The Impact of Debt and Income Variation on the Simulated Financial Performance of Large Pacific Northwest Grass Seed-Grain Farms

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THE IMPACT OF DEBT AND INCOME VARIATION ON THE SIMULATED FINANCIAL PERFORMANCE OF LARGE PACIFIC NORTHWEST GRASS SEED-GRAIN FARMS

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ABSTRACT

This bulletin discusses the financial impact of changing farm-level prices on unfavorably leveraged farms. The focus was on a computer simulation of a large Pacific Northwest grass seed-grain farm. For highly leveraged farms, prices as much as three times the historical level were used in an attempt to offset adverse debt conditions. The resulting effects on change in net worth over time were then analyzed.

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SUMMARY AND CONCLUSIONS

This study was conducted to enhance understanding of the economic consequences of various levels of debt on farm financial progress and the impact of changing commodity price levels. The central focus was to learn more about the favorable and unfavorable effects of financial leverage on the growth of farm net worth.

A computer model was used to simulate the financial performance of a typical (representative) large Pacific Northwest grass seed-grain farm over a 15-year period under selected debt and farm product price level situations. Crop prices, yields, production costs, land values, and general price inflation rates included in the model (a 15-year simulation) were based on the variations exhibited over a 20-year period, 1963-82. These were defined as the Base level ranges. Crop yields and prices were permitted to randomly vary within these ranges, and, together with debt level changes, directly influenced the effects of leverage on financial solvency and growth.

At Base level prices (the 20-year historical variation pattern) the farm became insolvent as the initial debt-to-asset ratio was increased. Higher price levels at the respective initial debt settings, not surprisingly, permitted the farm to decrease debt-to-asset ratios over the simulation period even though total debt increased substantially. However, the farm, under very high initial debt settings was forced to maintain high

debt-to-asset ratios despite prices set at the unrealistically high level of three times the base (3.0 Base prices). In the extreme case (90 percent debt-to-asset ratio), the farm became insolvent in the first year. In addition to high interest costs, difficulties at the higher debt levels were compounded by the fact that several of the early years in the simulated period had low incomes.

The results show that earnings on debt capital were below its cost in many years of the simulated period. This was confirmed by an analysis of returns to net worth. When prices were set at twice the Base level, as would be expected, leverage was favorable (earnings on debt capital exceeded the interest cost of debt) for a greater number of the years simulated. It was only at the very high initial debt level of 90 percent that leverage was not favorable enough to avoid insolvency. At 3.0 Base prices, leverage was favorable and highly profitable in most, but not all, years of the 15, 30, and 60 percent initial debt situations.

Financial growth as measured by change in net worth was predictably quite positive as earnings on debt capital exceeded its interest cost. However, for Base prices as a whole, such was not the case. At zero debt, ending net worth was 4.3 times the beginning level. But unfavorable leverage reduced net worth growth for the 15 and 30 percent debt ratio cases to 3.4 and 1.8, respectively. Both the 60 and 90 percent debt ratio cases became insolvent before the end of the 15-year simulation period.

At higher price levels, growth in net worth was understandably enhanced because of the magnifying effects of occasional favorable leverage. For example, at a 30 percent debt-to-asset ratio, the ending/initial net worth ratio was 1.8 and 9.3 for Base prices and 3.0 Base prices, respectively. The corresponding ratios for zero debt were 4.3 and 7.9.

The Base level assumptions used in this study are realistic. They reflect variability in yields and prices that could be expected from year to year in many farming situations. Under such circumstances, the results of this study clearly show that even unusually high prices cannot be expected to do more than mitigate the financial crises of farmers who are in extremely high leverage positions. Under the present adverse price-cost situations in agriculture, revenue levels needed by highly leveraged farms to avoid insolvency are much above those that could be realistically expected. But, the attainment of such high revenue levels would require that both prices and yields vary to the high extremes simultaneously. Such an event in reality would not be likely.

As with any simulation model, the application of results to individual farm situations must be done with caution. In the case of this study, a number of specific limitations were identified. Included were the price and yield assumptions, financial growth accompanied by constant physical farm size, debt rate and amortization assumptions, and land value growth rates.

INTRODUCTION

A computer simulation model was developed to analyze the impact of selected debt strategies and crop price levels on the financial performance of a typical grass seed-grain farm in the Pacific Northwest. The model was designed to simulate a 15-year passage of time. The 15-year simulation period was chosen because it is long enough to show the effects that price, yield, and cost variation patterns could be expected to have on the financial progress of a typical farm in a realistic operating environment.

Product price and input cost variation for the simulation were based

on the 20-year period, 1963-82. That 20-year time range was chosen as a base profile because it exhibited a fairly wide range of prices and yields as well as variable inflation rates. Moreover, it is characterized by periods of favorable leverage possibilities, periods of unfavorable leverage, and varying degrees of financial risk. A recent historical period such as this was considered more realistic for modeling purposes than an arbitrary steady state or probabilistic algorithm with no basis in reality.

To help concentrate on the impact of debt and income variation on financial performance, the physical size of the model farm was held constant over the 15-year simulation period. However, financial size as represented by the model farm's balance sheet was permitted to vary as affected by prices, costs, interest rate and other key variables assumed in the study.

No attempt was made in this study to forecast prices, yields, and costs into the future. Yet it seems reasonable to say that these historical patterns could be representative of future events given no quantum changes in agriculture's operating environment. Thus, results of these simulations could provide useful information about the likely impacts of leverage in any future period that might exhibit patterns of variability similar to the historical period. Even though the research method used in this study assumes the passage of a 15-year period, simulations of physical farm expansion situations or in-depth inquiries into particular historical time periods were considered to be beyond the scope of this study.

