FINANCIAL RISK MEASUREMENTS FOR A CENTRAL ARIZONA FARM.

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FINANCIAL RISK MEASUREMENTS FOR A CENTRAL ARIZONA FARM

by

Carl E. Gundersen

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STATEMENT BY AUTHOR

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This thesis has been approved on the date shown below:

Paul N. Wilson — December 13, 1983

Paul N. Wilson, Assistant Professor in Agricultural Economics — Date

Dedicated to my mother, Aggi, and to my father, Markus.

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ABSTRACT

During the last decade, American agriculture has been faced with financial difficulties unlike any in history. As farm debt has been increasing, farm income has remained relatively unchanged forcing economists to more closely examine the risks involved in the agricultural industry. Measuring financial risk has not previously been empirically tested on the micro level. Presented here is an approach to measuring financial risk, business risk, and total risk. Historically, risk measures have been presented in terms of an expected outcome with a variance representing the likelihood of an outcome that is less than expected. Presented herein is a Monte Carlo simulation approach for measuring the risk facing an individual farm. The results show that as a farm gets more deeply in debt financial risk considerations can become more important than business risk. Also shown herein, which has not be previously discussed in any of the literature, are the problems associated with interpreting the risk measures when the expected cash flow is negative or when the fixed debt payments are greater than the expected cash flow.

CHAPTER 1

INTRODUCTION

Since 1973, volatile markets, which have made profits less predictable, have combined with high inflation and high interest rates to create a smaller profit margin in the agricultural production industry. Lenders have become more interested in the variability involved in a producer's ability to service debt and interest payments. Lending institutions are placing an emphasis on a producer's track record in production and profitability and an even greater emphasis on the producer's ability to manage and service his debt via cash flow analysis or projections (McDonald, 1981).

National Outlook

The boom in farmland values, triggered by the inflationary pressures of the 1970's, had the effect of greatly increasing the nominal net worth of the landowners. Over the 1960-79 period, nominal gains on farmland averaged 9.3 percent annually. Real gains during the same period averaged 4.2 percent annually (Lins, 1979). These unrealized capital gains were often collateralized into loans to finance or refinance the producer's short-, intermediate-, and even long-term loans (Klinefelter, Penson and Fraser, 1980).

In the 1980's, the trend of increasing farmland values has reversed mostly because of low net farm incomes and high interest rates. U.S. farmland values fell an average of 6 percent during the year ending April 1, 1983. Real values of farmland (U.S. aggregate figures) have fallen for the third straight year and are now below 1980 levels by 18 percent (Farm Real Estate, 1983). From these data we can assume that producers can no longer look toward inflated land values for help in servicing or refinancing their debt.

Table 1. U.S. Net Farm Income in Billions of Dollars.

YEAR	NOMINAL	REAL
1972	18.9	18.9
1973	33.4	31.6
1974	26.0	22.4
1975	25.2	19.8
1976	18.7	14.1
1977	18.4	13.1
1978	26.7	17.8
1979	32.3	19.8
1980	20.1	11.3
1981	25.1	12.8
1982	22.1	10.7

Source: U.S. Department of Agriculture.

The variability of net farm income has also had an impact on the agricultural industry. An analysis of various time series suggests a rise in the relative variability of net farm income since 1963-64 (Smith, 1972). During the years encompassed in this study period, 1972-1982, net farm income (U.S. aggregate figures) has continued to be variable, reaching the low $30 billion range or

Table 2. U.S. Outstanding Farm Debt (millions of Dollars).

YEAR	RE DEBT	NON RE DEBT	TOTAL OUTSTANDING DEBT (NOMINAL)	(REAL)	DISTRIBUTION RE	NON RE
1972	32,208	24,644	56,852	56,852	.566	.434
1973	35,758	27,794	63,552	60,068	.563	.437
1974	41,253	32,134	73,387	63,254	.562	.438
1975	46,288	35,266	81,514	64,093	.568	.432
1976	51,069	39,406	90,475	68,366	.564	.436
1977	56,590	45,061	94,408	67,410	.545	.455
1978	58,071	48,643	106,714	70,944	.544	.456
1979	64,602	56,940	121,542	74,374	.532	.468
1980	75,461	66,950	142,411	79,720	.530	.470
1981	84,064	74,090	158,154	80,893	.531	.469
1982	93,318	80,256	173,574	83,901	.538	.462

Source: U.S. Department of Agriculture.

less in 1972, 1976, 1977 and 1980 (See Table 1). In real terms (see Appendix A for procedure on GNP implicit deflator), net farm income has declined over the study period. From the eleven annual observations, a t test on the slope variable at the .05 confidence level indicates that the slope is significantly different from zero (all trends discussed in this chapter are detailed in Appendix B, Regression Analysis). In 1982, net farm income, in real terms, reached its lowest point over the entire study period (See Figure I).

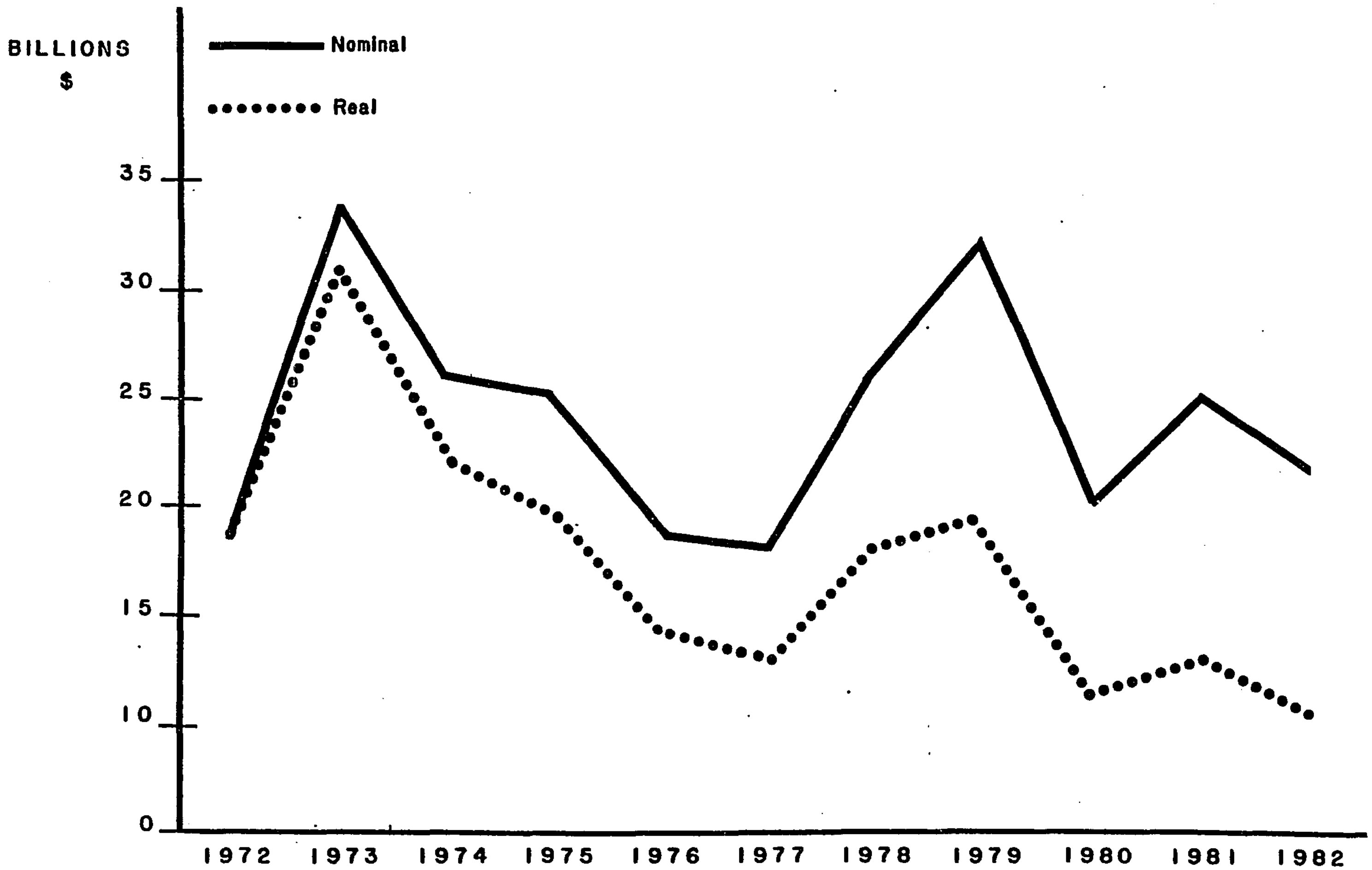

Figure 1. U.S. Net Farm Income.

Source: U.S. Department of Agriculture.

As net farm income has been falling, outstanding debt (U.S. aggregate figures) has been increasing (See Figure 2). During the study period, total farm debt has trebled to more than $173 billion, though in real terms it has increased by slightly less than 50 percent. Over the study period, there has been a shift in the distribution of real estate debt verses non-real estate debt. In 1972, real estate debt was approximately 57 percent and non-real estate debt was 43 percent of total outstanding debt (see Table 2). The trend has been one of increasing non-real estate debt and decreasing real estate debt to 46 percent and 54 percent respectively (See Figure 3). Real estate is still clearly the major source of outstanding debt.

When the rising debt levels in agriculture are coupled with a low nominal farm income it puts increasing pressure on the borrower's future income to service the debt. For both the borrower and the lender, their exposure to financial risk increases (Barry and Fraser, 1976). The wealth and income for an average farm may be sufficient in terms of the producer's resources, but the cash flow situation may be insufficient to meet current demands resulting in real financial difficulties.

