainder of the model period to a value of 1.55. Once again an existence threatening liquidity crisis has been successfully avoided.

The third financial strategy considered in this study is the sale-leaseback of the indebted portion of the firm's land as specified in model LESLF450 (Table 4.4). The most striking feature of Table 4.4 is the improvement in net income relative to the results presented for the three models discussed above. This benefit accrues to the firm as a result of the elimination of the firm's real estate debt and the attendant annual interest payments on that debt. Indeed the firm now has sufficient net income available for the payment of taxes, family living expenses, and principal obligations to retire the firm's entire initial debt load of $69,984 by the end of the fourth year of the planning horizon and to invest additional equity capital in the acquisition of additional assets. The result is a more rapid growth of the size of the firm as measured by the value of total assets under its control, both owned and leased, and thus a terminal firm size $207,208 or 12.7 percent larger than in the three scenarios discussed previously. However, the firm in this model does not reap the benefits of the appreciation in the value of the leased land. Thus, the firm of LESLF450 realizes a much slower rate of growth in equity relative to the three models in which all land controlled was owned. In return for a reduced rate of equity growth, the firm's current ratio climbs rapidly, and the firm is debt-free and thus free of financial risk by the fifth year of the planning horizon.

Model Series 453

The results of the initial deterministic runs of the four models of Series 453, those models characterized by an initial equity ratio of 50 percent and essentially no appreciation in the value of fixed assets, are displayed in Tables 4.5 to 4.8. The most prominent feature distinguishing the results of the models of Series 453 from their counterparts in Series 450 is the reduction in the rate of growth of assets controlled by the firm from an annual rate of approximately six percent to an annual rate of less than one percent as the appreciation of the firm's land base stagnates. The annual rate of growth of the firm's equity falls in turn to a level of approximately four percent as the firm's net worth grows through the model period to a level slightly greater than half that of each of the corresponding models of Series 450. In essence, appreciation in the value of owned land is not an available vehicle for substantial net worth accumulation for the farms of Series 453.

Other results from these deterministic runs of the four models of Series 453 parallel those obtained using the models of Series 450 as decribed above. However, in each model of Series 453 net income increases more rapidly during the ten-year time span than in the corresponding model of Series 450, a feature arising from the negative sign of the coefficient of fixed and intermediate assets in the equation estimating NOI (Eq. 3-1) as discussed earlier. With additional net income available for meeting

Table 4.5. Results of the deterministic run of Model FAST453B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	18,857	97,168	69,984	0	85,212	380,698	450,682	1.14
1982	24,538	101,443	72,408	753	88,389	365,473	437,881	1.15
1983	30,616	105,906	73,509	2,376	91,113	350,245	423,754	1.16
1984	37,031	110,566	73,717	4,571	93,516	335,020	408,737	1.18
1985	43,783	115,431	73,159	7,885	96,272	319,791	392,950	1.20
1986	50,806	120,510	72,342	10,281	97,851	304,562	376,904	1.23
1987	58,148	125,812	71,025	13,079	99,332	289,333	360,358	1.27
1988	65,759	131,348	69,586	16,063	100,877	274,105	343,691	1.30
1989	73,604	137,127	68,377	19,381	102,986	258,878	327,255	1.33
1990	81,627	143,161	67,872	22,794	105,894	243,650	311,522	1.35

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	.
1981	901,369	450,687	0.77	4.37	50.00
1982	908,275	470,394	0.78	4.50	51.79
1983	915,328	491,574	0.79	4.52	53.70
1984	922,552	513,815	0.80	4.52	55.69
1985	929,974	537,024	0.82	4.41	57.75
1986	937,619	560,715	0.84	4.36	59.80
1987	945,515	585,157	0.86	4.25	61.89
1988	953,691	610,000	0.89	4.09	63.96
1989	962,178	634,923	0.92	3.87	65.99
1990	971,006	659,484	0.95	3.61	67.92

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.6. Results of the deterministic run of Model REFI453B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	20,258	97,168	0	0	18,027	450,681	450,681	5.39
1982	25,927	101,443	4,911	963	23,901	432,655	437,566	4.24
1983	32,007	105,906	8,379	2,569	23,975	414,629	423,008	3.66
1984	38,434	110,566	10,914	4,825	33,766	396,603	407,517	3.27
1985	45,195	115,431	12,689	8,351	39,076	378,576	391,265	2.95
1986	52,215	120,510	14,299	10,817	43,143	360,549	374,848	2.79
1987	59,547	125,812	15,433	13,611	47,071	342,522	357,955	2.67
1988	67,150	131,348	16,451	16,647	51,125	324,495	340,946	2.57
1989	74,982	137,127	17,732	19,960	55,719	306,467	324,199	2.46
1990	82,991	143,161	19,733	23,366	61,126	288,439	308,172	2.34

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	450,688	0.77	4.44	50.00
1982	908,275	470,709	0.78	4.59	51.82
1983	915,328	492,320	0.79	4.61	53.79
1984	922,552	515,035	0.80	4.60	55.83
1985	929,974	538,709	0.82	4.47	57.93
1986	937,619	562,771	0.84	4.40	60.02
1987	945,515	587,560	0.86	4.29	62.14
1988	953,691	612,745	0.89	4.12	64.25
1989	962,178	637,979	0.92	3.90	66.31
1990	971,006	662,834	0.95	3.63	68.26

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.7. Results of the deterministic run of Model LESM453B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	17,147	97,168	48,584	69	65,450	398,811	447,395	1.48
1982	22,586	101,443	52,734	1,105	70,636	381,411	434,145	1.43
1983	28,564	105,906	54,549	2,467	73,813	363,708	418,257	1.43
1984	34,871	110,566	55,524	4,321	76,642	345,660	401,184	1.44
1985	41,521	115,431	55,688	7,138	79,623	327,214	382,902	1.45
1986	53,172	120,510	55,443	9,582	81,680	308,317	363,760	1.48
1987	60,103	125,812	57,060	13,822	86,110	289,333	346,393	1.46
1988	67,778	131,348	55,165	16,911	87,304	274,105	329,270	1.50
1989	75,685	137,127	53,514	20,255	88,997	258,878	312,392	1.54
1990	83,770	143,161	52,569	23,693	91,490	243,650	296,219	1.56

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	879,971	21,399	901,370	453,975	0.77	4.44	50.36
1982	885,915	22,360	908,275	474,130	0.78	4.84	52.20
1983	891,935	23,393	915,328	497,071	0.79	4.89	54.31
1984	898,049	24,504	922,553	521,369	0.80	4.93	56.51
1985	904,276	25,698	929,974	547,072	0.82	4.90	58.83
1986	937,620	0	937,620	573,860	0.84	4.40	61.20
1987	945,516	0	945,516	599,123	0.86	4.22	63.36
1988	953,692	0	953,692	624,422	0.89	4.06	65.47
1989	962,179	0	962,179	649,787	0.92	3.85	67.53
1990	971,008	0	971,008	674,789	0.95	3.59	69.49

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.8. Results of the deterministic run of Model LESLF453B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Current Ratio
	$	$	$	$	$	
1981	46,460	97,168	69,984	4,446	96,511	1.01
1982	53,062	101,443	48,529	4,940	78,550	1.29
1983	59,994	105,906	26,086	11,608	59,775	1.77
1984	67,090	110,566	3,888	15,414	41,383	2.67
1985	75,343	119,201	0	18,903	40,984	2.91
1986	84,640	129,467	0	22,757	44,838	2.89
1987	94,717	140,486	0	27,212	49,293	2.85
1988	105,548	152,223	0	32,037	54,118	2.81
1989	117,105	164,649	0	37,263	59,344	2.77
1990	129,334	177,700	0	43,265	65,346	2.72

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	520,667	380,702	901,369	450,683	1.53	6.21	86.56
1982	527,219	387,934	915,153	478,690	1.55	6.12	90.80
1983	534,061	395,305	929,366	507,975	1.58	5.78	95.12
1984	541,222	402,815	944,037	537,334	3.53	5.50	99.28
1985	566,906	410,468	977,374	566,906	4.04	5.60	100.00
1986	598,640	418,267	1,016,907	598,640	4.06	5.56	100.00
1987	631,949	426,214	1,058,163	631,949	4.04	5.48	100.00
1988	666,560	434,311	1,100,871	666,560	3.99	5.35	100.00
1989	702,254	442,563	1,144,817	702,254	3.92	5.19	100.00
1990	738,708	450,971	1,189,679	738,708	3.80	4.95	100.00

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

debt service obligations, family living expenses, and income taxes after production expenses and interest, the firm's annual current borrowing grows more slowly than in each analogous scenario of Series 450.