In the decade of the 1980s, severe financial problems in agriculture have been concentrated among farmers who were highly leveraged [Melichar, 1984]. Available cash flow before interest payments increased for many of

these farms. Yet, available cash flow after interest payments decreased significantly. Hence, these farmers fared much worse than similar operators with lower debt-to-asset ratios. Reduced net earnings and diminished prospects for income growth have lowered farm land values and, in some cases, forced distress sales by financially troubled operators, or in other cases, foreclosure by lenders.

Recent studies have shown that farms with 20 percent debt-to-asset ratios and an interest rate of 11 percent (both near the average) had a return to equity near zero at historical price and cost levels [Melichar, 1984]. Higher debt-to-asset ratios meant losses: moderate, if debt consisted mainly of old fixed-rate mortgage loans at interest rates averaging 7 percent; more severe, if debt consisted of short-term loans at rates averaging 15 percent. Consequently, high-leveraged operators may have had annual operating losses equaling as much as one-third of their equity. An exception to this situation was highly leveraged farms generating a relatively high dollar volume of sales. Their rate of return on assets was far above the average rate of interest being paid on outstanding debt. In that case, a rather high dollar volume of sales was generated in that case relative to the dollar value of assets. This was because of economies of size and the composition of products and expenses. Thus, even at high debt levels, debt service has not been a serious problem for operators of those farms.

OBJECTIVES

The specific objectives of this study were to:

1. Simulate the financial progress of a typical Pacific Northwest grass seed-grain farm over a 15-year period

at different debt levels.

2. Determine the impact on those results from assuming several selected product price levels.
3. Measure the cumulative impact of various degrees of leverage at selected product price levels on the model farm's change in net worth over the simulation.

THE CONCEPT OF FINANCIAL LEVERAGE

Leverage in the financial sense is defined as the ratio of total debt to total assets [Bolten and Conn, 1981]. The term is used in reference to the magnifying effect that debt has on return to net worth. As the ratio of debt-to-assets increases, so does the farm's financial leverage.

The degree of leverage affects return on net worth either positively or negatively depending on whether the percentage return on assets before tax exceeds the before-tax percentage cost of debt. Leverage is said to be favorable if return on assets is greater than the cost of debt. For favorable leverage, the return on net worth is magnified as the degree of leverage is increased. If return on assets is less than the cost of debt, leverage is said to be unfavorable. For unfavorable leverage, the decrease in the return on net worth is magnified as the degree of leverage is increased.

The relationship among return on net worth, return on assets, and the cost of debt is important [Barry, Hopkin, and Baker, 1983]. The return on assets is related functionally to the return on net worth and cost of debt. Specifically, the return on assets is the sum of return on net worth and the cost of debt. By definition, total assets equal the sum of the net worth and debt levels. Thus, the return on assets can be thought of as a

weighted average of the return on net worth and the cost of debt. The weights are simply the proportions that net worth and debt are of total assets.

With regard to the weighted average return concept, there is an expected ordering of returns based on the relative risk positions of the net worth and debt holders. The greater risk position of the net worth holder implies that the returns (cost) for net worth should exceed the cost of debt on average over time. Return on assets should fall between the returns to net worth and debt because of the weighted average concept.

In general, financial risk (loss of equity) increases as the degree of leverage is increased [Barry, Hopkin, and Baker, 1983]. This occurs because of increased susceptibility to adverse variation of expected net returns and reduced liquidity resulting from diminished credit reserves. As leverage increases, unfavorable events have a greater impact on the farm than do favorable events. Adding to financial risk in the last few years have been highly volatile interest rates and greater use of adjustable interest rate loans by farm lenders.

The greater variation of return on net worth as leverage increases is primarily caused by the fixed nature of principal and interest payments. As net income varies, the cash flow of the farm may become insufficient to meet its debt payments. In the extreme, the farm may become insolvent and result in complete loss of the farm operator's equity. The typical accounting definition of insolvency is that situation where the debt-to-asset ratio is greater than 1.0. However, in this study, a slightly different definition of insolvency was used. It was defined as a situation where the debt-to-asset ratio was greater than 1.0 and there was a negative net cash flow. This definition of insolvency was more stringent since it implies there was virtually no work out possibilities (such as Chapter 11

bankruptcy).

As indicated previously, the return to net worth tends to increase as financial leverage increases provided the marginal rate of return on assets exceeds the cost of debt. If some of the return on assets is reinvested in the business, saved, or used to decrease debt, net worth likely will increase. This process can lead to firm growth.

Increases in financial leverage however, are constrained for most farms [Lee, Boehlje, Nelson, and Murray, 1980]. Federal income tax rates are progressive since higher income levels are taxed at higher rates. Thus, higher taxable incomes may result in higher tax liabilities. To the extent that such is the case, the gains from higher leverage are reduced. Also, the farm family's marginal propensity to consume will likely decrease as earnings increase. Therefore, the share of earnings reinvested in the farm will increase, and that causes financial leverage to decrease.

Finally, the cost of debt tends to increase as financial leverage is increased. Lenders may even refuse to advance additional debt dollars as farms exhibit extremely high degrees of leverage (external capital rationing). An even greater restraint to financial leverage may be internal capital rationing by the farm operator. There may be a desire to limit financial risk by limiting the degree of financial leverage. Unused borrowing capacity resembles a reserve. Those credit reserves have value to the farm just as cash reserves and near-cash assets constitute reserves.