Since debt servicing hinges on the producer's financial capacity or strength. the best short term indicator of an enterprise's financial strength is an analysis of its cash flow situation. Of primary importance

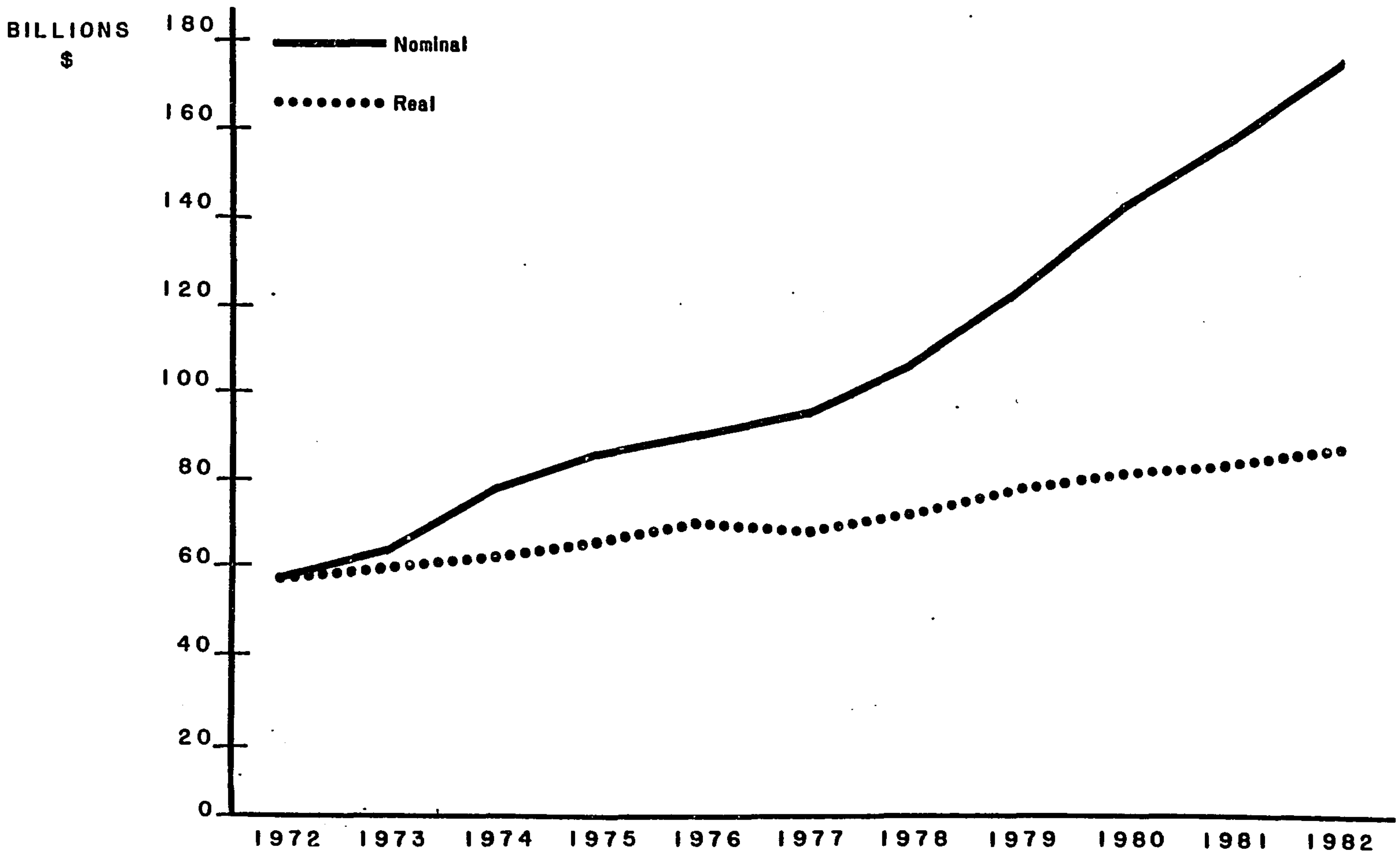

Figure 2. U.S. Outstanding Farm Debt.

Source: U.S. Department of Agriculture/E.R.S., 1982.

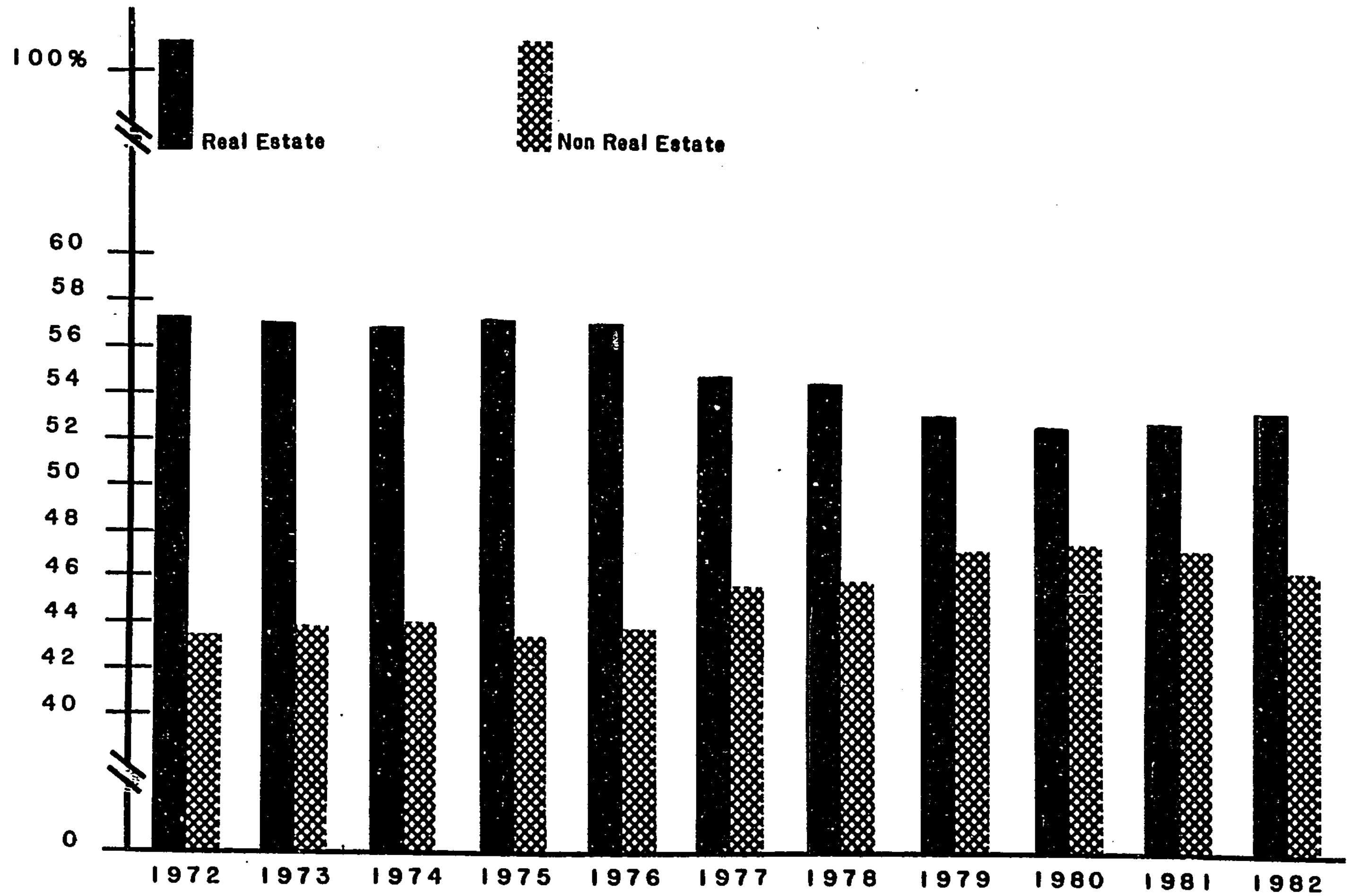

Figure 3. U.S. Farm Debt Distribution.

Source: U.S. Department of Agriculture/E.R.S., 1982.

TABLE 3. Interest Rates Charged Producers.

YEAR	PRIME RATE	P.C.A.	F.I.C.B.	F.L.B.
1975	6.33	8.91	8.14	8.69
1976	5.35	8.24	7.36	8.66
1977	5.60	7.88	6.94	8.39
1978	7.99	8.83	8.06	8.35
1979	10.91	10.71	10.90	9.20
1980	12.29	12.86	11.10	10.39
1981	14.76	14.87	14.18	11.27
1982	14.61	14.57	13.57	11.04

Source: U.S. Department of Commerce.

is that the 'typical' producer relies on annual borrowing to provide an ever increasing share of cash inflows. In the period from 1975 to 1982, the average interest rate charged by local Production Credit Associations nearly doubled from 8.9 percent to 14.6 percent. The high interest rates charged to producers (See Table 3) has had the effect of increasing the costs for annual operating and capital expenditures and has been another force helping to lower nominal net farm income. In response to declining cash farm incomes and the increasing burden of servicing farm debt, cash flow analysis has increased in importance. The cash flow status helps provide a good perspective into the short term debt servicing capability of the producer's enterprise.

Arizona Outlook

In Arizona, the farm ecomomic conditions are similar to the national outlook. Average farmland values have been decreasing since 1980. During the year ending April 1, 1983, Arizona farmland values fell 5 percent (USDA, Farm Real Estate, 1983). Net farm income for Arizona farmers has been extremely variable. From 1972 to 1974, net farm income rose from $155.4 million to $388.4 million, then in 1975 it declined to $197.5 million. The following year it doubled to $397.5 million (See Table 4). In real terms, 1981 net farm income was at the lowest level for the period 1972-82. In both real and nominal terms no trend is evident (See Figure 4).

Table 4. Arizona Net Farm Income in Millions of Dollars.

YEAR	NOMINAL	REAL
1972	155.4	155.4
1973	240.6	227.4
1974	388.4	334.8
1975	197.5	155.3
1976	397.7	300.5
1977	299.8	214.1
1978	367.8	244.4
1979	439.6	269.0
1980	393.3	220.2
1981	227.9	116.7

Source: U.S. Department of Agriculture.