Nonetheless, the firm of model FAST453B, as was its counterpart in model FAST450B, is confronted with an existence-threatening liquidity crisis as defined by the failure of the firm to maintain its current ratio above the threshold level of 1.5. As was the case in the scenarios of Series 450, the liquidity crisis can be averted if the firm is provided the opportunity to restructure its liabilities by converting its initial short- and intermediate-term debt to long-term debt as specified in model REFI453B. Under the assumption of no appreciation of land values as specified in the models of Series 453, however, the availability of this debt-restructuring strategy to the farmer is expected to be extremely limited if available at all. Thus, the firm would be forced to rely on one of the other financial strategies included in the analysis, the sale-leaseback of indebted machinery or of indebted land. As in the analysis of these strategies under the assumptions included in the models of Series 450, the sale-leaseback of the firm's indebted machinery narrowly averts the firm's liquidity bottleneck by extending the machinery "payment" period over a span of five years, whereas the sale-leaseback of the firm's indebted land again allows the firm to become debt-free and thus free of all financial risk after only five years.

Model Series 470

The results of the deterministic runs of the four models of Series 470, those models characterized by an initial 70 percent debt-to-asset ratio and trend growth of all asset values, are displayed in Tables 4.9 to 4.12. The results from the first of these models, FAST470B, the model incorporating the most stringent debt retirement scheme of the four, indicates that this more highly leveraged firm is unable to maintain a positive cash flow as shown by a rapidly deteriorating current ratio. In fact net income after payment of production expenses and interest assumes negative values in the first four years of the planning period and grows very slowly thereafter.[1]

As a result of the firm's low level of income, almost no progress is made in the retirement of outstanding debt; the firm must borrow heavily in the short-term market each year in order to meet its longer term obligations. Indeed, short-term debt more than triples over the ten-year period modeled. Consequently the current ratio deteriorates rapidly from the already unacceptable level of 0.81.

Nonetheless, if a source of credit were available to allow the continuance of this operation through an additional ten years as modeled, the trend appreciation of the firm's assets would serve to increase the firm's initial equity by more than 350 percent. The annual rate of growth

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[1]The ISU Business and Financial Planner is not designed to accomodate negative values of net income; proper treatment of tax considerations of operating losses is not built into this model. However, where negative values of net income appear, the magnitude of the values is small, and the model results are therefore believed to be qualitatively reliable.

Table 4.9. Results of the deterministic run of Model FAST470B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	-3,333	97,168	97,976	0	119,295	532,943	630,919	0.81
1982	-2,697	101,443	128,622	0	149,941	511,627	640,249	0.68
1983	-1,924	105,906	158,632	0	179,951	490,309	648,941	0.59
1984	-1,003	110,566	187,869	0	209,188	468,993	656,862	0.53
1985	83	115,431	216,183	0	237,502	447,677	663,860	0.49
1986	1,348	120,510	243,412	0	264,731	426,362	669,774	0.46
1987	2,816	125,812	269,376	0	290,695	405,045	674,421	0.43
1988	4,505	131,348	293,871	0	315,190	383,730	677,601	0.42
1989	6,438	137,127	316,678	0	337,997	362,415	679,093	0.41
1990	8,639	143,161	337,551	69	358,939	341,102	678,653	0.40

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	270,450	5.58	15.15	30.00
1982	951,675	311,426	5.71	14.66	32.72
1983	1,006,034	357,093	5.84	14.23	35.50
1984	1,064,780	407,918	5.96	13.85	38.31
1985	1,128,271	464,411	6.08	13.50	41.16
1986	1,196,893	527,119	6.20	13.19	44.04
1987	1,271,060	596,639	6.31	12.90	46.94
1988	1,351,217	673,616	6.41	12.64	49.85
1989	1,437,842	758,749	6.51	12.39	52.77
1990	1,531,448	852,795	6.60	12.16	55.69

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.10. Results of the deterministic run of Model REFI470B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	-1,374	97,168	0	0	25,238	630,962	630,962	3.85
1982	-542	101,443	32,613	0	57,851	605,724	638,337	1.75
1983	453	105,906	64,394	0	89,632	580,485	644,879	1.18
1984	1,626	110,566	95,180	0	120,418	555,247	650,427	0.92
1985	3,001	115,431	124,793	0	150,031	530,008	654,801	0.77
1986	4,596	120,510	153,030	0	178,268	504,770	657,800	0.68
1987	6,440	125,812	179,672	0	204,910	479,530	659,202	0.61
1988	8,555	131,348	204,470	14	229,722	454,292	658,762	0.57
1989	10,974	137,127	227,168	294	252,700	429,052	656,220	0.54
1990	13,688	143,161	247,726	682	273,646	403,813	651,539	0.52

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	270,407	5.58	15.88	30.00
1982	951,675	313,338	5.71	15.26	32.92
1983	1,006,034	361,155	5.84	14.73	35.90
1984	1,064,780	414,353	5.96	14.27	38.91
1985	1,128,271	473,470	6.08	13.86	41.96
1986	1,196,893	539,093	6.20	13.50	45.04
1987	1,271,060	611,858	6.31	13.17	48.14
1988	1,351,217	692,455	6.41	12.88	51.25
1989	1,437,842	781,622	6.51	12.57	54.36
1990	1,531,448	879,909	6.60	12.29	57.46

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.11. Results of the deterministic run of Model LESM470B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	-5,730	97,168	68,018	0	91,534	558,300	626,318	1.06
1982	-5,430	101,443	101,061	0	124,577	533,943	635,004	0.81
1983	-5,039	105,906	133,803	0	157,319	509,158	642,961	0.67
1984	-4,554	110,566	166,155	0	189,671	483,890	650,045	0.58
1985	-3,965	115,431	198,021	0	221,537	458,068	656,089	0.52
1986	3,324	120,510	229,298	0	252,614	431,617	660,915	0.48
1987	4,230	125,812	259,277	0	280,596	405,045	664,322	0.45
1988	6,117	131,348	282,359	0	303,678	383,730	666,089	0.43
1989	8,275	137,127	303,553	14	324,886	362,415	665,968	0.42
1990	10,732	143,161	322,604	294	344,217	341,102	663,706	0.42

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	871,411	29,958	901,369	275,051	5.58	15.13	30.51
1982	920,371	31,304	951,675	316,671	5.71	14.65	33.28
1983	973,291	32,742	1,006,033	363,072	5.84	14.23	36.09
1984	1,030,499	34,281	1,064,780	414,735	5.96	13.85	38.95
1985	1,092,345	35,925	1,128,270	472,181	6.08	13.51	41.85
1986	1,196,893	0	1,196,893	535,978	6.20	13.20	44.78
1987	1,271,060	0	1,271,060	606,738	6.31	12.92	47.73
1988	1,351,217	0	1,351,217	685,128	6.41	12.66	50.70
1989	1,437,842	0	1,437,842	771,874	6.51	12.42	53.69
1990	1,531,448	0	1,531,448	867,742	6.60	12.17	56.66