In a conceptual sense, there is an optimum degree of financial leverage. Beyond that point, it does not pay to use additional debt. The gain from the use of leverage is maximized when the marginal rate of return on assets is the same as the marginal cost of debt. Empirical evidence shows that both farm operators and lenders tend to restrict a farm's

financial leverage [Lee, Boehlje, Nelson, and Murray, 1980]. Although the level of financial leverage varies widely among farms, debt-asset ratios above 75 percent are rarely encountered on viable farms. Lenders are usually quite cautious when the debt-asset ratio exceeds 66 percent.

PROCEDURES

The focus of the study was a large grass seed-grain farm, representative of a number of areas in the Pacific Northwest. The vehicle of analysis was a computer model which was designed to simulate the expected financial flows of that type of farm. In short, the model simulated changes in farm income, taxation, and financial growth for various initial debt and product price levels. For a more detailed description of the model, see Burt and Wirth, 1983.

For each 15-year run of the computer model, gross income and tax deductible expenses were calculated. All pertinent tax regulations were incorporated into the model. Tax calculations based on government rules for the period were then completed and followed by a determination of available cash flow. Changes in debt levels were directly affected by cash flow generation from business activity. If cash flow from operations was not sufficient to cover consumption, debt dollars were used to meet the deficiency. Excess cash flow after consumption and debt amortization requirements was assumed to be placed in a financial (equity) accumulation account earning 10 percent interest. If current cash flow was insufficient to meet requirements, the financial accumulation account was employed to capacity before resorting to additional debt financing.

Computer simulations for the model farm were effected at different initial debt-asset ratios. This was done to reflect various leverage

strategies. These debt-asset ratios represent the proportion of assets that were debt financed. Five beginning debt-asset ratios were chosen: no debt, 15 percent, 30 percent, 60 percent, and 90 percent. The average pre-tax interest rate on all outstanding debt assumed for the simulation period was 10 percent. All debt amortization was calculated on an annual, end-of-year-payment basis.

The rate of interest on debt was chosen as an estimate of the blended rate a farmer might pay considering old and new debt from all sources, that would range from high rates on credit cards and other commercial accounts to below-market rates that often characterize special family financing arrangements. It is clear, however, that no matter what debt rate is chosen for the simulation, a higher rate would affect the model farm adversely just as a lower rate would produce beneficial results.

Upper and lower bounds for prices were established using the 1963-82 historical range (Table 1). The prices used each year for the 15-year simulation were randomly obtained values within those bounds. Thus, each value had the same probability of occurring as any other value within the range. The pattern of prices so obtained was defined as "Base level prices."

In addressing the question of higher price level impacts at differing degrees of leverage, the same variation pattern as exhibited with base level prices was used for all other price levels examined — 2.0 (times) base and 3.0 (times) base. Farm operating costs were escalated at an annual growth rate of 7.8 percent. The value of farm real estate was increased at 5 percent per year. These growth rates were considered representative of the historical time period, but they may not be representative of what will happen in the future.

The large grass seed-grain farm used as a model for the simulations

was assumed to include 1,950 acres. The normal rotation on this type of farm would be expected to average 470 acres in seed-producing grass, 230 acres of nonseed-producing grass, 500 acres of wheat, 300 acres of barley, 250 acres of dry field peas, 150 acres fallow, and 50 acres nontillable. The simulated yields used in this study were derived in the same manner as base level prices discussed above. The resulting yield pattern was used throughout the study. Assets for the farm at the beginning of the 15-year period were assumed to have a current market value of $696,000 [Burt and Wirth, 1983].

LIMITATIONS OF THE MODEL

To focus more clearly on the impact of debt and income variation on farm financial performance, a number of elements affecting the model farm were simplified. By doing that, the farm, in some respects, was removed from a truly realistic operating environment. This section is intended to enumerate the more important limitations of this procedure and thus underline the need to apply the results of this study to individual farm situations with due caution.

1). In most situations there is some correlation between prices and yields for a particular crop. In contrast, the model used prices and yields generated at random, but subject to a historic range constraint. This was done to reduce the influence of a particular time period on the model results while keeping price and yield levels within the scope of recent income levels for operations similar to the model farm. This procedure was not done under the assumption that the historical data could somehow best be described by a uniform distribution.

2). Discrete and simultaneous price changes (e.g., Base to 2.0 Base) for

all commodities are an unlikely event. The purpose for doing so was to examine the impact that higher income would have on the adverse leverage situations for the model farm under Base price conditions. Specifically, the procedure helped to identify what level of prices above the Base level was necessary for the model farm to exhibit initial signs of favorable leverage.

3). The physical size of the model farm was kept constant throughout the simulation. This was done to better identify the influence of debt level and income changes on the farm's financial performance. In reality, many farming operations strive to physically grow in an attempt to generate economies of size (lower average costs of production). Within the limits of available cash flow, economies of size may make leverage more attractive. In such a situation, higher interest costs because of increased leverage might be offset by lower average costs for some inputs as a result of economies as well as the possibility of negotiating lower interest rates on debt. The cash flow and debt configuration of the model farm would likely preclude the use of increased debt for physical expansion of the farm in any realistic setting. Instead, outside equity capital would have to be employed — an unlikely event given existing risk levels in the simulation.