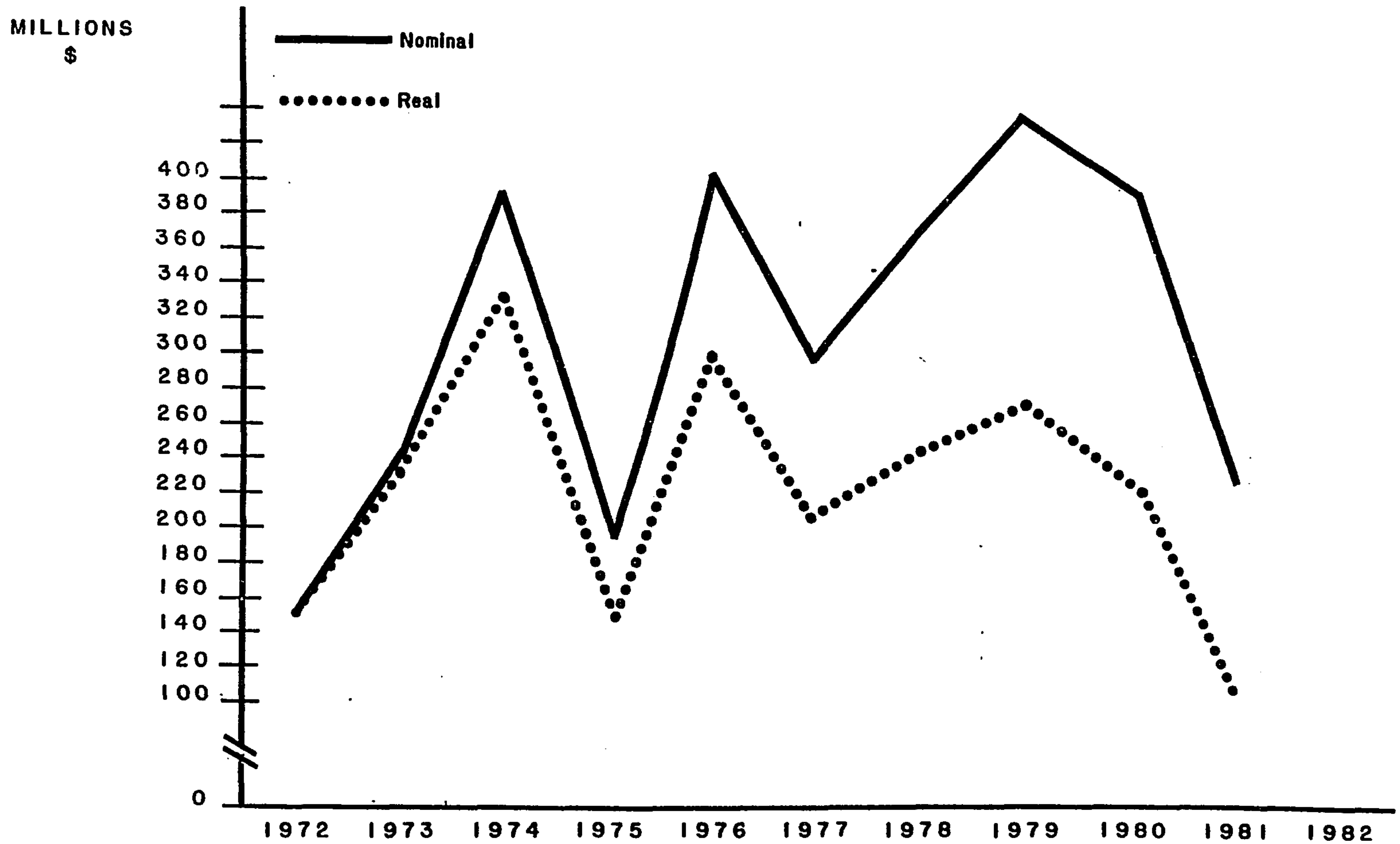

Figure 4. Arizona Net Farm Income.

Source: U.S. Department of Agriculture/E.R.S., 1982.

Table 5. Arizona Outstanding Farm Debt in Millions of Dollars.

YEAR	RE DEBT	NON RE DEBT	TOTAL OUTSTANDING DEBT (NOMINAL)	(REAL)	DISTRIBUTION RE	NON RE
1972	310	322	632	632	.491	.509
1973	337	401	738	698	.457	.543
1974	376	468	844	727	.445	.555
1975	397	430	827	650	.480	.520
1976	436	456	892	674	.489	.511
1977	444	440	884	631	.502	.498
1978	470	516	986	655	.477	.523
1979	489	689	1,078	660	.454	.546
1980	621	815	1,436	804	.432	.568
1981	686	905	1,591	814	.431	.569
1982	727	993	1,720	832	.423	.577

Source: U.S. Department of Agriculture.

As Arizona net farm income has remainedrelatively unchanged outstanding farm debt has been increasing (See Figure 5). Nominally, the total farm debt has nearly trebled, while in real terms it has only increased by approximately 31 percent, substantially less than the national increase. Over the study period, there has been a shift in the distribution of the real estate debt verses non real estate debt (See Figure 6). Real estate debt was 49 percent of total debt in 1972 and in 1982 it was 42 percent, a change of 7 percentage points. Non real estate debt went

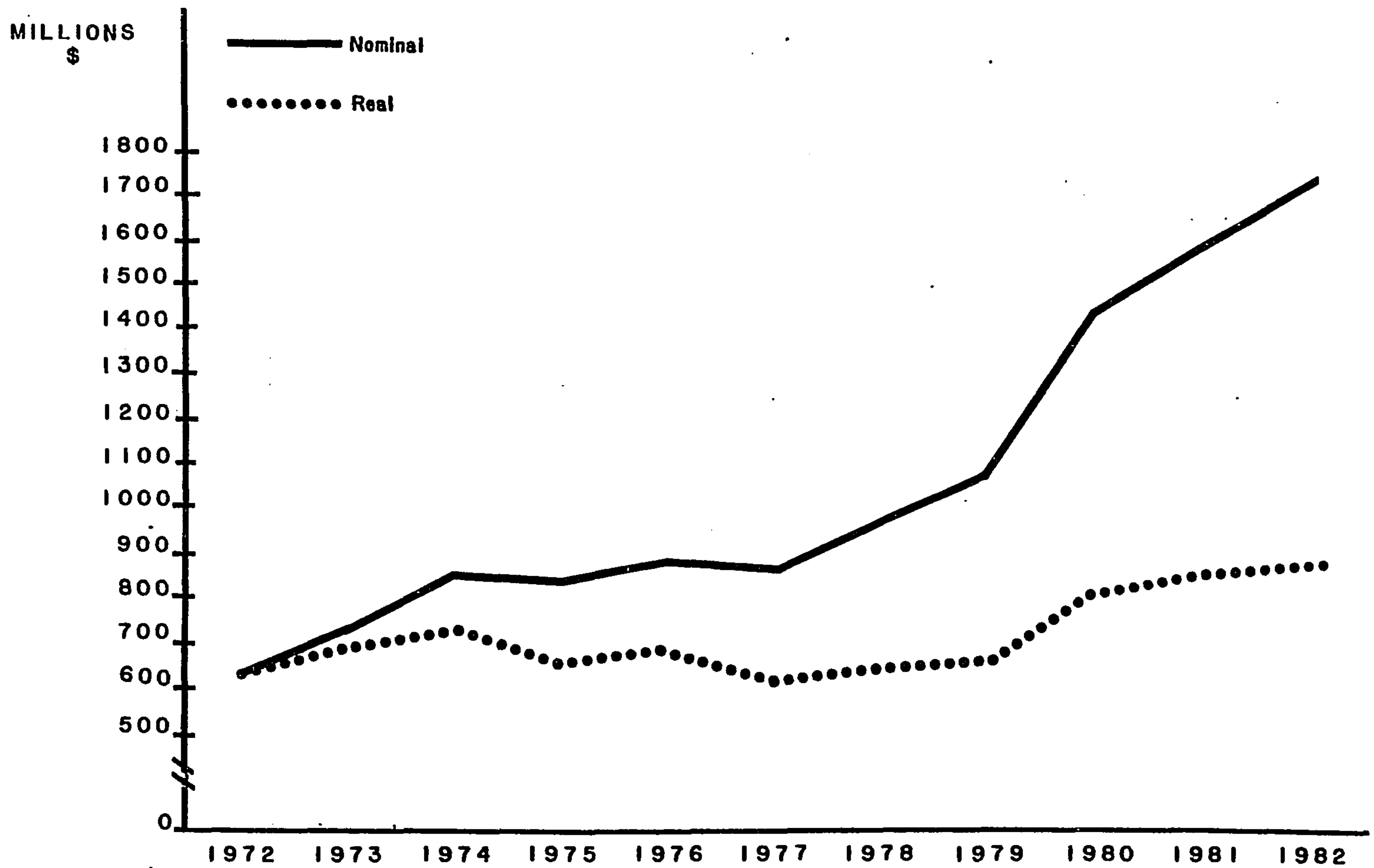

Figure 5. Arizona Outstanding Farm Debt.

Source: U.S. Department of Agriculture/E.R.S., 1982.

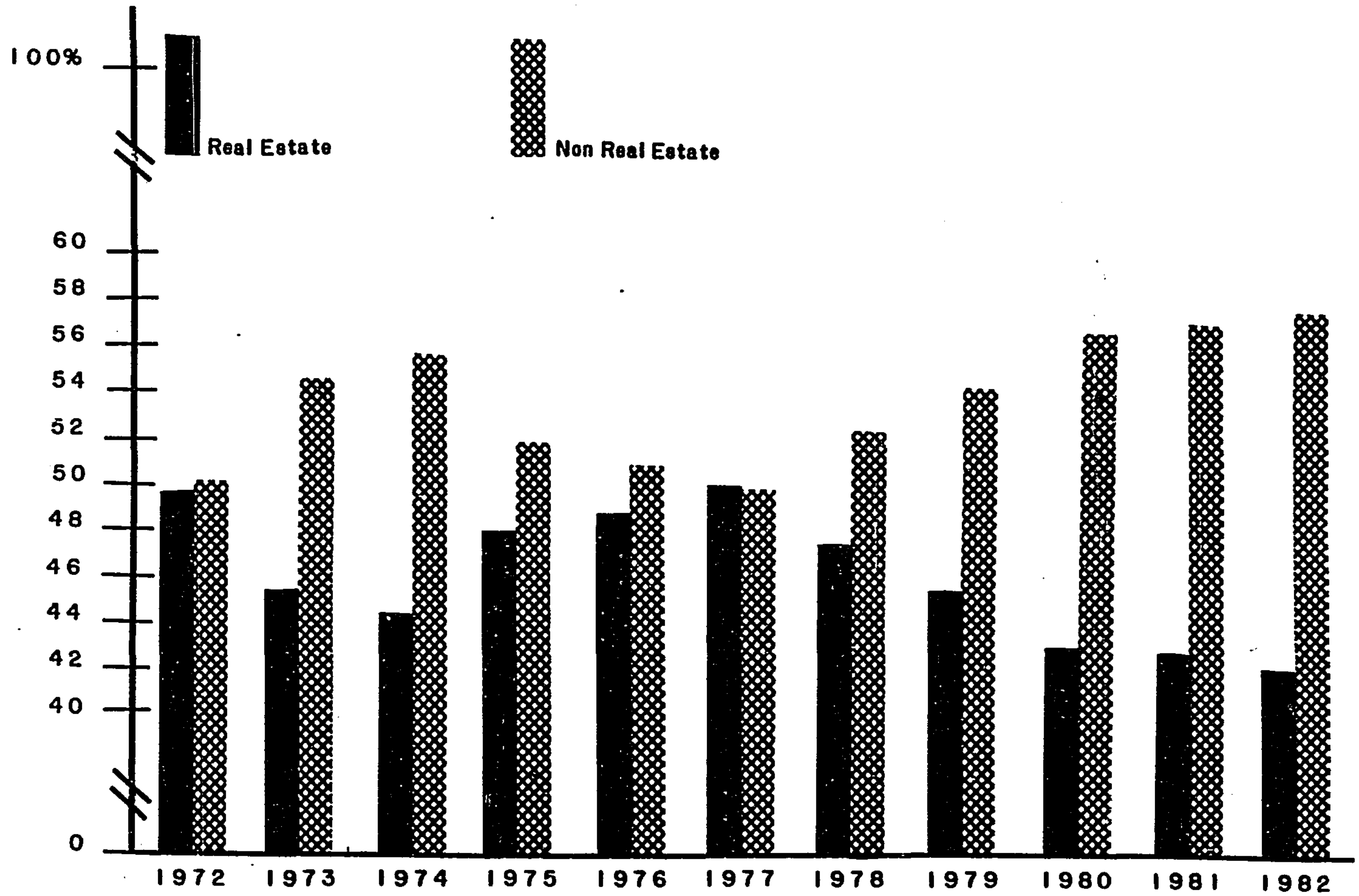

Figure 6. Arizona Farm Debt Distribution.