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.12. Results of the deterministic run of Model LESLF470

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Current Ratio
	$	$	$	$	$	
1981	35,309	97,168	97,975	2,107	130,998	0.74
1982	37,315	101,443	83,110	3,229	117,252	0.87
1983	39,135	105,906	68,583	4,571	104,067	1.02
1984	40,564	110,566	55,719	5,665	92,297	1.20
1985	41,598	115,431	44,408	7,326	82,647	1.40
1986	42,142	120,510	35,180	7,509	73,602	1.64
1987	42,229	125,812	27,623	7,540	66,076	1.90
1988	41,792	131,348	22,043	7,397	60,353	2.18
1989	40,763	137,127	18,726	7,063	56,702	2.42
1990	39,078	143,161	17,923	6,085	54,921	2.61

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	368,388	532,986	901,374	270,413	6.65	12.68	73.40
1982	387,818	573,492	961,310	304,708	6.71	11.63	78.57
1983	408,735	617,077	1,025,812	340,152	6.77	10.40	83.22
1984	431,260	663,974	1,095,234	375,541	6.82	9.47	87.08
1985	455,522	714,436	1,169,958	411,114	6.88	8.60	90.25
1986	481,664	768,733	1,250,397	446,484	6.93	8.00	92.70
1987	509,833	827,156	1,336,989	482,210	6.97	7.45	94.58
1988	540,194	890,019	1,430,213	518,151	7.02	6.96	95.92
1989	572,917	957,660	1,530,577	554,191	7.06	6.51	96.73
1990	608,193	1,030,441	1,638,634	590,270	7.10	6.14	97.05

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

of the owner's equity ranges from 15 to 12 percent, and the equity ratio grows from 30 to 56 percent during the model period. Although the firm is not insolvent, the firm's severe cash flow shortage that occurs from the outset of the planning horizon effectively eliminates the opportunity for the firm to remain in existence for a period of sufficient duration to realize the capital gains otherwise accruing to its assets.

The results from the first alternative considered for easing the high-leverage firm's intractable liquidity position, the restructuring of its liabilities as specified in model REFI470B, are presented in Table 4.10. Although a strategy of lengthening the repayment period for the firm's initial short- and intermediate-term debt was effective in reducing the pressure on the cash flow for the firm with an initial equity ratio of 50 percent, the income generated by the more highly leveraged firm of model REFI470B remains insufficient to meet even this relaxed repayment schedule. The current ratio does exceed the critical value of unity for the first three years modeled, but net income is initially negative and remains at low levels as short-term debt explodes to $247,726 in ten years. Again the firm is not in existence long enough for capital gains to accrue.

Although a sale-leaseback arrangement for the indebted portion of the machinery of the firm of model LESM450B was just sufficient to provide the firm with existence-preserving latitude in its cash flow, a similar arrangement for the firm of model LESM470B (Table 4.11) is not sufficient to allow for more than a temporary alleviation of the firm's liquidity problem. The five-year financial lease in the place of a one-year loan on machinery valued at $29,960 does reduce initial current obligations sufficiently to boost the current ratio above the critical value of unity for one year. Thereafter, however, net income continues to fall short of debt service obligations, short-term debt mounts, and the current ratio deteriorates.

Only the final strategy, that of leasing rather than owning the indebted portion of the firm's land as presented in model LESLF470 (Table 4.12), reduces the firm's debt load sufficiently that income is consistent with periodic debt-service obligations. As a result of the elimination of the firm's real estate debt and the attendant annual interest payments, net income available for family living expenses, taxes, and debt-retirement is increased to the $35,000 to $40,000 range. Hence, the firm now has sufficient cash flow to gradually retire the debt against its current assets and machinery reducing its outstanding obligation from $97,975 to $17,923 during the ten-year program. In addition the current ratio shows steady improvement from the initially unacceptable level of 0.74 attaining a value exceeding unity in the third model year. In forfeiting ownership of the land, the firm does sacrifice capital gains potentially accruing to owned land. Nonetheless, the firm's equity increases at an annual rate ranging from 12.7 to 6.1 percent for a total growth of 230 percent over the planning horizon. By reducing its debt load to a serviceable level, the firm has positioned itself to benefit from a more modest but attainable level of net worth accumulation through operating earnings as well as capital appreciation.

Model Series 473

As discussed previously, lowering the exogenously specified rate of appreciation of the value of fixed assets in the ISU Business and Financial Planner imparts a positive increment to net income as shown by a comparison of the results of the deterministic runs of the models of Series 473 (Tables 4.13 to 4.16) with those of Series 470 as discussed in the preceding paragraphs. Although net income is considerably higher in each year of the planning horizon after the initial year in each model of Series 473 relative to the corresponding model of Series 470, in general the results from the two sets of models are qualitatively identical. The major difference distinguishing the results of the two sets of models is the reduced rate of equity accumulation in the models of Series 473 relative to the corresponding models of Series 470 as the stagnant land market of Series 473 does not provide the firm with the large capital gains available in the scenarios of Series 470.

The firm of model FAST473B (Table 4.13) is unable to generate sufficient net income to cover family living expenses and principal payment obligations resulting in extensive annual short-term borrowing and an unfavorable and deteriorating current ratio. Restructuring the firm's liabilities according to the scenario of REFI473B (Table 4.14) temporarily eases the firm's cash flow crisis, but income is inadequate to cover debt service obligations, short-term borrowing mounts, and the current ratio plunges below the critical value of unity in year four. The use of a financial lease rather than borrowing to finance the acquisition of machinery similarly imparts an only temporary amelioration of the firm's

Table 4.13. Results of the deterministic run of Model FAST473B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	-3,333	97,168	97,976	0	119,295	532,943	630,919	0.81
1982	-875	101,443	128,622	0	149,941	511,627	640,249	0.68
1983	2,139	105,906	156,809	0	178,128	490,309	647,118	0.59
1984	5,794	110,566	181,981	0	203,300	468,993	650,974	0.54
1985	10,187	115,431	203,498	179	224,996	447,677	651,175	0.51
1986	15,403	120,510	220,801	893	243,013	426,362	647,163	0.50
1987	21,497	125,812	233,603	1,836	256,758	405,045	638,648	0.49
1988	28,533	131,348	241,501	3,229	266,049	383,730	625,231	0.49
1989	35,561	137,127	251,353	4,965	277,637	362,415	613,768	0.49
1990	42,712	143,161	262,307	7,608	291,234	341,102	603,409	0.49

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	270,450	0.77	-0.90	30.00
1982	908,275	268,026	0.78	0.07	29.51
1983	915,328	268,210	0.79	1.26	29.30
1984	922,552	271,578	0.80	2.66	29.44
1985	929,974	278,799	0.82	4.18	29.98
1986	937,619	290,456	0.84	5.65	30.98
1987	945,515	306,867	0.86	7.04	32.46
1988	953,691	328,460	0.89	6.07	34.44
1989	962,178	348,410	0.92	5.51	36.21
1990	971,006	367,597	0.95	4.99	37.86

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.14. Results of the deterministic run of Model REFI473B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	-1,374	97,168	0	0	25,238	630,962	630,962	3.85
1982	1,280	101,443	32,613	0	57,851	605,724	638,337	1.75
1983	4,518	105,906	62,571	0	87,809	580,485	643,056	1.21
1984	8,424	110,566	89,292	0	114,530	555,247	644,539	0.97
1985	13,106	115,431	112,107	542	137,887	530,008	642,115	0.84
1986	18,600	120,510	130,782	1,345	157,365	504,770	635,552	0.77
1987	25,000	125,812	144,765	2,467	172,470	479,530	624,295	0.73
1988	31,803	131,348	157,672	4,071	186,981	454,292	911,964	0.70
1989	38,728	137,127	171,626	5,845	202,709	429,052	600,678	0.68
1990	45,807	143,161	186,436	8,629	220,303	403,813	590,249	0.65