4). Instead of an arbitrary variable pattern, a fixed "blended" rate of interest was used for the entire 15-year simulation for both equity and debt balances of the model farm operation. At 10 percent, the rate represented a mix of debt and equity sources. Although a constant blend rate over 15 years is a possibility, that situation probably will not be typical for the forseeable future.

5). Land value growth for the model farm was simulated at an average

annual rate of 5 percent. This reflected the situation that existed during the 20-year historical base period guiding data input for the simulations. It is possible that the 5 percent rate might also represent a future long-term land value growth rate. However, agricultural land values in the more recent past have remained steady or, in many cases, declined. The resulting collateral impairment has forced many lenders and borrowers to reorganize farm debt structure. Frequently, operating and longer term lines of credit have been reduced causing severe strains on farm cash flow. In that respect, the financial adversity characterized by the model farm simulations might well understate current financial stress conditions that characterize a number of current farm situations.

6). The model is constructed such that an initial debt-to-asset ratio is established at the beginning of the 15-year farm simulation. Operating surpluses are kept in the farm business as interest-earning equity rather than reducing the debt level below that implied by the initial debt-to-asset ratio. Increasing debt-to-asset ratios during the simulation implied financial adversity. Such adversity is initially indicated when internal equity balances are used to offset deficiencies in cash operating balances. If the equity balances became depleted, increased debt was used to meet the cash flow needs, and such increases typically led to higher debt-to-asset ratios. This procedure introduces an element of debt management inflexibility. It is conceivable that changes in perceived price/cost relationships could make either increased or decreased leverage attractive at different times during a 15-year period. The model precludes this flexibility by assuming that the farm operator establishes various initial debt levels and maintains that as a goal throughout the simulation. Some farm managers would not do that. As an example, certain farmers tend to increase debt levels when prices are perceived to be on the increase.

Lenders may be less conservative in assessing credit requests at such times, and especially when collateral values such as land prices are thought to be increasing.

RESULTS

Separate analyses were done for the model farm under the single proprietor and corporate business forms. Each analysis included simulations for 5 different initial debt-to-asset ratios and three levels for crop price patterns. Since the outcomes were quite similar, only the results for the single proprietor form are reported here.

Ending Debt-to-Asset Levels

At Base prices, only when the model farm had a 15 percent initial debt-to-asset ratio was it able to reduce that ratio over the 15-year period (Table 2). The reduction was only to 12 percent, but even then, the level of debt nearly tripled. The 30 percent initial debt-to-asset ratio situation showed both a large increase in the ratio and in the level of debt by the end of the period, suggesting eventual insolvency at some point beyond the end of the 15-year simulation period. For both the 60 and 90 percent initial debt levels, the farm became insolvent in the fifth and first years, respectively. In both cases, the simulations were continued through the 15 years. They show the inexorable effects of a debt burden that cannot be carried.

These simulations led to an important conclusion. They suggest that leverage was on the whole not favorable under the simulated cost-price conditions represented by the Base level assumptions. They further imply that initial debt-to-asset ratios as high as 30 percent would lead to

eventual insolvency, a condition that is unfortunately becoming all too common to highly-leveraged farmers in the 1980s.

When prices were set at the 2.0 Base level (a doubling of prices received on all crops), the simulation outcomes, quite expectedly, improved. The model farm was able to reduce its debt-to-asset ratio in all cases except the 90 percent initial debt ratio (Table 3). In that case, the farm became insolvent in the second year. At both the 15 and 30 percent initial debt levels, the farm experienced substantial decreases in its debt-to-asset ratio over the 15-year period. The 60 percent initial debt-to-asset ratio farm showed a modest decrease in the ratio over the 15-year period.

All initial debt-to-asset ratios for the farm, as expected, showed declining ratios at the end when price levels were tripled to 3.0 Base (Table 4). At the 60 percent initial debt level, ending debt represented only about 28 percent of the farm's asset value. The ending debt for the 90 percent initial debt-to-asset situation was about 70 percent of the assets. Despite this decrease to a 70 percent debt-to-asset ratio, insolvency would have been experienced in 7 of the 15 years, the first time in the second year (Table 7). Insolvency occurs even with prices at the extreme level of three times base because gross farm receipts simulated for the second year, and several other early years, were considerably below average [Burt and Wirth, 1983].

The results cited above for the situations of 2.0 and 3.0 Base level prices are instructive concerning the way financial risk increases as debt-to-asset ratios increase. Unfavorable prices or yields when the debt load is severe can cause early insolvency. It also means that given typical price-yield variability, the historical point in time when the farmer begins business becomes critical. This situation is not unlike a number of

highly leveraged farmers who started farming in the late 1970s and early 1980s, or established farmers who became highly leveraged during these years [Agricultural Statistics, 1983]. Because this period has been one of great adversity for agriculture, many of these people are experiencing extreme financial stress; some have been forced into liquidation or even gone bankrupt.

Change in Debt-To-Asset Ratios

An analysis of year-to-year changes in debt-to-asset ratios was done for each initial debt-asset setting and price level. Tracking these changes over time presents a clear picture of the farm's degree of financial leverage and risk.

Even at an initial debt setting of 15 percent, the model farm at Base prices exhibited some financial adversity (Table 5). Three times during the 15-year period the farm had a debt-to-asset ratio above 15 percent. The ratio never fell below 12 percent, the ending value. At the 30 percent initial debt-asset ratio, the farm's debt exceeded 30 percent in all but the first year. It reached 66 percent in the tenth year and declined only to about 50 percent at the end of the fifteenth year. The debt-to-asset ratios of the farm at the 60 percent initial debt level increased rapidly as the farm moved toward insolvency in the fifth year. The 90 percent debt-to-asset situation became insolvent in the first year.