Source: U.S. Department of Agriculture/E.R.S., 1982.

from 51 percent in 1972, to 58 percent in 1982 (See Table 5). The direction of the shift is similar to national data except for the magnitude. The shift in Arizona has been more than twice the national figures. A comparison of the distribution of debt is more interesting. Nationally, as of 1982 real estate debt accounted for 54 percent of total debt and non real estate debt for 46 percent. In Arizona real estate debt accounted for 42 percent and non real estate debt 58 percent of total outstanding debt. The difference in non real estate debt is substantial, with Arizona having 16 percent more of its debt in this catagory. Even when accounting for problems inherent with aggregation the difference is large. The difference between the distributions reflects the cash intensiveness associated with irrigated crop production in the southwest and particularly in Arizona.

Crop Yields and Prices

Market and production forces have the greatest impact on the variability of net farm income. The representative farm described in this study is no exception to these forces. To gain insight into the situation facing typical farms, we must examine prices and yields for the crops raised on this farm. The following yields and prices are from the Arizona Crop and Livestock Reports for Pinal County, Arizona.

Table 6. Upland Cotton Seasonal Average Prices for Pinal County (in cents per pound).

YEAR	NOMINAL PRICE	REAL PRICE
1972	29.30	29.30
1973	43.30	40.90
1974	44.10	38.01
1975	53.10	41.75
1976	64.20	48.51
1977	58.40	41.70
1978	57.40	38.16
1979	68.10	41.67
1980	74.20	41.54
1981	56.00	28.64
1982	58.90	28.47

Source: U.S. Department of Agriculture.

There is no indication of any trend in upland cotton yields although annual yields have widely fluctuated over the eleven year study period (See Figure 7). The mean yield was 1,064 pounds of lint per acre and the standard deviation was 148 pounds per acre. Yields have fluctuated more than 500 pounds during the period. The lowest yield was 829 pounds per acre in 1975 and the highest was 1,372 pounds per acre in 1981. What variation there is in annual yields has probably been the result of weather and insect damage (Selley and Daugherty, 1983).

Prices for upland cotton have also shown considerable variation during the study period (See Figure 8). The mean price was 55.2 cents per pound and the standard deviation was 12.56 cents per pound. In nominal terms there appears to be an upward trend in the price. However, in real terms, no trend is apparent, yet in 1981

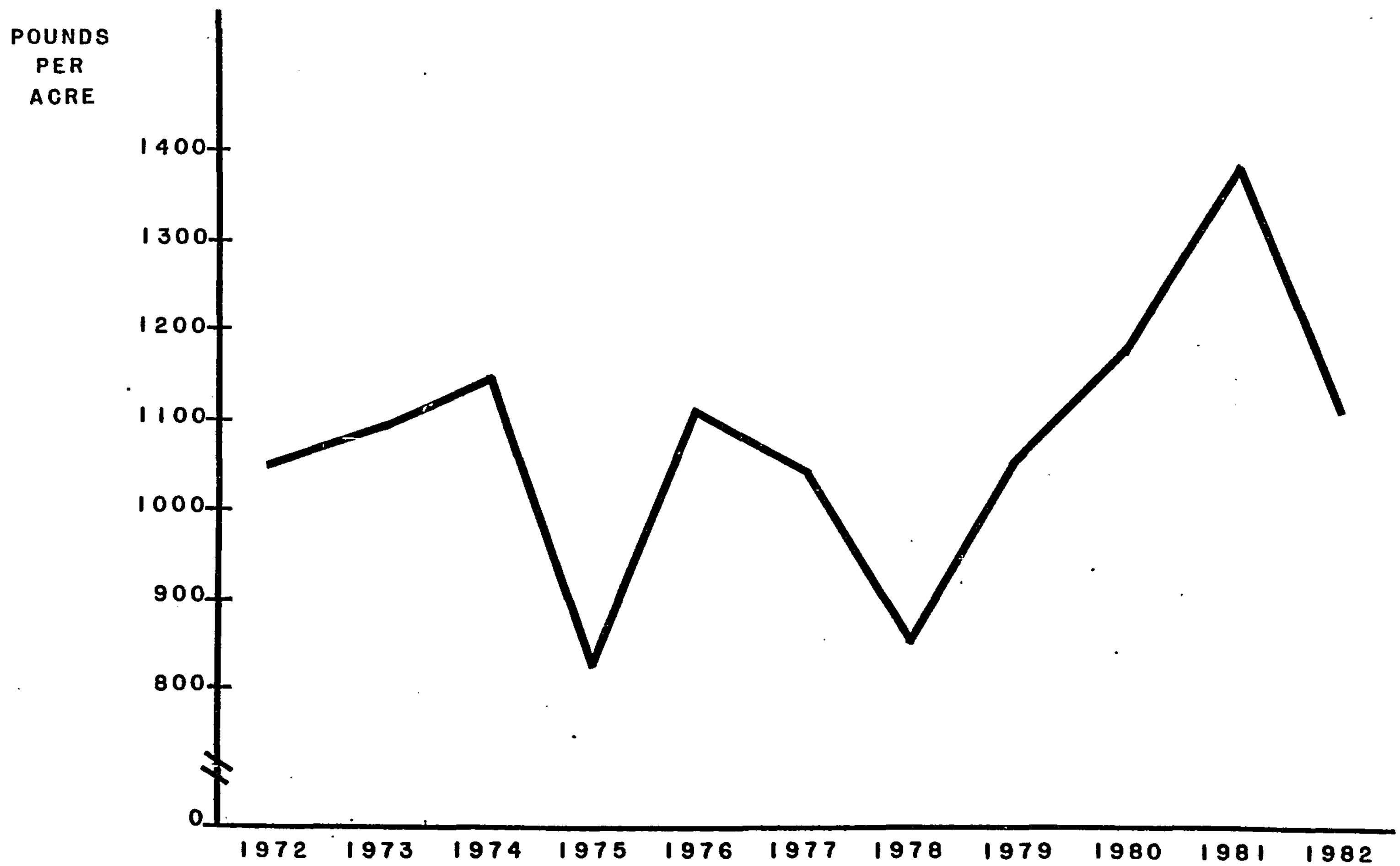

Figure 7. Average Upland Cotton Yields for Pinal County.

Source: Arizona Crop and Livestock Reporting Service, 1982.

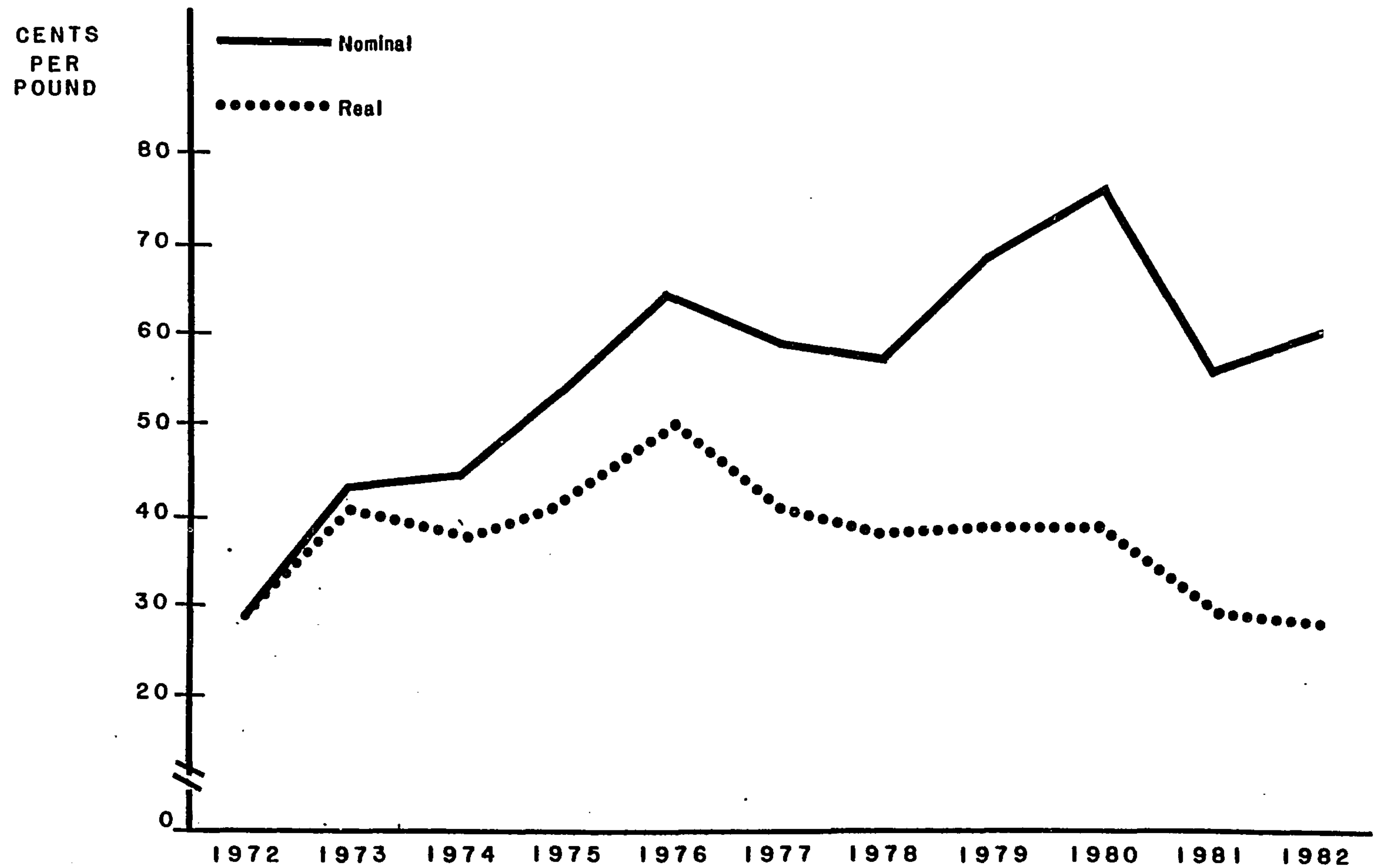

Figure 8. Seasonal Average Prices for Upland Cotton in Pinal County.

Source: Arizona Crop and Livestock Reporting Service, 1982.

and 1982 prices were at their lowest level for the study period (See Table 6).

Alfalfa yields have also fluctuated over the study period and there is an indication of some trend that yields have been improving (See Figure 9). The mean yield for the period was 5.85 tons per acre with a standard deviation of .75 tons per acre. Alfalfa yield was lowest in 1972 at 4.7 tons per acre and was highest in 1982 at 6.8 tons per acre. In 1978, yields dropped to 5.3 tons per acre from 6.5 tons per acre the previous year then in 1979 increased back up to 6.2 tons per acre.

In nominal terms, the price of alfalfa appears to have an upward trend over the study period. The trend is not encouraging because in real terms there appears to be no trend (See Appendix B) even though the price in 1982 is at the lowest level for the study period (See Table 7).

Table 7. Alfalfa Seasonal Average Prices for Pinal County (Dollars per ton).