Year	Total Assets	Total Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	%	%	
1981	901,369	270,407	0.77	-0.17	30.00
1982	908,275	269,938	0.78	0.86	29.72
1983	915,328	272,272	0.79	2.11	29.75
1984	922,552	278,013	0.80	3.54	30.14
1985	929,974	287,859	0.82	4.94	30.95
1986	937,619	302,067	0.84	6.34	32.22
1987	945,515	321,220	0.86	6.38	33.97
1988	953,691	341,727	0.89	5.79	35.83
1989	962,178	361,500	0.92	5.33	37.57
1990	971,006	380,757	0.95	4.86	39.21

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.15. Results of the deterministic run of Model LESM473B

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Fixed Liab.	Total Liab.	Current Ratio
	$	$	$	$	$	$	$	
1981	-5,730	97,168	68,018	0	91,534	558,300	626,318	1.06
1982	-3,607	101,443	101,061	0	124,577	533,943	635,004	0.81
1983	-975	105,906	131,980	0	155,496	509,158	641,138	0.68
1984	2,243	110,566	160,267	0	183,783	483,890	644,157	0.60
1985	6,139	115,431	185,336	0	208,852	458,068	643,404	0.55
1986	17,404	120,510	206,508	354	230,178	431,617	638,125	0.52
1987	23,015	125,812	222,761	2,107	246,187	405,045	627,806	0.51
1988	29,962	131,348	231,294	3,571	256,184	383,730	615,024	0.51
1989	36,974	137,127	241,263	5,385	267,967	362,415	603,678	0.51
1990	44,125	143,161	252,215	8,074	281,608	341,102	593,317	0.51

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	871,411	29,958	901,369	275,051	0.77	-0.65	30.51
1982	876,971	31,304	908,275	273,271	0.78	0.34	30.09
1983	882,577	32,750	915,327	274,189	0.79	1.53	29.96
1984	888,246	34,305	922,551	278,394	0.80	2.94	30.18
1985	893,996	35,977	929,973	286,569	0.82	4.51	30.81
1986	937,619	0	937,619	299,494	0.84	6.08	31.94
1987	945,515	0	945,515	317,709	0.86	6.60	33.60
1988	953,691	0	953,691	338,667	0.89	5.86	35.51
1989	962,178	0	962,178	358,500	0.92	5.35	37.26
1990	971,006	0	971,006	377,689	0.95	4.87	38.90

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

Table 4.16. Results of the deterministic run of Model LESLF473

Year	Net Income[a]	Current Assets	Current Borrow.	Income Taxes	Current Liab.[b]	Current Ratio
	$	$	$	$	$	
1981	35,309	97,168	97,975	2,107	130,998	0.74
1982	40,740	101,443	83,110	4,071	118,904	0.86
1983	46,525	105,906	67,037	7,009	104,959	1.01
1984	52,447	110,566	51,356	9,894	92,163	1.20
1985	53,536	115,431	35,906	13,392	80,211	1.44
1986	64,737	120,510	21,152	15,814	67,879	1.78
1987	71,108	125,812	6,733	18,492	56,138	2.24
1988	73,765	133,482	0	21,109	52,022	2.57
1989	88,230	143,887	0	24,257	55,170	2.61
1990	98,206	154,779	0	29,150	60,063	2.58

Year	Assets Owned	Assets Leased	Total Assets	Equity	Asset Growth	Equity Growth	Equity Ratio
	$	$	$	$	%	%	%
1981	368,388	532,986	901,374	270,413	1.83	7.87	73.40
1982	374,798	543,112	917,910	291,688	1.86	7.82	77.83
1983	381,530	553,430	934,960	314,493	1.88	7.24	82.43
1984	388,611	563,945	952,556	337,255	1.91	6.79	86.78
1985	396,067	574,660	970,727	360,161	1.93	6.28	90.93
1986	403,930	585,578	989,508	382,778	1.96	5.93	94.76
1987	412,228	596,703	1,008,931	405,495	2.68	5.52	98.37
1988	427,893	608,040	1,035,933	427,893	3.41	5.55	100.00
1989	451,636	619,592	1,071,228	451,636	3.37	5.40	100.00
1990	476,014	631,364	1,107,378	476,014	3.24	5.01	100.00

[a]Income net of all production expenses and interest.

[b]Includes current borrowings, portion of intermediate- and long-term debt and rent due in following year, and income tax liability.

liquidity difficulties as shown by model LESM473B (Table 4.15). As in the previous model series, however, the sale-leaseback of the indebted portion of the firm's land (model LESLF473, Table 4.16) reduces the firm's debt service obligations to the extent that net income is sufficient to allow for relatively rapid retirement of the remaining shorter-term obligations such that the firm is debt-free and capable of investing additional equity capital by the eighth year of the planning horizon.

Stochastic Runs

Model Series 450

The simulation results discussed above were all obtained by setting the Monte Carlo variate used in deriving NOI at its mean value of unity. In order to simulate the production risk inherent in the agricultural production environment, the Monte Carlo variate is now allowed to vary about its mean value of unity in an additional 50 runs of each of the 16 models specified in Table 3.2. The results of the 50 simulations of each model in which NOI is stochastic are summarized in Table 4.17.

In the initial year of the planning horizon of model FAST450B, the firm's current ratio is 1.14 due to the inclusion of the firm's entire machinery debt and the current year's portion of the land debt in current liabilities. In 45 of the 50 stochastic runs of this model (90 percent), the firm fails to attain a current ratio of two by the end of the second year of the planning horizon or to maintain a current ratio of two or greater through the end of the planning horizon. Similarly the probability of an existence-threatening liquidity crisis falls to 62

Table 4.17. Results From 50 Stochastic Runs of Each Model

Model	P(C.R < __)			Terminal Equity	Range	
Series 450	1.0	1.5	2.0	Value	Ratio	Member of Efficient Set[a]
	--	%	--	$	%	
FAST450B	14	62	90	1,297,776	77.15	No
				1,580,763	85.42	
REFI450B	0	4	12	1,305,890	77.66	Yes
				1,628,102	83.57	
LESM450B	8	36	64	1,307,656	77.78	Yes
				1,606,728	85.61	
LESLF450	0	2	10	1,079,232	100	No
				1,709,469	100	
Series 453						
FAST453B	14	56	92	676,692	66.72	No (No)
				1,022,629	79.12	
REFI453B	0	2	12	685,322	67.56	No (No)
				1,046,486	76.56	
LESM453B	8	28	56	686,736	67.73	No (Yes)
				1,043,886	79.44	
LESLF453	0	2	20	815,569	100	Yes
				1,639,984	100	

Series 470						
FAST470B	100	100	100	879,571	51.57	No
				1,202,660	70.00	
REFI70B	66	90	98	908,208	53.14	Yes
				1,213,623	71.14	
LESM470B	96	100	100	895,041	52.46	Yes
				1,229,925	71.67	
LESLF470	8	54	90	646,140	99.62	No
				1,212,238	100	
Series 473						
FAST473B	100	100	100	317,960	29.04	No (No)
				617,991	57.67	
REFI473B	42	76	94	336,898	30.82	No (Yes)
				633,236	59.04	
LESM473B	94	100	100	334,957	30.69	No (Yes)
				644,539	60.21	
LESLF473	8	48	88	532,095	100	Yes
				1,422,969	100	

[a]Parentheses indicate a comparison of the three dominated strategies excluding Model LESLF453 or Model LESLF473.

percent if the firm's lender is willing to tolerate a current ratio of 1.5. In 14 percent of the runs the firm was unable to maintain a current ratio above a value of unity throughout the planning horizon.