The situation for the model farm was much different in some cases at 2.0 Base prices (Table 6). The farm was able to continuously decrease the debt-to-asset ratio when the initial value was set at 15 percent. By the end of year 15, it had declined to about 6 percent. The same pattern was evident for the 30 percent initial debt-asset level, a decline to just over

15 percent at the end of year 15.

Financial adversity was apparent at the 60 percent initial debt-asset level even though prices were 2.0 Base. The ratio was quite variable and reached almost 80 percent at one point before declining to about 52 percent in the last year. After the first year for the 90 percent initial debt-asset ratio, as with the Base price situation, the farm became insolvent.

As expected, decreasing debt-to-asset ratios were even more apparent at the 3.0 Base price level (Table 7). Financial stress for the model farm was restricted to the 90 percent initial debt situation which became insolvent in the second year. Even at that very high initial debt level, debt-to-asset ratios for the farm would have eventually declined steadily below the starting level provided that debt holders had been willing to delay foreclosure on the farm during earlier insolvent periods (an unlikely event). For the 15, 30, and 60 percent situations, the ratios declined steadily throughout the 15-year period.

Return on Assets and Net Worth Compared to the Cost of Debt

To determine whether leverage for the model farm was favorable or unfavorable, net farm income before tax was calculated as a rate of return on assets. The resulting impact on return to net worth was also examined. This was done for each initial debt-asset level and price situation for each year of the simulation period. These values were then compared with the 10 percent before-tax interest rate assumed to be paid on debt over the 15-year period.

At Base Prices

The model farm at Base prices exhibited highly unfavorable leverage for most years (Table 8). The average return on assets over the 15-year

period for the farm with no debt was only 3.9 percent. Yearly returns ranged from a low of minus 7.6 percent to a high of 21.0 percent. Returns were negative in 4 of the 15 years. If the farm had any debt at all, leverage would have been favorable in only 3 of 15 years.

The average return on assets for the 15-year period was succeedingly lower as the debt-asset ratio was increased. Total assets remained the same, while the interest burden of higher debt levels had an increasingly negative impact on the return to those assets. At the 15 percent initial debt-asset level, returns averaged 2.4 percent and exceeded the rate on debt in only 3 years. Returns were negative in 1 of every 3 years.

The model farm at the 30 percent initial debt-asset level (and higher) never developed enough cash flow to adequately service debt commitments. The 15-year average return was negative in the 30 and 60 percent cases and was above the cost of debt in only 1 year. At the 90 percent initial debt-asset level, the model farm became insolvent in the first year.

The unfavorable leverage situation for the model farm at base prices could be seen more directly by looking at return to net worth as the initial debt-asset ratio was increased (Table 9). The 15-year average return to net worth declined from 3.9 percent (associated with no debt) to negative average rates as the initial debt-asset level was increased to 30 percent and higher. Only years 3, 11, and 12 had net incomes high enough to keep the returns to equity above the rate on debt. For initial debt levels above 60 percent, the model farm became insolvent early in the simulated 15-year period.

At 2.0 Base Prices

Unfavorable leverage situations for the model farm were lessened somewhat, as would be expected, when prices were raised to the 2.0 Base

level (Table 10). On average, the zero and 15 percent initial debt-asset levels showed returns on assets that were above the cost of debt. As the initial debt-asset ratio was increased above 15 percent, higher interest expenses caused returns on assets to fall below the cost of debt. For the 90 percent initial debt-asset level, the model farm became insolvent in the second year.

The lessening of unfavorable leverage for the model farm at 2.0 Base prices was evident also by examination of the corresponding returns to net worth (Table 11). Average returns to net worth improved as the initial debt-asset ratio was increased. The only exception was early insolvency for the model farm when the initial debt-asset ratio was set at 90 percent.

At 3.0 Base Prices

Not surprisingly, the 3.0 Base price situation improved the leverage impact on the model farm for all initial debt-asset levels (Table 12). However, even at these extreme price levels, leverage was still not favorable in all years for any of the initial debt-asset levels.

At zero debt, the average return on assets was more than 17 percent. There were no negative years, but returns exceeded the cost of debt in only 9 of 15 years. As the initial debt-asset ratio was increased, returns on assets on average declined as would be expected, but remained above the cost of debt in all cases. The degree of favorable leverage started to decline at the 60 percent initial debt-asset level, exceeding the cost of debt in just 7 of 15 years. The 3.0 Base price level was still not high enough to avoid eventual insolvency at the 90 percent debt level.

The greater degree of favorable leverage when prices were set at the 3.0 Base level, of course, was evident in higher returns to net worth (Table 13). The average return to net worth increased at an increasing rate as the initial debt-asset ratio was increased. However, in only 9 of

13 years were returns to net worth above the cost of debt for initial debt-asset levels as high as 60 percent. Furthermore, there were negative returns to net worth for some years at both the 30 and 60 percent initial debt-asset levels.

The model farm again became insolvent at the 90 percent initial debt level. This confirmed the conclusion for the 90 percent debt case, that a truly favorable leverage condition would require price levels even more extreme than 3.0 Base, or a more favorable income variability pattern than that used in the simulations. The high interest costs for the 90 percent case forced insolvency because years 1 and 2 in the simulation pattern were both low income years.