YEAR	NOMINAL PRICE	REAL PRICE
1972	41.04	41.04
1973	47.17	44.58
1974	62.75	54.09
1975	64.46	50.68
1976	75.58	57.11
1977	71.79	51.26
1978	66.79	44.40
1979	83.38	51.02
1980	93.04	52.08
1981	84.42	43.18
1982	80.42	38.87

Source: U.S. Department of Agriculture.

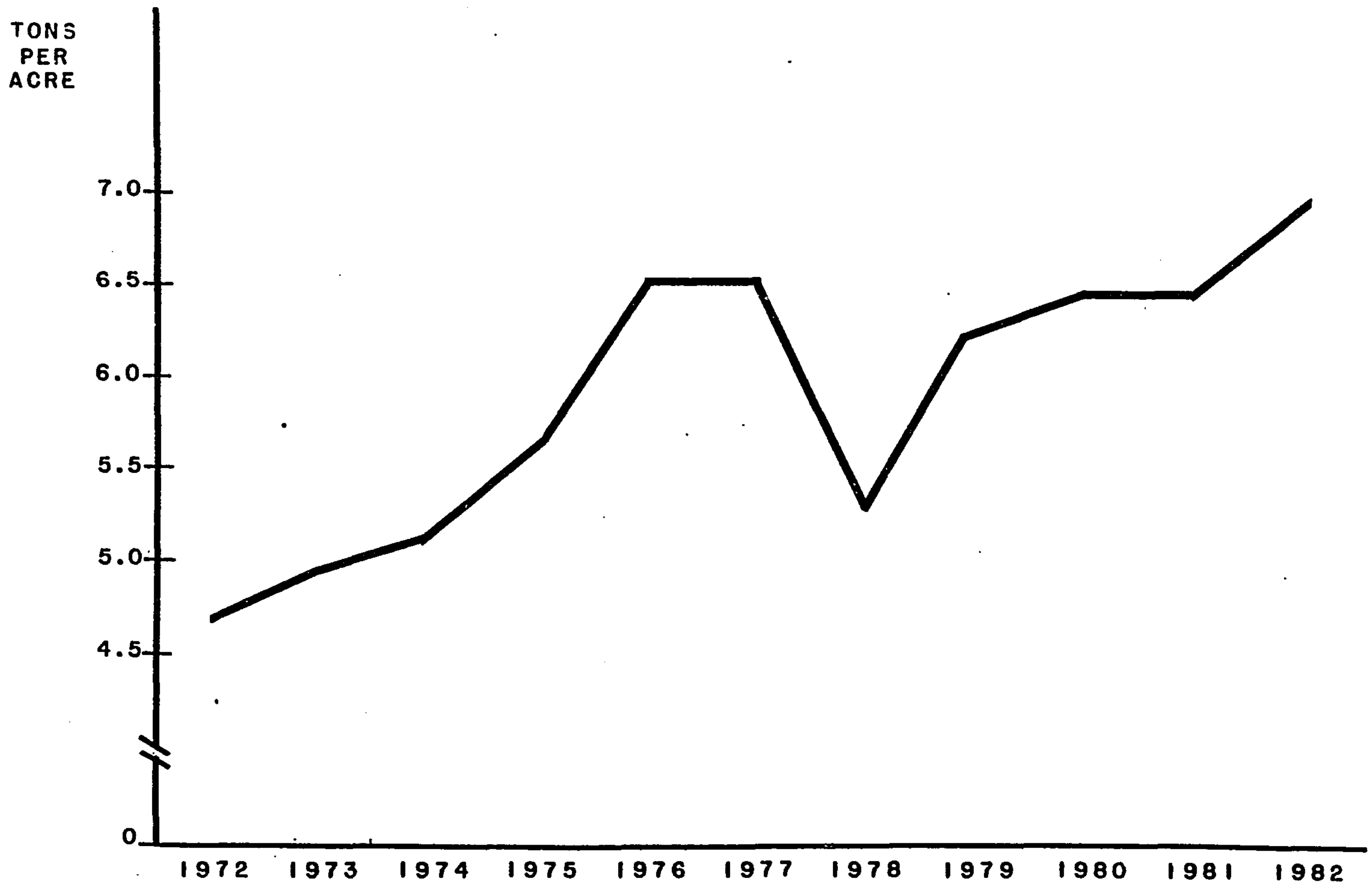

Figure 9. Average Alfalfa Yields for Pinal County.

Source: Arizona Crop and Livestock Reporting Service, 1982.

Table 8. Wheat Seasonal Average Prices for Pinal County (dollars per ton).

YEAR	NOMINAL PRICE	REAL PRICE
1972	54.70	54.70
1973	104.20	101.35
1974	124.90	107.65
1975	105.70	83.11
1976	130.40	98.53
1977	87.70	62.62
1978	94.70	62.96
1979	128.00	78.33
1980	139.00	77.81
1981	158.70	81.17
1982	116.70	56.41

Source: U.S. Department of Agriculture.

Nominally, alfalfa prices have been very variable (See Figure 10). The mean price for the study period equaled 70.08 dollars per ton and the standard deviation was 15.86 dollars per ton.

A regression on wheat yields indicates that there is an upward trend over the study period, especially from the mid-seventies when durham wheat was introduced (See Figure 11). The mean yield for the study period was 4,316 pounds per acre with a standard deviation of 359 pounds per acre. In the market, wheat prices have been highly variable (See Figure 12). Nominally, prices have trended upward over the period, In real terms the trend is downward. In 1982, wheat prices approached the lowest level in real terms since 1972 (See Table 8).

An examination of the yields for the three crops studied reveals that upland cotton and alfalfa suffered

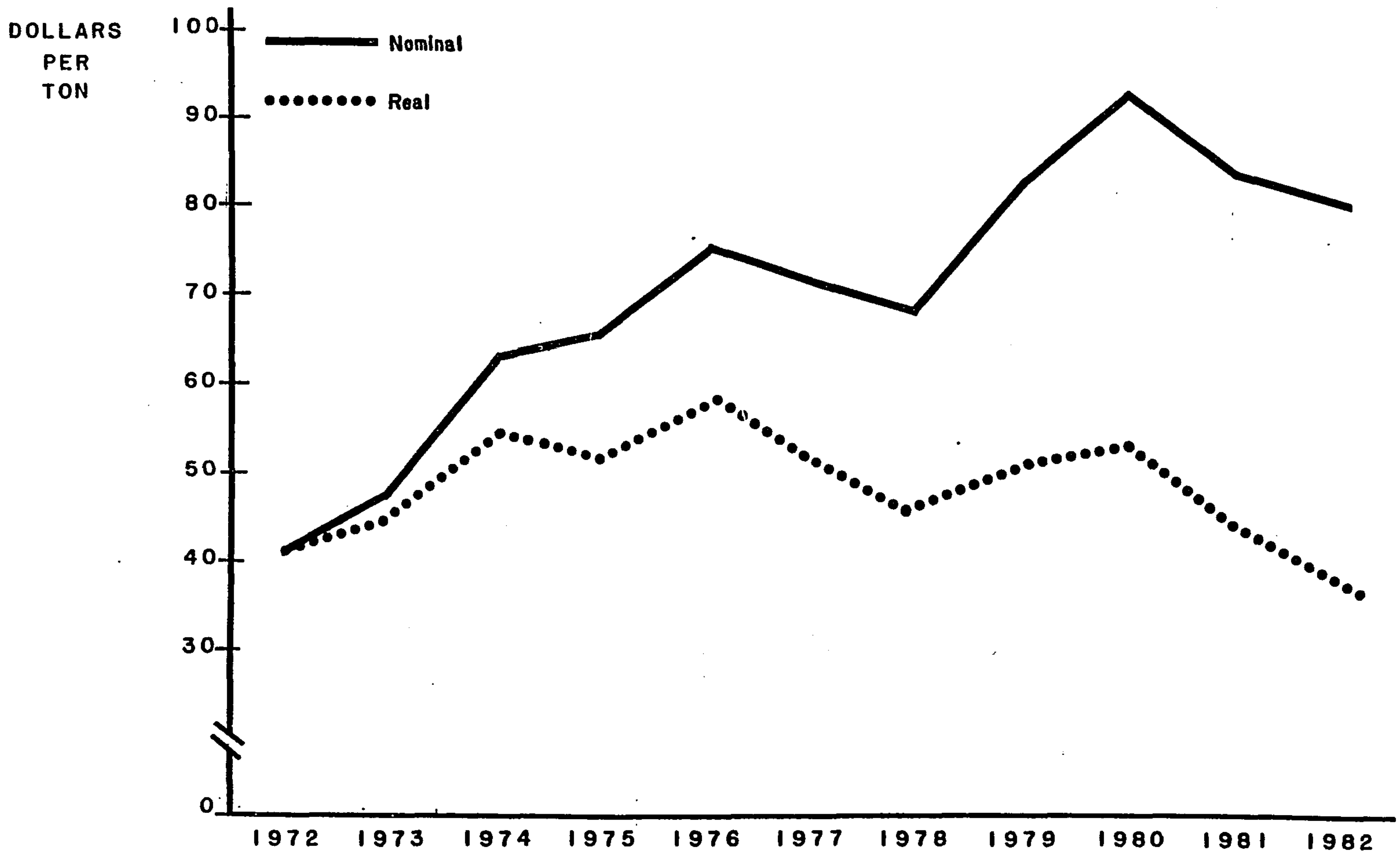

Figure 10. Seasonal Average Prices for Alfalfa Cubes in Pinal County.

Source: Arizona Crop and Livestock Reporting Service, 1982.