If the firm is provided the opportunity to convert all debts to long-term liabilities as in model REFI450B, the probability of the firm's maintaining a strong cash position rises substantially. The probability of a cash flow shortage as defined by a current ratio less than two is reduced from 90 percent as in model FAST450B to only 12 percent. In only four percent of the runs does the firm's current ratio fall below a value of 1.5, and in no instance does the current ratio fall below a value of unity under the scenario of model REFI450B. Lengthening the machinery payment period to five years with a financial lease (model LESM450B) is less effective than refinancing all initial shorter term liabilities in reducing the probability of the occurrence of a liquidity problem during the ten-year planning horizon. In 64 percent of the simulations of model LESM450B, the current ratio slips below the initial level of two, in 36 percent of the 50 simulations the current ratio falls beneath 1.5 at some point during the ten-year planning horizon, and in eight percent of these runs the firm's current ratio falls below a value of unity. Finally, the sale-leaseback of the indebted portion of the firm's land (model LESLF450) is slightly more effective than the strategy of refinancing all short- and intermediate-term debt in averting a cash-flow crisis. The firm operating under the scenario of LESLF450 is able to attain and maintain a current ratio of two as required in 45 simulations of the model, and a current ratio exceeding 1.5 is maintained in 49 of the model simulations.

The final step in evaluating the results of the stochastic simulations of the models of Series 450 is the comparison of the distribution of terminal net worth generated under each financial strategy considered according to the theorems of stochastic dominance. Calculations used in determining dominance among the financial strategies considered in this analysis follow the method outlined by Anderson et al. (1977) for discrete distributions.

The CDF's of terminal net worth for the models of Series 450 are displayed in Figure 4.1. In an environment of trend appreciation of land values, the strategy embodying the most severe debt repayment schedule, model FAST450B, is dominated in the sense of first-degree stochastic efficiency by the strategy of refinancing the firm's initial current- and intermediate-term debt (model REFI450B) and the strategy of financing the otherwise indebted portion of the firm's machinery with a financial lease rather than borrowed capital (model LESM450B). However, the assumption of nonsatiation with respect to net worth is not sufficient for determining the members of the efficient set from among the remaining three models of Series 450B. An appeal to the more restrictive but plausible behavioral assumption of risk aversion provides for the elimination of the strategy involving the sale-leaseback of the firm's indebted land (model LESLF450) from the efficient set; the strategy of model REFI450B dominates that of LESLF450 in the sense of second-degree stochastic efficiency. Finally, resorting to the even more restrictive behavioral assumption of decreasing absolute risk aversion in addition to nonsatiation and risk aversion is not sufficient to eliminate either the strategy of model REFI450B or that

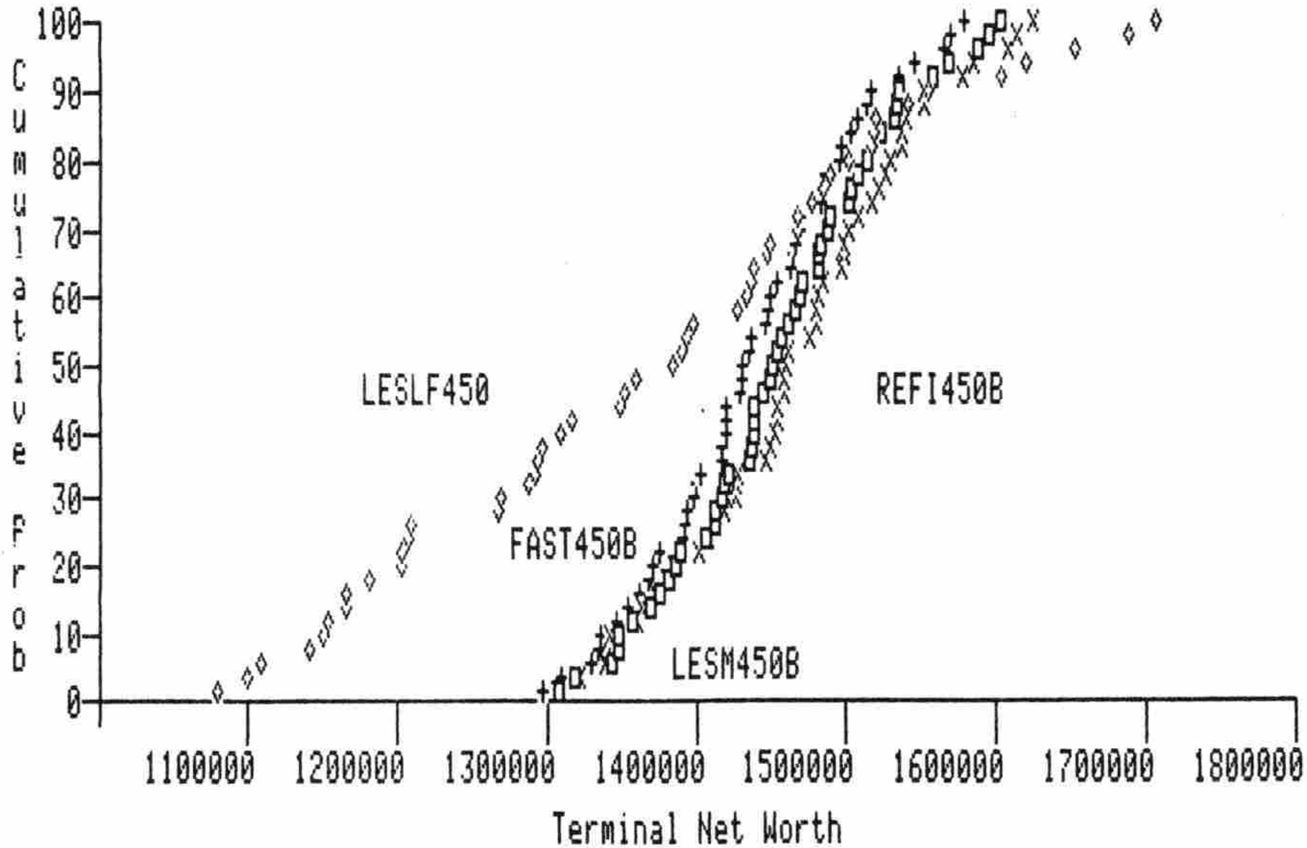

Figure 4.1. Cumulative distribution functions for the models of Series 450

of model LESM450B from the efficient set with respect to third-degree stochastic efficiency as shown in Table 4.18.

Given that the intent of the firm is the maximization of terminal net worth subject to the condition that the firm's interim survival is not jeopardized by a liquidity crisis at some point during the planning horizon, the strategy of model REFI450B is the strategy of choice. The probability of an existence-threatening liquidity crisis in these 50 trials of model REFI450B is only four percent compared with a corresponding probability of 36 percent (using the value of 1.5 as the minimally acceptable level of the current ratio) for the other member of the efficient set, model LESM450B.