Financial Growth of the Model Farm

To assess the overall impact of leverage on the model farm's financial growth, change in net worth was analyzed for each of the initial debt ratios and at the three price levels. This analysis included an examination of ending/initial net worth ratios (ending net worth divided by initial net worth).

As previously noted (Table 8), financial leverage was unfavorable over much of the 15-year period at Base level prices — returns to assets were below the cost of debt. This caused the net worth ratio to steadily deteriorate over the 15-year period as the initial debt-to-asset ratio was increased (Table 14). When the farm's initial debt-asset ratio was set at zero, the change in net worth over the 15-year simulation period was $2.3 million. That represented an increase of 4.3 times the initial net worth of $696,000. The ending/initial net worth ratio decreased as the initial debt-asset ratio was steadily increased. For the 30 percent initial debt-

asset ratio, the ratio of ending/initial net worth was only 1.8. The farm was insolvent at higher initial debt-asset ratio levels.

A slightly improved upward trend situation existed for the 2.0 Base price conditions and the corresponding values were all larger (Table 15). The ending/initial net worth ratio was 6.8 for the zero initial debt-asset level. Ending net worth was $4.7 million, a 4.0 million increase over the 15-year simulation period. The ending/initial net worth ratio moved upward slightly as the initial debt-asset ratio was increased to 15, 30, and 60 percent, respectively. The farm became insolvent in the first year when the initial debt/asset ratio was set at 90 percent.

The favorable leverage conditions that prevailed for a majority of the 15 years at the 3.0 Base price level were apparent in the upward trend of the model farm's ending/initial net worth ratio as the initial debt-asset ratio setting was increased (Table 16). When the initial debt-asset ratio was set at zero, ending net worth was $5.5 million, an increase of $4.8 million. That represented a 7.9 ratio of ending to initial net worth. At the 60 percent initial debt-asset ratio setting, the corresponding ratio of ending/initial net worth was only 9.7. Net worth for the model farm increased $2.4 million to a 15-year ending value of $2.7 million. The model farm with an initial debt-to-asset ratio of 90 percent still became insolvent during the 15-year simulation period. This implied a need for price levels higher than 3.0 Base to make the model farm exhibit a truly favorable leverage situation (expanded growth in the ending/initial net worth ratio as leverage is increased).

Table 1. Historical ranges in selected Pacific Northwest crop prices and yields, 1963-82

Crop	Unit	Range in yield (unit/acre)		Range in price ($ yield)	
		High	Low	High	Low
Winter wheat	bu.	57.0	34.0	5.89	1.22
Spring barley	bu.	61.0	27.0	3.45	0.81
Dry edible field peas	cwt.	24.33	4.60	31.00	3.02
Common Kentucky bluegrass seed	cwt.	7.20	2.31	83.50	21.40

Source: U.S. Department of Agriculture, Agricultural Statistics, selected years; Economic Information Office, Oregon State University.

Table 2. Initial debt, initial and ending debt/asset ratios, Base price level

Initial Debt Thousand $	Debt/Asset Ratio	
	Initial %	Ending %
0	0.0	0.0
104	15.0	12.0
209	30.0	49.8
418	60.0	183.8[a]
626	90.0	301.1[b]

[a]The farm became insolvent in the fifth year. The simulation was continued to the end of the fifteenth year to show the extreme position that might have been realized from continued deficit debt financing, if that were possible.

[b]The farm became insolvent in the first year. The simulation was continued to the end of the fifteenth year to show the extreme position that might have been realized from continued deficit debt financing, if that were possible.

Table 3. Initial debt, initial and ending debt/asset ratios, 2.0 Base price level

Initial Debt	Debt/Asset Ratio	
Thousand $	Initial %	Ending %
0	0.0	0.0
104	15.0	6.2
209	30.0	15.1
418	60.0	52.3
626	90.0	160.4[a]

[a]The farm became insolvent in the second year. The simulation was continued to the end of the fifteenth year to show the extreme position that might have been realized from continued deficit debt financing.

Table 4. Initial debt, initial and ending debt/asset ratios, 3.0 Base price level

Initial Debt	Debt/Asset Ratio	
Thousand $	Initial %	Ending %
0	0.0	0.0
104	15.0	4.4
209	30.0	10.1
418	60.0	28.3
626	90.0	69.9[a]

[a]The farm became insolvent during some years of the 15-year simulation period. The simulation was completed to show the ending position that would have been realized from continued deficit debt financing.

Table 5. Debt-asset ratios for the 15-year period by initial debt, Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0[a]	90.0[a]
	Debt-asset ratio (%)				
1	0.0	15.0	29.5	65.0	Insolvent
2	0.0	21.0	31.0	75.0	"
3	0.0	14.9	38.4	82.6	"
4	0.0	14.2	36.2	92.1	"
5	0.0	15.0	45.5	Insolvent	"
6	0.0	14.7	46.6	"	"
7	0.0	15.6	51.8	"	"
8	0.0	15.0	57.0	"	"
9	0.0	15.9	64.3	"	"
10	0.0	14.8	66.4	"	"
11	0.0	13.2	56.3	"	"
12	0.0	12.3	49.2	"	"
13	0.0	12.2	50.3	"	"
14	0.0	12.2	52.3	"	"
15	0.0	12.0	49.8	"	"

[a]If the farm had been continued on with deficit debt financing, the ratios would have continuously deteriorated. In the fifteenth year, the ratios would have been 183 and 301 for the 60 and 90 debt situations.