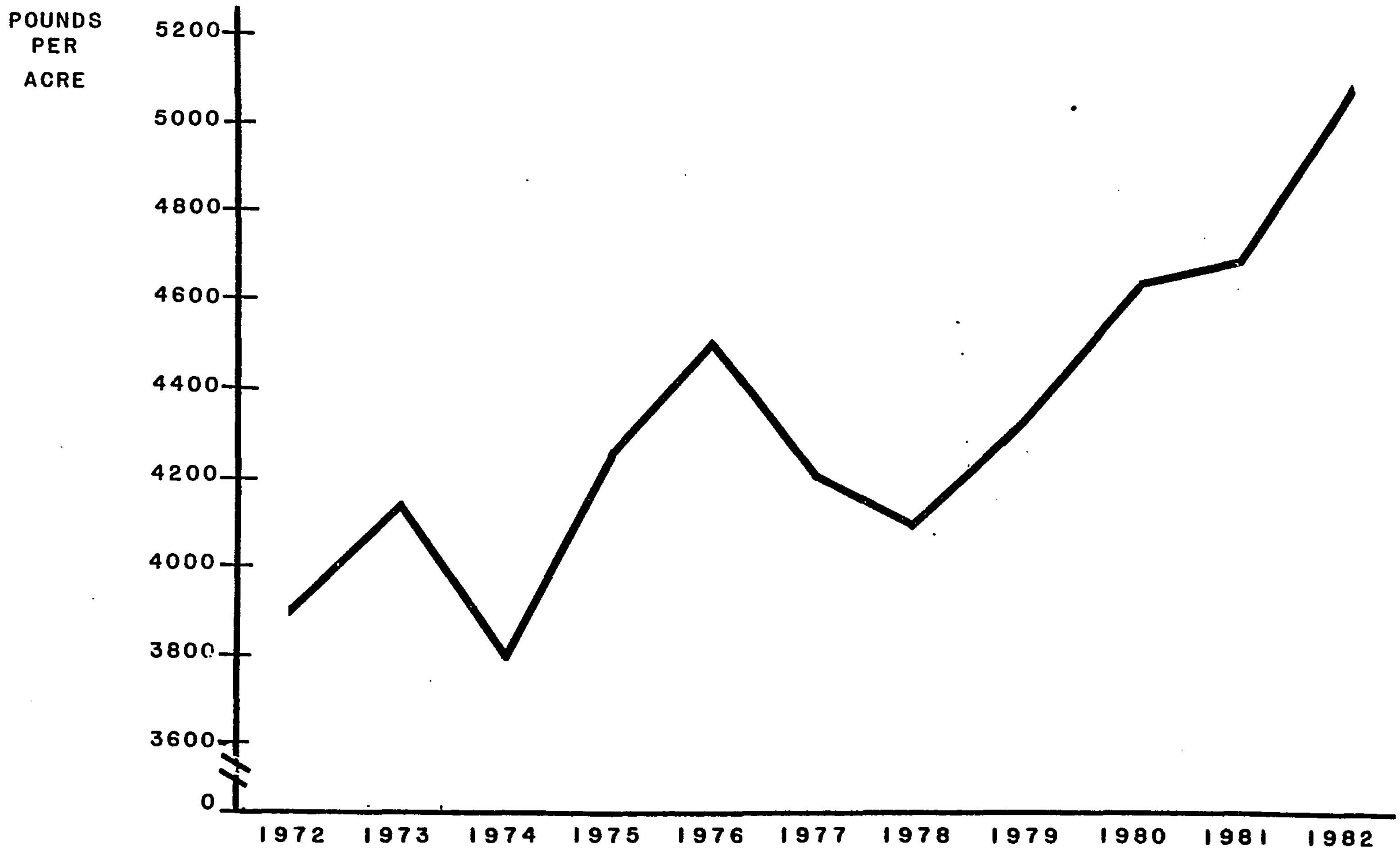

Figure 11. Average Wheat Yields for Pinal County.

Source: Arizona Crop and Livestock Reporting Service, 1982.

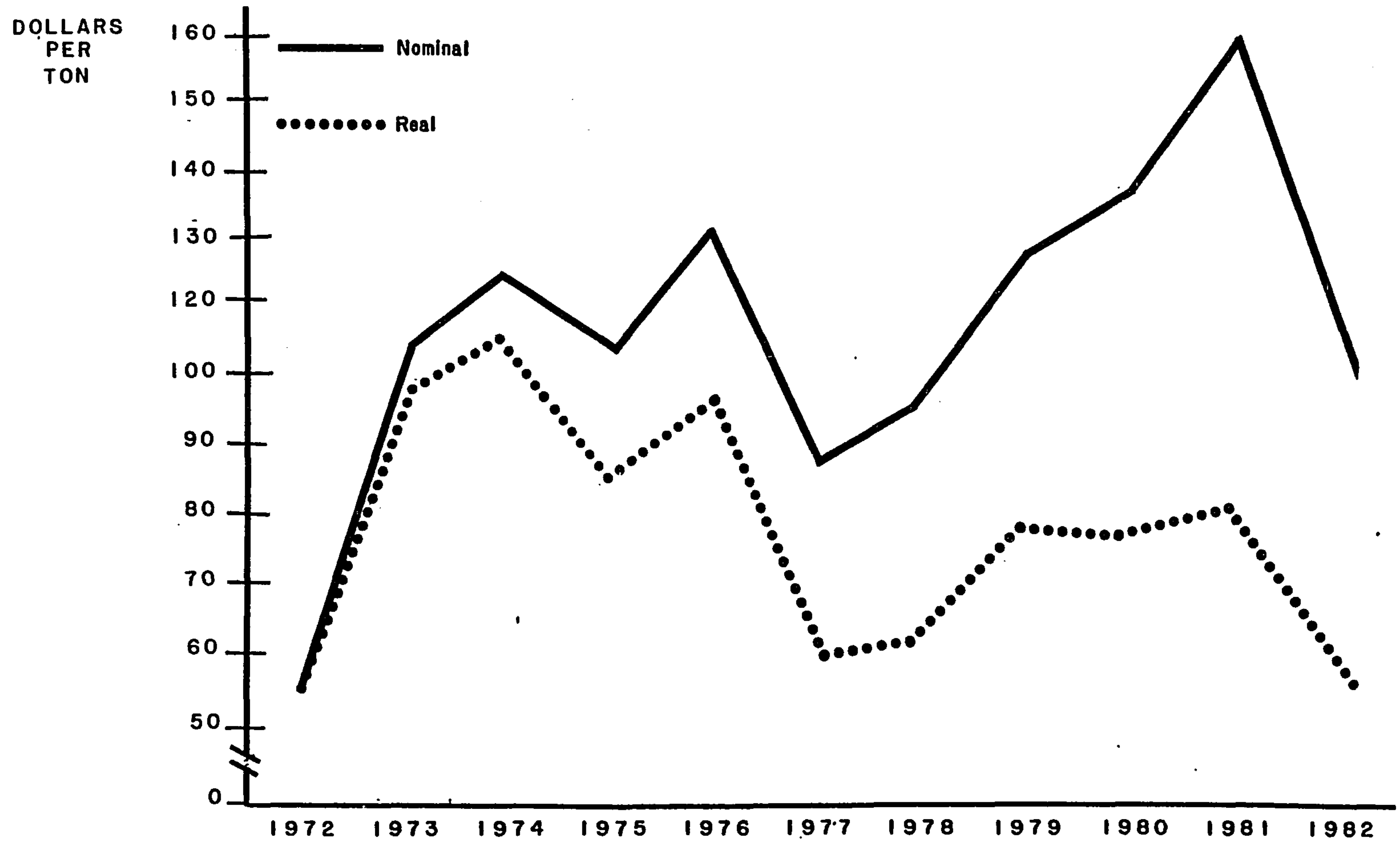

Figure 12. Seasonal Average Prices for Wheat in Pinal County.

Source: Arizona Crop and Livestock Reporting Service, 1982.

substantial yield decreases in 1978, wheat yields were also down sharply. This phenomenon reflects the fact that 1978 was an extremely wet year, especially during the critical planting and harvest months. Precipitation, as measured at the Casa Grande station, was up more than 87 percent for the year 1978. Total precipitation was 15.18 inches compared to the normal average of 8.11 inches (Climatological Data, Arizona, 1978).

Literature Review

Most of the literature on risk distinguishes between uncertainty and risk. Uncertainty is the term used to refer to events or outcomes for which a probability distribution cannot be estimated because of a lack of information about the situation. Risk usually is used to refer to events or outcomes where either an objective or subjective procedure can be used to estimate a probability distribution given the situation. Think of an example where a producer farms river bottom land. If the river was known to flood frequently, such as three times in every ten years, the flooding would represent a risk. The probability of a flood in any given year would be .3. Knowing he faced this risk, the producer could take it into account when he planned his production (for example, he might buy flood insurance). However, if the producer had no information about the occurance of the river flooding, then he is facing uncertainty (in which case he would not know that he might need flood insurance).

It is also important to differentiate business risk from financial risk. Business risk is defined to be that risk which is inherent in the firm and is independent of the way the firm is financed (Gabriel and Baker, 1980). Business risk considerations in agriculture include weather effects on crop or livestock production due to such phenomena as drought, hail, flood, excessive heat or precipitation. There are also the risks of disease and pests, commodity price changes due to supply and demand forces, changes in technology, changes in the costs of inputs (i.e. fertilizer, insecticides, seed, fuel, etc.) and the the costs for capital equipment. There is the risk of a decline in asset value, risk from inflation, government commodity programs, laws and regulations. Though the list is not exhaustive, it recognizes the major business risk components facing today's producers. Business risk (returns to the business without any financing) can be reflected in the variability of the net cash flows or net operating income for a producer's enterprise.

Financial risk is defined as the added variability of net cash flows or net operating income that results from the fixed financial obligations which follow debt financing (Van Horne, 1974). It includes the risk of illiquidity and availability of credit reserves (Barry, Baker and Sanint, 1981). To determine financial risk, business risk is subtracted from the total risk. The residual is the additional variability, of net cash flows, resulting from debt financing. This concept will be developed in more detail in chapter two.

The introduction of debt financing brings into play leverage and the principle of increasing risk. Leverage is the ratio of non-equity capital to equity capital. Changes in leverage are positively correlated to financial risk. Thus, financial risk increases as leverage increases because of the greater fixed debt payments needed to pay creditors. The principle of increasing risk states that risk will become greater at an increasing rate as the relative amount of non-equity capital verses equity capital in a business increases (Lee, et al., 1980).

Leverage and the principle of increasing risk have unique implications in todays cash intensive agricultural industry. To understand the financial complexities generated from volatile prices in commodity markets and high variability in commodity yields it is necessary to reexamine what has happened to net farm income and outstanding debt levels. In real terms, net farm income in 1982 was at its lowest level since 1972 and the trend is downward. Debt levels were at the highest, in both real and nominal terms in 1982, the trend is upward with no stop in sight. In any one year, the non-equity to equity capital position can change dramatically for any producer as a result of negative variability in the prices and yields of his commodities. As a result, the cash intensiveness inherent in the operation of an irrigated crop enterprise in the southwest, and particularly in Arizona, magnifies the risk via the principle of increasing risk.

In a milieu of uncertain and volatile markets, financial decisions can become the number one priority in risk management. The objective is to stablize and improve the predictability of the financial environment. If such objectives could be met, the producer could more easily develop plans for handling his marketing and production risks.

Objectives

1. Develope a simple cash-flow simulation model of a Central Arizona farm principally engaged in growing cotton, wheat, and alfalfa.

2. Using the model, identify, analyze, and evaluate the relationships between business, financial and total risk.

Statement of Objectives

Developed in this thesis is an approach to analyzing the expected cash flow of a representative farm and correlating the information with measures of business, financial and total risk. The measures of risk will be examined over time and under a variety of financial assumptions to identify any policy implications that develop. In chapter two the framework for the method used in the cash flow simulation model and in the construction of the representative farm will be developed.

CHAPTER 2

ANALYTICAL FRAMEWORK

Evaluation of Previous Financial Risk Measurement Techniques

The modification of risk in the production process has been identified as affecting resource allocation and subsequently the level of production (Just, 1975; Wiens, 1976; Wolgin, 1975). Most models and studies on risk have focused solely on business risk (price and yield variability) in efforts to explain producer behavior, or on methodolgy to explicitly determine producer risk preferences (Young, 1981).