Model Series 453

As shown in Table 4.17, the results from the 50 stochastic simulations of each of the four models of series 453 parallel those of Series 450 precisely. The strategy of leasing the otherwise indebted portion of the firm's machinery (model LESM453B) is moderately successful in reducing the probability of a liquidity crisis for the firm, whereas the strategies of refinancing the firm's shorter term obligations and leasing the otherwise indebted portion of the firm's land nearly eliminates the probability of a liquidity crisis as defined in this study in these 50 runs of each model. Hence, the reduction in the rate of land value appreciation did not have a qualitative effect on the probability of a liquidity crisis occurring under the financial scenarios studied. As was the case for the deterministic simulations to these models, the major

Table 4.18. Determination of the Efficient Set of Strategies in Each Model Series According to the Theorems of Stochastic Dominance

SERIES 450	FSE[a]	SSE	TSE
FAST450B	No		
REFI450B	Yes	Yes	Yes
LESM450B	Yes	Yes	Yes
LESLF450	Yes	No	
SERIES 453			
FAST453B	No(No)[b]		
REFI453B	No(Yes)	(Yes)	(No)
LESM453B	No(Yes)	(Yes)	(Yes)
LESLF453	Yes		
SERIES 470			
FAST470B	No		
REFI470B	Yes	Yes	Yes
LESM470B	Yes	Yes	Yes
LESLF470	No		
SERIES 473			
FAST473B	No(No)		
REFI473B	No(Yes)	(Yes)	(Yes)
LESM473B	No(Yes)	(Yes)	(Yes)
LESLF473	Yes		

[a]Member of the efficient set with respect to first-degree stochastic efficiency(FSE), second-degree stochastic efficiency (SSE), and third-degree stochastic efficiency (TSE).

[b]Parentheses indicate a comparison of the three dominated strategies excluding Model LESLF453 or Model LESLF473.

difference distinguishing the results of the stochastic trials of the models of Series 450 from those of Series 453 is the lower range of terminal net worth values derived from the stochastic solutions of each model of Series 453 as dictated by the lower (zero) rate of land value appreciation.

However, in comparing the CDFs of terminal net worth generated from the models of Series 453, additional differences from the results of the models of Series 450 are distingushed. As depicted in Figure 4.2, the strategy of leasing the otherwise indebted portion of the firm's initial land base (model LESLF453) not only reduces the probability of a liquidity crisis to a nearly negligible level but also dominates all other strategies in the sense of first-degree stochastic efficiency given that land values are stagnant. Recall that under the assumption of trend appreciation of land values as in Series 450, the strategy of leasing land (model LESLF450) was not a member of the efficient set.

Additional results of interest are revealed if the CDF's of the three dominated strategies are compared assuming that for some reason the firm is either unwilling or unable to effect the sale-leaseback arrangement of its indebted land as specified in model LESLF453. The rapid debt repayment strategy of model FAST453B is eliminated from the efficient set in the sense of first-degree stochastic efficiency. Neither the strategy of model REFI453B or that of LESM453B is dominant in the sense of second-degree stochastic efficiency, but only the strategy of model LESM453B is a member of the efficient set in the sense of third-degree stochastic efficiency. Even though the strategy of model LESM453B is the sole member

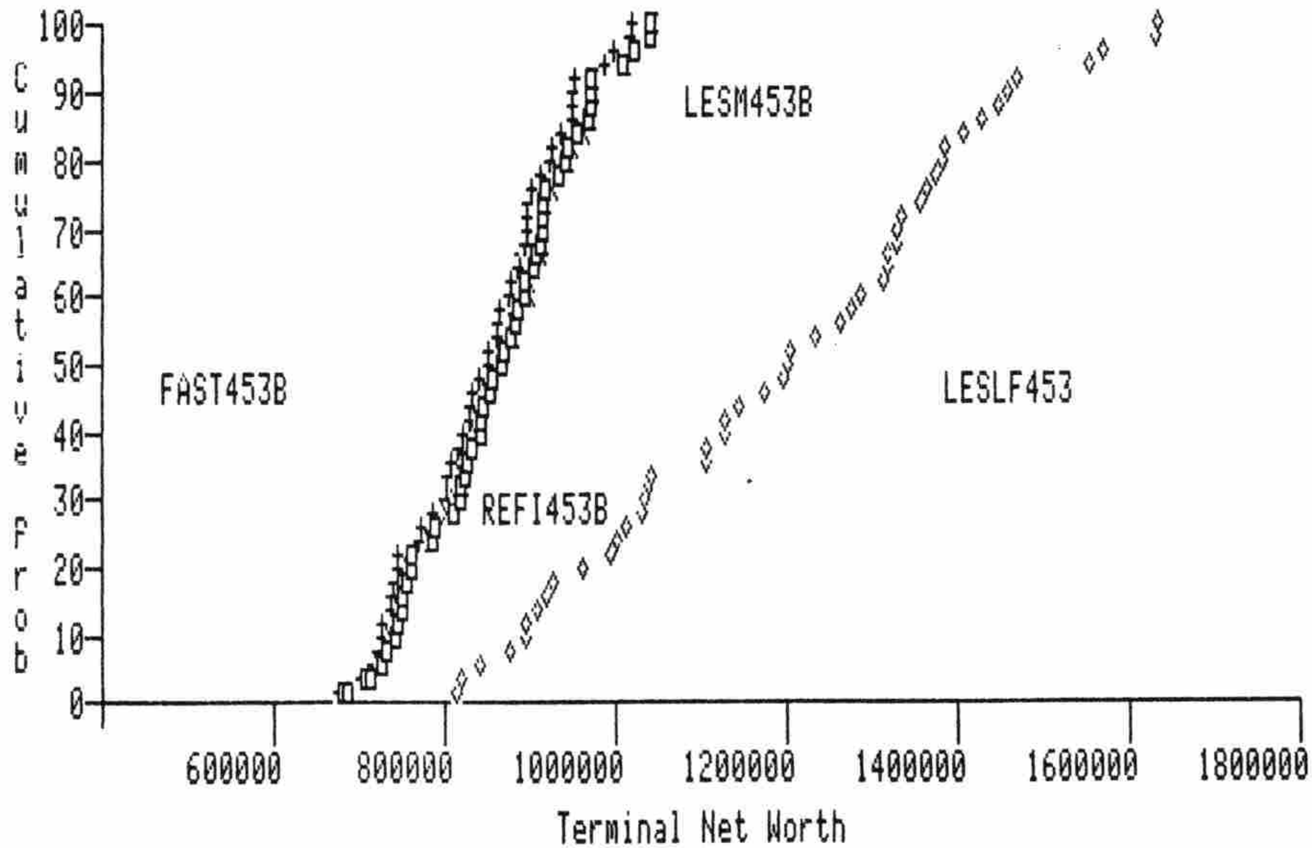

Figure 4.2. Cumulative distribution functions for the models of Series 453

of the efficient set, it entails a higher probability of an interim liquidity crisis (P = 0.28) relative to that of the dominated strategy of Model REFI453B (P = 0.02). Hence, the firm considering these two alternative strategies would be faced with a difficult decision, a dilemma which will be addressed in a subsequent section of this discussion.

Model Series 470

As summarized in Table 4.17, 100 percent of the 50 stochastic simulations of model FAST470B result in the failure of the firm to maintain a current ratio of one or greater. Refinancing the firm's shorter term obligations as specified in model REFI470B reduces the probability of the firm's current ratio falling beneath a value of one to 66 percent, and the probabilities of the firm failing to maintain a current ratio of 1.5 and 2.0 during the ten-year planning horizon are 90 percent and 98 percent, respectively. The sale-leaseback of the indebted portion of the firm's machinery (model LESM470B) is less effective in reducing the chance of the firm's suffering a cash flow crisis than is the strategy of model REFI470B and provides a nearly negligible improvement over the strategy of model FAST450B. If the firm is willing and able to exercise a sale-leaseback arrangement with the indebted portion of its land (model LESLF470), however, substantial improvement in its odds of escaping a liquidity crisis is realized. In eight percent of 50 stochastic simulations of model LESLF470 did the firm's current ratio fall below a value of one, and in only 54 percent of these 50 simulations was the firm unable to attain and maintain a current ratio of 1.5 by the end of the second year of the planning horizon.