Table 6. Debt-asset ratios for the 15-year period by initial debt, 2.0 Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0[a]
	Debt-asset ratio (%)				
1	0.0	13.8	28.4	60.4	96.7
2	0.0	14.1	30.0	72.4	Insolvent
3	0.0	12.2	26.5	65.5	"
4	0.0	11.0	24.1	60.1	"
5	0.0	11.0	25.0	72.2	"
6	0.0	10.4	23.8	70.9	"
7	0.0	10.1	23.5	74.6	"
8	0.0	9.2	21.9	76.3	"
9	0.0	8.5	20.8	79.9	"
10	0.0	7.9	19.6	79.0	"
11	0.0	7.0	17.0	60.2	"
12	0.0	6.5	15.7	53.5	"
13	0.0	6.4	15.5	53.8	"
14	0.0	6.4	15.5	54.5	"
15	0.0	6.2	15.1	52.3	"

[a]If the farm had been continued with deficit debt financing, the debt-to-asset ratio would have continuously deterioriated. It would have been 160 percent in the fifteenth year.

Table 7. Debt-asset ratios for the 15-year period by initial debt, 3.0 Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0[a]
	Debt-asset ratio (%)				
1	0.0	13.2	27.1	57.0	90.3
2	0.0	12.9	27.3	62.9	Insolvent
3	0.0	10.6	22.7	53.0	"
4	0.0	9.2	19.9	47.6	"
5	0.0	8.9	19.8	50.6	"
6	0.0	8.3	18.5	48.0	"
7	0.0	7.9	17.8	47.7	"
8	0.0	7.0	16.0	44.5	"
9	0.0	6.3	14.6	42.4	"
10	0.0	5.8	13.5	39.9	"
11	0.0	5.0	11.6	32.8	"
12	0.0	4.7	10.6	29.5	"
13	0.0	4.6	10.5	29.2	"
14	0.0	4.5	10.4	29.3	"
15	0.0	4.4	10.1	28.3	"

[a]If the farm had been continued with deficit debt financing, it would have had a 70 percent ratio in year 15. The ratio would have been above 100 for 7 of the 15 years.

Table 8. Return on total assets before tax for the 15-year period by initial debt, Base prices

Year	Initial debt-asset ratio (%) 0.0	15.0	30.0	60.0	90.0
	Return on total assets before tax (%)				
1	(1.9)	(3.4)	(4.9)	(8.4)	Insolvent
2	(7.6)	(9.7)	(10.7)	(15.1)	"
3	13.7	12.2	9.9	5.4	"
4	8.9	7.5	5.3	(0.3)	"
5	(6.7)	(8.2)	(11.3)	Insolvent	"
6	3.4	1.9	(1.3)	"	"
7	(1.4)	(3.0)	(6.6)	"	"
8	2.3	0.8	(3.4)	"	"
9	0.3	(1.3)	(6.1)	"	"
10	3.5	2.0	(3.1)	"	"
11	21.0	19.7	15.4	"	"
12	12.9	11.7	8.0	"	"
13	2.4	1.2	(2.6)	"	"
14	1.2	0.0	(4.0)	"	"
15	5.8	4.6	0.8	"	"
Years 1-15 unweighted average	3.9	2.4	(1.0)	(4.6)	0
Number of years return on total assets before tax exceeded the average cost of debt	3	3	1	0	0
Number of years return on total assets before tax were negative	4	5	10	3	0

Table 9. Return on net worth before tax for the 15-year period by initial debt, Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
	Return on net worth before tax (%)				
1	(1.9)	(4.0)	(6.9)	(24.0)	Insolvent
2	(7.6)	(12.3)	(15.5)	(60.4)	"
3	13.7	14.3	16.0	31.3	"
4	8.9	8.7	8.3	(3.9)	"
5	(6.7)	(9.6)	(20.6)	Insolvent	"
6	3.4	2.3	(2.4)	"	"
7	(1.4)	(3.5)	(13.7)	"	"
8	2.3	0.9	(7.9)	"	"
9	0.3	(1.5)	(17.2)	"	"
10	3.5	2.4	(9.3)	"	"
11	21.0	22.7	35.2	"	"
12	12.9	13.3	15.7	"	"
13	2.4	1.3	(5.3)	"	"
14	1.2	0.0	(8.4)	"	"
15	5.8	5.2	1.6	"	"
Years 1-15 unweighted average	3.9	2.7	(2.0)	(14.3)	0
Number of years return on net worth before tax exceeded the average cost of debt	3	3	3	1	0
Number of years return on net worth before tax were negative	4	5	10	3	0

Table 10. Return on total assets before tax for the 15-year period by initial debt, 2.0 Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
	Return on total assets before tax (%)				
1	9.5	8.1	6.7	3.5	(0.2)
2	(1.9)	(3.3)	(4.9)	(9.1)	Insolvent
3	30.7	29.5	28.1	24.2	"
4	21.9	20.8	19.5	15.9	"
5	(2.1)	(3.2)	(4.6)	(9.3)	"
6	11.9	10.9	9.5	4.8	"
7	4.9	3.9	2.6	(2.6)	"
8	9.3	8.4	7.1	1.7	"
9	6.2	5.4	4.1	(1.8)	"
10	10.0	9.2	8.0	2.1	"
11	31.3	30.6	29.6	25.3	"
12	22.0	21.4	20.4	16.7	"
13	7.2	6.6	5.7	1.8	"
14	5.9	5.3	4.4	0.4	"
15	12.6	12.0	11.1	7.4	"
Years 1-15 unweighted average	12.0	11.0	9.8	8.6	(0.2)
Number of years return on total assets before tax exceeded the average cost of debt	6	6	5	4	0
Number of years return on total assets before tax were negative	2	2	2	4	1