Although methodology for measuring the additional risk generated by debt-financed investments has been developed by many financial analysts (Penson and Lins, 1980; Weston and Brigham, 1981; Maxim and Cook, 1972; Gabriel and Baker, 1980), there has been no adequate empirical treatment of analyzing and comparing the relationship between business risk and financial risk over time at the firm level. Most of the methods examining risk are based on the use of either subjectively estimated probability distributions or empirically derived probability distributions. The methodology in this thesis is similar.

Barry, Baker, and Sanint (1981) developed a model for measuring credit risk using an extension of the mean-variance portfolio model. Credit risk is a component of financial risk and encompasses the availability of loanable funds and factors that effect a farmers credit worthiness. This kind of model is based on the historical pattern that on average investors are risk averse implying that less risk is preferred to more risk. Credit risk measures were derived using expected value of net cash flows and standard deviation of net cash flows. Their empirical evidence showed that farmers' credit is positively correlated with changes in farm income and that the evidence was stronger for capital credit than for operating credit. The problem with this study is that they only measured credit risk which is just one component of financial risk. Getting a precise measure of credit risk for a producer is possible but this cannot be used on the macro level (two or more producers) because each farmer's credit worthiness is unique. In other words, credit risk must be based on each individual farmer's merits.

Penson and Lins (1980) formulated a method for explicitly measuring financial risk. First they computed a coefficient of variation without debt financing:

(2.1) $$CVo = SDi/E(X)i$$

where CVo = coefficient of variation without debt financing.

SDi = standard deviation of net cash flows in period i

E(X)i = expected value of net cash flow in period i. CVo, therefore, actually is a measure of just business risk. Then they compute a coefficient of variation using debt financing:

(2.2) CVw = SDi/E(X)i

where CVw = coefficient of variation with debt financing.

SDi = standard deviation of net cash flows with debt financing in period I.

E(X)i = expected value of net cash flows with debt financing in period i.

Even though CVw includes debt financing, by itself it is not a measure of financial risk. CVw is total risk. Since business risk is computed as CVo, then financial risk (as measured by the additional variability of net cash flows) is the residual of total risk minus business risk, alternatively stated: FR = CVw-CVo.

Penson and Lins have shown the appropriateness of using subjectively estimated probability distributions in the computation of expected value, standard deviation, and coefficient of variation of net cash flows when measuring the additional financial risk associated with debt financing. However, they have not shown any empirical work using their methods nor have they measured financial risk over time. Their model, as defined, is also computationally difficult as a new CVw must be calculated if you want to vary the levels of principle and interest payments.

Weston and Brigham (1981) developed methods useful for measuring (total) risk in a portfolio framework but do not separate financial risk and business risk. Maxim and Cook (1972) developed methods for examining (total) risk in a model for analyzing capital investments and they show the appropriateness of applying simulation methods in risk analysis. They also do not separate business risk from financial risk.

Gabriel and Baker (1980) suggested that there is a financial response to business risk modifications. They presented a conceptual framework linking production and investment decisions to the financing decision via a risk constraint. The results of their empirical analysis showed that, in the aggregate, producers respond to a rise (fall) in business risk by making financial adjustments which in turn decrease (increase) financial risk resulting in no great change in the total risk.

Gabriel and Baker specify financial risk (FR), business risk (BR), and total risk (TR) as:

(2.3) $$FR = SD2/CX\text{-}I - SD1/CX$$

(2.4) $$BR = SD1/CX$$

(2.5) $$TR = SD2/CX\text{-}I$$

where SD1 = the standard deviation of net cash flows without debt financing.

SD2 = the standard deviation of net cash flows with debt financing but before the deduction of debt servicing payments.

CX = expected value of net cash flows without debt financing (they assumed no leverage effects so that CX would be the same with or without debt financing).

I = fixed debt servicing obligations (principle and interest).

Gabriel and Baker's arguement appears meaningless when I is greater than CX. If the cashflow is examined on a monthly basis one might expect to see I>CX more often as producers do not buy their production inputs and market their commodities in the same period. I>CX could also occur on an annual basis, pointing to the case when producers are forced to carry forward their debt because of a lack of positive cash flow. In this case, I>CX, the denominator becomes negative. This indicates that the expected cash income is less than the fixed debt obligation. In the short run the producer may operate under these conditions, but in order to stay in business he must make up these costs in the long run. Thus, when I>CX, it indicates that the producer is having financial difficulties or that he should expect financial difficulties and act accordingly.

In an attempt to avoid the problem of I>CX, which could happen for any individual farmer, the model in this thesis has been developed in a simulation framework. The method will also avoid the computational difficulties associated with the Penson and Lins model. Once the standard deviation of the net cash flows has been computed, the debt assumptions concerning 'I' (principle and interest payments) can be changed at will.

Proposed Method

Specification of a representative farm is usually approached in the context of a mean or a mode. Since the mean approach is the average of all farms, it may not be a good approximation of any specific farm. The alternative is to define the representative farm so that it approximates the greatest number of real farms.

Hatch (et al., 1982) laid out a three-step procedure for developing representative farm descriptive data. First, relevant farm types and production regions are identified. Second, farm characteristics, such as the size and the mix of crop and livestock enterprises, are derived from census data. The third step consists of creating budgets for each of the revenue generating enterprises and aggregating them into a whole farm budget.

Both Hatch (1982) and Jensen (1981) have used this procedure to identify representative farm types in Arizona. Following their criteria and using the Arizona Field-Crop Farm Data Base (Firch, 1978), a representative farm in

Pinal County, Arizona has been identified. The farm has a gross acreage of 1399. Table 9 reflects the historical cropping patern of this farm.

The machinery complement necessary to operate this farm is specified in Appendix C. It was derived, as were the individual crop budgets (and subsequentially the whole farm budget), from the specifications in the Arizona Field Crop Budgets (Hathorn, 1975-82).

The individual crop budgets were calculated on a per acre basis then multiplied by the acreage for that crop for the respective year. The whole farm budget is a combination of the individual budgets for upland cotton, wheat, and alfalfa made into alfalfa cubes.

Table 9. Historical Cropping Pattern in Acres.

YEAR	UPLAND COTTON	WHEAT	ALFALFA
1975	257	502	200
1976	409	710	200
1977	580	500	200
1978	485	389	200
1979	864	222	200
1980	743	440	200
1981	792	395	120
1982	750	210	120

Mathematical Method

The mathematical methodology used for this study is a variation of subjectively estimated probability distributions used to compute the expected value and the standard deviation of net cash flows. Here risk is treated in probabilistic terms (in a normal distribution) with the standard deviation used to measure the likelihood of events occurring which yield results that are less than expected. Following Gabriel and Baker:

(2.6) Total Risk (TR) = SD2/E($)-I

(2.7) Business Risk (BR) = SD1/E($)

(2.8) Financial Risk (FR) = SD2/E($)-I - SD1/E($)

where: SD1 = standard deviation of net cash flows without debt financing.

SD2 = standard deviation of net cash flows with debt financing but before the deduction of debt servicing payments.

E($) = expected net cash flows without debt financing (assume no leverage effects so that E($) is the same with or without debt financing).

I = fixed debt servicing obligations (principle and interest payments).

Equation 2.9 shows how to compute the standard deviation of the net cash flow (NCF). Equation 2.10 determines E($), which is also the mean of NCF.

$$(2.9) \qquad SD = \left(\sum_{i=1}^{50} (NCFi-NCF*)^{2} / N-1\right)^{1/2}$$

where: NCFi = net cash flow for observation i.

NCF* = mean of net cash flows.

$$(2.10) \qquad E(\$) = \sum_{i=1}^{50} (NCFi)/50$$

$$(2.11) \qquad NCFi = (Pu \times Yu \times Au) + (Pw \times Yw \times Aw) + (Pa \times Ya \times Aa) - VC$$

where: P = price Y = yield A = acreage

u = upland cotton w = wheat a = alfalfa

VC = variable costs

Equation 2.11 shows how NCF is calculated for each observation. The observations for P and Y were determined by a random number generator which operates on the mean and standard deviation for each P and Y for each individual crop. A three year moving average is used to compute the expected value for P and Y as follows: Pt = (Pt-1 + Pt-2 + Pt-3)/3 and Yt = (Yt-1 + Yt-2 = Yt-3)/3. The standard deviation was computed using the data from these equations.

Equation 2.11 is used to compute NCF for each of the 50 observations to be used in equations 2.9 and 2.10. This procedure is followed for each of the 8 study years

(1975-82). Having determined SD in equation 2.9 and E($) in equation 2.10, these results are now placed back into equations 2.6, 2.7, and 2.8. Now we are free to change assumptions concerning I.

CHAPTER 3

THE DATA

One of the methods used to research the literature for this study was a computer search of the cataloging and indexing database (AGRICOLA) of the U.S. National Agricultural Library. AGRICOLA contains worldwide journal and monographic literature on agriculture and related subjects and also has a subfile for agricultural economics. Two searches were performed for this study. One searched the general agriculture file and the second searched the agricultural economics subfile. The searches located all references to the key words of leverage, cash flow, farm income, and liquidity that were used in conjunction with either financial risk, risk, or uncertainty. All the references were reviewed. Those reviewed in great detail are cited throughout this text.

The data on prices and yields of upland cotton, wheat and alfalfa are from the Arizona Agricultural Statistics as reported by the Arizona Crop and Livestock Reporting Service. These annual reports contain seasonal average price and yield data for a variety of crops in all the counties of Arizona. Since the representative farm is in Pinal County, those data was used. In the case of the price of alfalfa cubes no data were available, so a six dollar premium was added to the historical alfalfa hay price to represent alfalfa cube price.

The price and yield data were gathered for the years 1972 through 1982. This period was chosen because detailed farm budgets have been developed only since 1975. The prices (yields) from 1972, 1973, and 1974 were used to compute the expected price (yield) and the standard deviation of the price (yield) for the year 1975 (See Table 10). Subsequent figures were derived using the formula:

$$E(Pt) = (Pt-1 + Pt-2 + Pt-3)/3 \qquad (3.1)$$

The standard deviation was calculated as the square root of:

$$\sum_{i=1}^{N} (Pt-i - E(Pt)^{2} \qquad (3.2)$$

where: E(Pt) = the expected price (yield) in year t.

Pt-i = the actual price (yield) in year t.

t = 1975, 1976,..., 1982.

N = 1, 2, 3.