The comparison of the CDFs of terminal net worth from the models of Series 470 is depicted graphically in Figure 4.3. The strategies of models LESM470B and REFI470B dominate the strategies of models LESLF470 and FAST470B in the sense of first-degree stochastic efficiency as specified in Table 4.18. However, neither the strategy of model REFI470B nor that of model LESM470B can be eliminated from the efficient set in the sense of second- or third-degree stochastic efficiency. Given that both model REFI470B and model LESM470B are members of the efficient set and that model REFI470B provides a lesser probability of an existence-threatening liquidity crisis than does model LESM470B, this analysis would indicate that model REFI470B represents the strategy of choice. Recalling that the lowest probability of a liquidity crisis is secured under the strategy of model LESLF470, the firm intent on the maximization of terminal net worth and the minimization of the probability of an interim, existence-threatening, liquidity crisis is confronted with the same dilemma recognized in the discussion of the simulation results of the models of Series 450.

Model Series 473

As shown in Table 4.17, the results of the 50 stochastic simulations of the models of Series 473 parallel those obtained from the models of Series 470. Under the rapid debt repayment strategy of model FAST473B, the firm fails to maintain a current ratio exceeding unity in all 50 model runs. A marked reduction in the probability of suffering a payments problem is realized if the firm is provided the opportunity to refinance

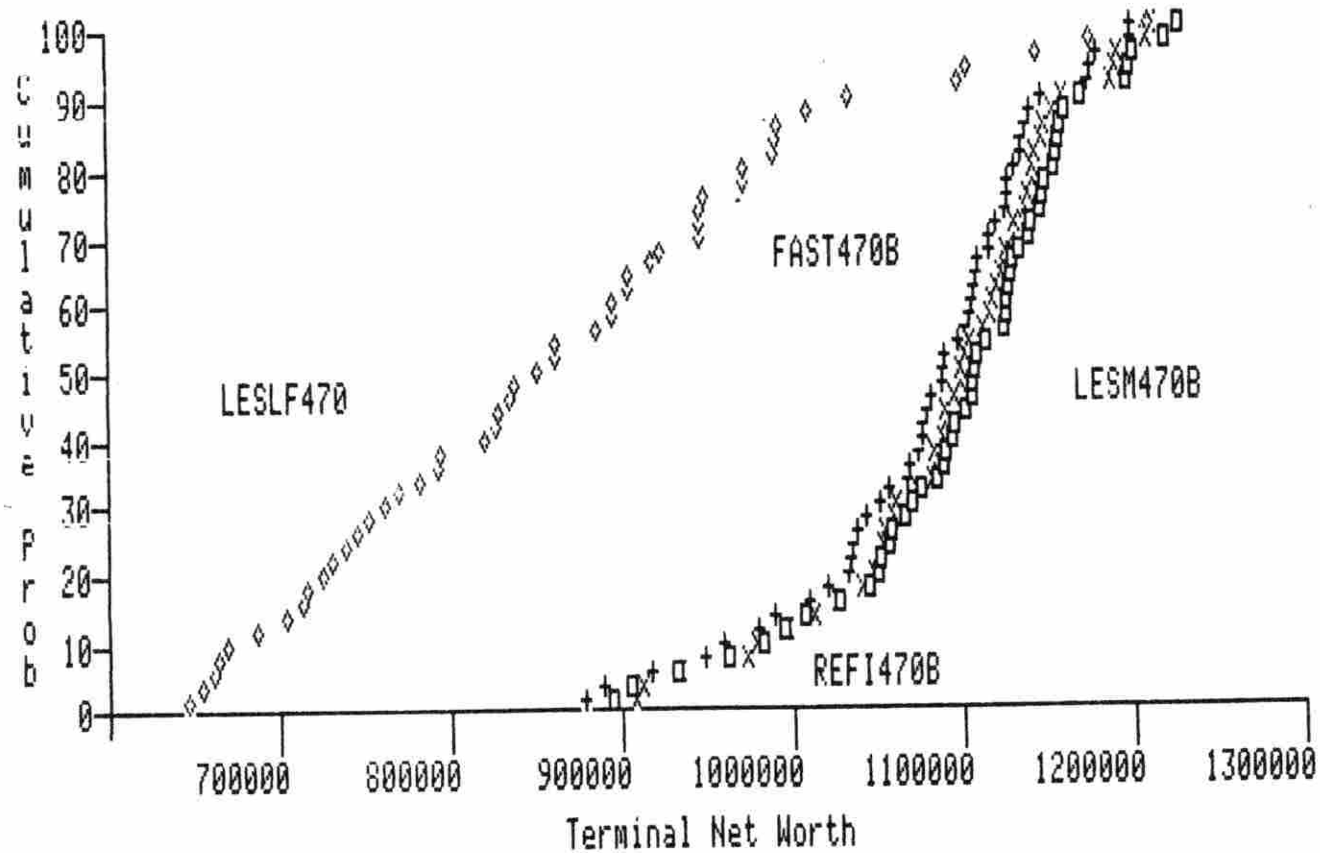

Figure 4.3. Cumulative distribution functions for the models of Series 470

its initial shorter term obligations (model REFI473B). As was evident in the models of Series 470, the sale-leaseback of indebted machinery is only marginally effective in reducing the probability of a liquidity crisis; however, if the firm exercises a sale-leaseback strategy for the indebted portion of its land rather than machinery, the firm escapes from the much larger annual debt-service obligations associated with the real-estate debt, stochastic NOI is generally sufficient to cover the firm's reduced financial obligations, and the probability of an existence-threatening payments crisis is reduced drastically. Again, for this more highly leveraged firm, the reduction in land value appreciation made no qualitative differences in the probabilities of occurrence of liquidity crises in the models of Series 473 relative to those of Series 470.

The CDF's of terminal net worth from the models of Series 473 shown in Figure 4.4 clearly indicate that the strategy of LESLF473 dominates the other financial strategies in the sense of first-degree stochastic efficiency. Moreover, the firm would choose the strategy of model LESLF473 to minimize the probability of a payments crisis during the planning horizon. If the firm were unable or unwilling to consider the land sale-leaseback strategy of model LESLF473, a comparison among the remaining three models is relevant. The strategies of models REFI473B and LESM473B dominate that of model FAST473B in the sense of first-degree stochastic efficiency, and neither can be eliminated from the efficient set in the sense of second- or third-degree stochastic efficiency. Since the strategy of model REFI473B is a member of the efficient set and provides the lowest probability of a payments crisis among this set of