Table 11. Return on net worth before tax for the 15-year period by initial debt, 2.0 Base prices

Year	Initial debt-asset ratio (%) 0.0	15.0	30.0	60.0	90.0
	Return on net worth before tax (%)				
1	9.5	9.4	9.3	8.7	(5.2)
2	(1.9)	(3.9)	(7.0)	(33.1)	Insolvent
3	30.7	33.6	38.2	70.0	"
4	21.9	23.4	25.7	39.8	"
5	(2.1)	(3.6)	(6.1)	(33.5)	"
6	11.9	12.1	12.5	16.5	"
7	4.9	4.3	3.3	(10.1)	"
8	9.3	9.2	9.1	7.0	"
9	6.2	5.8	5.2	(8.9)	"
10	10.0	10.0	10.0	10.0	"
11	31.3	32.9	35.7	63.5	"
12	22.0	22.8	24.2	35.8	"
13	7.2	7.0	6.7	3.9	"
14	5.9	5.6	5.1	1.0	"
15	12.6	12.8	13.1	15.5	"
Years 1-15 unweighted average	12.0	12.1	12.3	21.4	(5.2)
Number of years return on net worth before tax exceeded the average cost of debt	6	6	6	6	0
Number of years return on net worth before tax were negative	2	2	2	4	1

Table 12. Return on total assets before tax for the 15-year period by initial debt, 3.0 Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
	Return on total assets before tax (%)				
1	20.0	18.7	17.3	14.3	11.0
2	2.7	1.4	0.0	(3.6)	Insolvent
3	44.8	43.7	42.5	39.5	"
4	31.7	30.8	29.7	26.9	"
5	0.9	0.0	(1.1)	(4.2)	"
6	17.4	16.6	15.6	12.6	"
7	8.5	7.7	6.7	3.7	"
8	13.4	12.7	11.8	9.0	"
9	9.6	9.0	8.1	5.4	"
10	13.7	13.1	12.4	9.7	"
11	37.4	36.9	36.2	34.1	"
12	26.6	26.1	25.5	23.7	"
13	9.9	9.4	8.9	7.0	"
14	8.2	7.8	7.2	5.3	"
15	15.6	15.2	14.6	12.8	"
Years 1-15 unweighted average	17.4	16.6	15.7	13.1	11.0
Number of years return on total assets before tax exceeded the average cost of debt	9	9	9	7	1
Number of years return on total assets before tax were negative	0	0	1	2	0

Table 13. Return on net worth before tax for the 15-year period by initial debt, 3.0 Base prices

Year	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
	Return on net worth before tax (%)				
1	20.0	21.5	23.7	33.3	113.1
2	2.7	1.6	0.0	(9.7)	Insolvent
3	44.8	48.9	55.0	84.0	"
4	31.7	33.9	37.1	51.4	"
5	0.9	0.0	(1.3)	(8.4)	"
6	17.4	18.1	19.1	24.2	"
7	8.5	8.4	8.2	7.1	"
8	13.4	13.7	14.0	16.1	"
9	9.6	9.6	9.5	9.3	"
10	13.7	13.9	14.3	16.2	"
11	37.4	38.8	41.0	50.8	"
12	26.6	27.4	28.6	33.5	"
13	9.9	9.9	9.9	9.9	"
14	8.2	8.1	8.0	7.5	"
15	15.6	15.9	16.2	17.8	"
Years 1-15 unweighted average	17.4	18.0	18.9	39.8	113.1
Number of years return on net worth before tax exceeded the average cost of debt	9	9	9	9	1
Number of years return on net worth before tax were negative	0	0	1	2	0

Table 14. Initial net worth, ending net worth, change in net worth, and ending/initial ratio for the 15-year simulation period by initial debt-asset ratio and Base price level

Item	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
Initial net worth (thousand $)	696	592	487	278	70
Ending net worth (thousand $)	2993	2013	877	0	0
Change in net worth (thousand $)	2297	1421	390	(278)	(70)
Ending/initial net worth ratio	4.3	3.4	1.8	NA	NA

NA - Not applicable since the model farm became insolvent during the 15-year simulation period.

Table 15. Initial net worth, ending net worth, change in net worth, and ending/initial ratio for the 15-year simulation period by initial debt-asset ratio and 2.0 Base price level

Item	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
Initial net worth (thousand $)	696	592	487	278	70
Ending net worth (thousand $)	4733	4203	3652	2168	0
Change in net worth (thousand $)	4037	3611	3165	1890	(70)
Ending/initial net worth ratio	6.8	7.1	7.5	7.8	NA

NA - Not applicable since the model farm became insolvent during the 15-year simulation period.

Table 16. Initial net worth, ending net worth, change in net worth, and ending/initial ratio for the 15-year simulation period by initial debt-asset ratio and 3.0 Base price level

Item	Initial debt-asset ratio (%)				
	0.0	15.0	30.0	60.0	90.0
Initial net worth (thousand $)	696	592	487	278	70
Ending net worth (thousand $)	5,498	5,091	4,529	2,697	0
Change in net worth (thousand $)	4,802	4,499	4,042	2,419	(70)
Ending/initial net worth ratio	7.9	8.6	9.3	9.7	NA

NA - Not applicable since the model farm became insolvent during the 15-year simulation period.

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