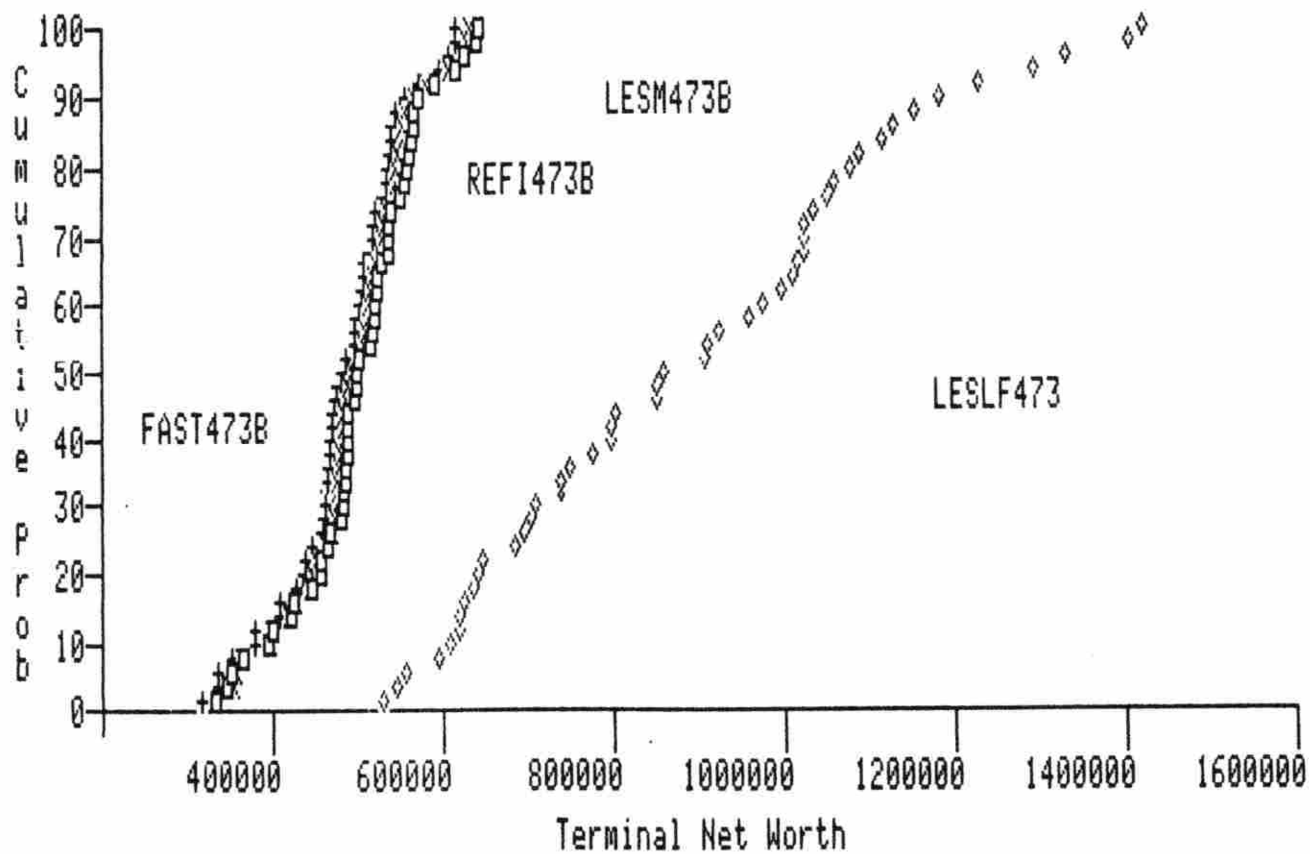

Figure 4.4. Cumulative distribution functions for the models of Series 473.

three strategies, it is the strategy of choice for the firm.

Summary, Conclusions, and Implications for Future Research

The results of the foregoing analyses as summarized in Tables 4.17 and 4.18 and discussed above are not surprising in that they indicate that regardless of the firm's leverage position, the preferred strategy with respect to maximization of net worth always includes the retention of land ownership when land values are appreciating at the trend rate as in the models of Series 450 and Series 470. Under the behavioral assumptions of nonsatiation, risk aversion, and decreasing absolute risk-aversion all with respect to net worth (determining third-degree stochastic efficiency), the firm operating under the economic scenario of Series 450 would be indifferent between refinancing all shorter-term liabilities (model REFI450B) or refinancing the indebted portion of its machinery with a financial lease (model LESM450B) while retaining land ownership and thus the accumulation of the capital gains accruing to the owners of land. However, when the shorter run objective of the firm is the minimization of the probability of an existence-threatening liquidity crisis as defined by the current ratio, the firm would choose either the strategy of model REFI450B, a member of the efficient set, or that of model LESLF450, not a member of the efficient set and clearly the poorest choice for net worth maximization over the long run.

Similarly, the firm of Series 470 under the behavioral assumptions of nonsatiation, risk aversion, and decreasing absolute risk aversion with respect to net worth would also be indifferent in choosing between the strategy of refinancing shorter term liabilities (model REFI470B) and that of the sale-leaseback of indebted machinery (model LESM470B), in neither case relinquishing the title to land. Since the strategy of REFI470B offers a better chance than that of model LESM470B for avoiding interim liquidity crises, model REFI470B represents the preferred strategy. Nonetheless, the best choice for maintaining the integrity of the firm during the planning horizon entails the sale-leaseback of the indebted portion of the firm's land, the poorest choice for net worth accumulation in the longer run.

Under the assumption of stagnant land values maintained in Series 453 and Series 473, ownership of land is stripped of its value as a vehicle for accumulating net worth through capital gains. Regardless of the firm's leverage position, the strategy of leasing rather than borrowing to gain control of land (models LESLF453 and LESLF473) is the dominant strategy under the assumption of nonsatiation with respect to net worth (first-degree stochastic efficiency). Moreover, the land sale-leaseback strategy is again the safest with regard to minimizing the probability of an existence-threatening liquidity crisis in Series 453 and Series 473.

However, if the land sale-leaseback strategy of model LESLF453 is for some reason eliminated from consideration so that the firm's choice is limited to the first three models of Series 453, the now familiar conflict between the firm's goal of net worth maximization in the long run while avoiding liquidity crises in the short run is encountered again. Of the three models remaining after excluding model LESLF453 from consideration among the models of Series 453, model LESM453B is the only member of the efficient set in the sense of third-degree stochastic efficiency. But the probability of a liquidity crisis under model LESM453B exceeds that under model REFI453B.

Robinson and Lev (ca. 1984) have recently attempted to reconcile the apparent conflict between the firm's longer-run goal of net worth maximization and shorter-run goal of survival as noted in the examples above. In their conceptualization, a change in the relationship between initial and final impact variables causes a switch in the decision-maker's strategy choices even though his risk preferencs are stable. Ad hoc safety-first rules for the explanation of decision-maker behavior are not required.

The concepts of Robinson and Lev are strongly appealing for the single-period case which they analyze, but the adaptation of these concepts to the multi-period case considered herein is not perfectly straightforward. The essence of the problem of conflicting short- and long-run goals recurring in the analyses discussed above is the failure to relate the impact of an existence-threatening liquidity crisis in the short run on the long-run goal of net worth maximization. Recall that in all simulations of each of the 16 scenarios considered in this study, the firm had substantial equity holdings regardless of whether difficulty in meeting periodic financial obligations was encountered at some point during the planning horizon.

One method of translating a short-run liquidity crisis into terms of terminal net worth and thus reconciling the apparent conflict in short- and long-run goals encountered in the foregoing analyses would be to define terminal net worth more precisely as that net worth accumulated to the end of the planning horizon <u>or</u> the net worth accumulated up to the time at which the liquidity crisis occurs as determined by the lender-specified critical value of the current ratio, less liquidation losses, plus the return on the remaining equity to the end of the planning horizon. This approach would, of course, require additional research to estimate losses arising from the untimely liquidation of assets as the result of a payments crisis as acknowledged earlier (Boehlje and Eidman, 1983). The rate of return on the residual net worth during the years remaining in the planning horizon could most easily be approximated by the rate of return on government bonds.

The analyses would be completed by generating CDFs of terminal net worth as defined above for the strategies of interest and evaluating those strategies according to the theorems of stochastic dominance following the procedure outlined in Chapter 3 and used in the foregoing analyses. One would expect that the range of the CDFs of this more precisely defined terminal net worth would extend to lower equity levels significantly altering the shape of the CDFs and the conclusions derived from the application of the theorems of stochastic dominance. Hopefully, the apparent conflict between the longer-run objective of net worth maximization and the shorter-run goal of preserving the integrity of the firm through the avoidance of liquidity crises during the planning horizon will disappear when terminal net worth is defined more carefully. This alternative form of analysis represents the next logical step in this area of research.

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