Table 10. Price and Yield Data

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Upland Cotton lb./Acre											
Actual Yield	1052	1095	1138	829	1101	1049	854	1056	1186	1372	1112
Expected Yield				1095	1021	1023	993	1001	986	1032	1205
Standard Deviation				43	167	169	144	130	115	167	159
Upland Cotton $/lb.											
Actual Price	.2930	.4330	.4410	.5310	.6420	.5840	.5740	.6810	.7420	.5600	.5890
Expected Price				.3890	.4677	.5380	.5857	.6000	.6130	.6657	.6610
Standard Deviation				.083	.055	.011	.056	.038	.059	.085	.093
Cottonseed $/lb.											
Actual Price	.025	.054	.074	.051	.053	.038	.051	.055	.061	.042	.042
Wheat Tons/Acre											
Actual Yield	1.9500	2.0700	1.8900	2.1250	2.2200	2.1000	2.0700	2.1600	2.3000	2.3350	2.5200
Expected Yield				1.9700	2.0285	2.0785	2.1485	2.1300	2.1100	2.1765	2.2650
Standard Deviation				.0915	.1230	.1700	.0635	.0795	.0460	.1160	.0925
Wheat $/Ton											
Actual Price	54.70	104.20	124.90	105.70	130.40	87.70	94.70	128.00	139.00	158.70	116.70
Expected Price				94.60	111.60	120.33	107.93	04.27	103.47	120.57	141.90
Standard Deviation				36.07	11.54	12.97	21.44	22.90	21.53	23.07	15.55
Alfalfa Tons/Acre											
Actual Yield	4.70	4.90	5.10	5.60	6.50	6.50	5.30	6.20	6.40	6.40	6.80
Expected Yield				4.90	5.20	5.73	6.20	6.10	6.00	5.97	6.33
Standard Deviation				.20	.36	.71	.52	.69	.62	.59	.12
Alfalfa Cubes $/Ton											
Actual Price	41.04	47.17	62.75	64.46	75.58	71.79	66.79	83.38	93.04	84.42	80.42
Expected Yield				50.32	58.13	67.60	70.61	71.39	73.99	81.07	86.95
Standard Deviation				11.19	9.53	6.97	5.65	4.41	8.51	13.28	5.30

Representative Farm Budget

Hathorn's crop budget reports were used as a general guide for designing a representative machinery complement and for computing the costs of production for each crop of upland cotton, alfalfa, and wheat. The reports are separated by county and there are detailed budgets for each of that county's major crops. These reports are based on a series of tables, two of which are important to this study. The Table of Operations and Costs shows variable costs and fixed costs per operation needed to produce one acre of a crop. The Calendar of Operations Table shows how long it takes to perform an operation, what machinery and tooling is necessary to perform each operation, and in which month it is usually performed. In the reports, the term machinery is used to describe machines that are self-propelled (i.e., tractors, trucks, combines, etc.). The term tooling is used to describe the necessary implements (discs, harrow, plows, etc.).

Using the calendar of operations it was possible to determine the machinery compliment necessary to operate the representative farm. The calendar of operations describes how many hours of use each piece of machinery is needed and in which month it is needed to produce one acre of a particular crop. By multiplying the hours needed in a particular month (ex. for a tractor) by the number of acres you want to produce will yield the number of hours that piece of machinery is needed that month. These computations are done for each piece of machinery and tooling specified as being needed for each crop each month. In this way you can develop a farm machinery calendar which reflects the hours of use required each month for each piece of machinery and tooling. (See example for 1976 in Appendix D). The machinery complement (See Appendix C) was determined by looking for each piece of machinery's highest use month and then dividing that number by the number of hours one machine can be used in a month. For example, if in December we need 519 hours of tractor time and one tractor can be used approximately 250-260 hours per month then we need 519/260 = 1.99 tractors. Since machinery cannot be fractioned, • two tractors are required. This procedure was followed to develop the machinery complement necessary for the representative farm.

Determining the number of pick-up trucks needed was done on a mileage basis. The Calendar of Operations, Table 11, shows the number of pick-up truck miles per acre needed to produce an acre. For upland cotton a pick-up is needed for 60 miles of use for each acre. For each acre of wheat pick-up truck use is 30 miles, and for alfalfa, pick-up use is 20 miles per acre. Using the historical crop mix (See Table 9) we determined the total number of pick-up truck

Table 11. Annual Pick-up Truck Use Mileage Per Crop.

Year	Wheat	Alfalfa	Cotton	Total Mileage	Pick-ups
1975	15060	4000	15420	34480	2
1976	21300	8000	24540	53840	3
1977	15000	8000	34800	57800	3
1978	11670	8000	29100	48770	3
1979	6600	8000	51840	66440	4
1980	13200	8000	44580	65780	4
1981	11850	2400	47520	60170	4
1982	6300	4800	59300	56100	3

miles needed. Hathorn based the number of pick-ups needed on an annual expected use of 15,000-18,000 miles per truck. After determining the total mileage needed, it is divided by the expected use range which allows a littled flexibility in the computations (See Table 11).

The details of costs per acre were obtained from Hathorn's table entitled Costs of Operations of Producing an Acre. This table shows machinery fixed costs and variable costs for machinery, labor, services, and materials, Machinery fixed costs were not used in the preparation of the budgets used in this study because we will later want to make various assumptions concerning how the fixed costs are financed by the producer.

The variable cost for machinery includes fuel, oil, and maintenance costs. Labor variable costs are for hired labor. Variable costs for services include custom work such as aerial applications for herbicides, defoliant, insecticides, and fertilizer. Services also include ginning, hauling, and cubing costs in the case of alfalfa. Material variable costs cover fertilizer, herbicide, insecticide, defoliant, and seed. Hathorn includes the cost of production credit in his variable costs for services. This study does not use any costs arising from debt servicing (principle and interest costs) in determining the representative farm budget because we want to completely separate all financing functions from the operations cost.

The variable costs of production (See Table 12) are separated into four catagories called machinery, labor, services, and materials. In Table 12, total variable cost per acre for each crop is shown for each of the study years. Also shown in the table are the total variable costs per crop for each year and the total variable costs for the whole farm operation.

The number of wells and their capital cost was also derived from the Hathorn budget schedules. Hathorn lists the acre inches of water necessary to raise each crop and breaks the water use down on a monthly basis. Each well has a capacity to service 160 acres of cotton, or 300 acres of wheat, or 130 acres of alfalfa. The cost of the wells was based on actual costs just like the machinery complement. Costs associated with the wells are described in Chapter Four under the intermediate debt assumptions.

Not listed in the variable costs of production are expenses for family living, general farm maintenance, and

Table 12. Variable Costs of Production (in dollars)

Year	1975	1976	1977	1978	1979	1980	1981	1982
Machinery	$ 96.55	$ 69.33	$ 67.53	$ 88.51	$ 86.60	$ 96:49	$102.35	$117.88
Labor	12.95	14.52	16.45	17.98	19.19	20.24	21.16	22.79
Service	6.66	7.07	7.07	7.07	7.24	7.56	7.56	10.20
Materials	74.61	68.69	57.14	57.50	66.42	68.28	80.08	83.38
Total variable cost/acre	190.77	159.60	148.19	171.06	179.45	192.57	211.15	234.25
x Acreage	502	710	500	389	222	440	395	210
Total Variable	$95,766	$113,316	$74,095	$66,542	$39,838	$84,731	$83,404	$49,193

UPLAND COTTON

	1975	1976	1977	1978	1979	1980	1981	1982
Machinery	$191.06	$147.64	$140.65	$168.15	$177.22	$199.28	$217.05	$244.51
Labor	33.02	42.64	46.50	47.12	47.78	50.47	50.24	54.09
Service	81.73	85.16	89.04	92.84	95.64	103.39	117.43	136.55
Materials	73.48	65.39	63.50	71.74	101.75	110.09	107.16	115.77
Total Variable Cost/Acre	379.29	340.83	339.69	379.85	422.39	463.23	491.88	550.92
x Acreage	257	409	480	485	864	743	792	750
Total Variable	$ 97,399	$139,399	$197,020	$184,227	$364,945	$344,180	$389,569	$413,190

ALFALFA

	1975	1976	1977	1978	1979	1980	1981	1982
Machinery	$ 11.60	$110.38	$102.04	$140.65	$144.83	$154.11	$ 74.85	$192.11
Labor	6.66	18.88	19.90	23.10	26.95	28.48	19.34	32.16
Service	---	178.60	164.80	164.80	172.00	186.69	---	198.10
Materials	81.83	10.31	12.31	11.34	13.73	15.48	96.20	18.64
Total Variable Cost/Acre	100.09	318.17	299.05	339.89	357.51	384.76	190.53	441.01
x Acreage	200	200	200	200	200	200	120	120
	$220,18	$63,634	$59,810	$67,978	$71,502	$76,952	$22,864	$52,921
Total Variable Cost for whole Farm	$213,262	316,349	330,925	$318,747	$476,285	$505,863	$495,837	$515,304

Table 13. Family Living Expenses (in dollars).

1975	1976	1977	1978	1979	1980	1981	1982
18000	18929	20317	22183	24523	27263	30299	32346

property taxes. Family living expenses (See Table 13) were based on a need of $1500 per month in 1975, which is an annual expense of $18,000. Determining family living expenses for subsequent years was based on the GNP implicit price deflator.

General farm maintenance (GFM) was based on the number of acres in production each year. GFM expenses are for weed control around roads and irrigation ditches and for general maintenance of roads and irrigation ditches necessary for operations. In 1975, GFM equaled $10 per acre, in 1976 it was $12 per acre, in 1977 it was $13 per acre, and in subsequent years it was $14 per acre (Hathorn budget estimates).

Property taxes are based on the County Assessor's valuation of land for agricultural purposes. To determine the tax liability the land value is multiplied by the assessment ratio then times the tax rate times the number of acres (See Table 14).

All the cash outflows used for computing net farm income are recapped in Table 15. The total cash outflows for each year are the sum of variable costs, family living expenses, general farm maintenance, and property taxes.

Table 14. Property Tax Liability.

Year	Value of Land	Assessed Ratio	Tax Rate	Acres	Tax Liability
1975	310	.18	.1000	1399	$7806
1976	310	.18	.1038	1399	8103
1977	310	.18	.1173	1399	9157
1978	310	.18	.1192	1399	9305
1979	310	.18	.1388	1399	10835
1980	372	.18	.1227	1399	11494
1981	372	.18	.1227	1399	11494
1982	372	.18	.1012	1399	9480

Table 15. Summary of Total Cash Outflows (in Dollars).

CASH OUTFLOWS		1975	1976	1977	1978	1979	1980	1981	1982
ACRES	Upland Cotton	257	409	580	485	864	743	792	750
	Wheat	502	710	500	389	222	440	395	210
	Alfalfa	200	200	200	200	200	200	120	120
Variable Cost Includes: Machinery, Labor Service and Materials		213,262	316,349	330,925	318,747	476,285	505,863	495,837	515,304
Family Living Expenses		18,000	18,929	20,317	22,183	24,523	27,263	30,299	32,346
General Farm Maintenance		9,590	15,828	16,640	15,036	18,004	19,362	18,298	15,120
Taxes (property)		7,806	8,103	9,157	9,306	10,835	11,494	11,494	9,480
Total Cash Outflows		$248,658	359,209	377,039	365,272	529,647	563,982	555,928	572,250

Model Simulation Technique

Naylor et al. (1966) describe the use of, and techniques for, Monte Carlo simulation for use in model simulation. At the University of Arizona there is access to a variety of programs for generating random numbers. The International Mathematical and Statistical Libraries, Inc. (IMSL) has a routine for the purpose of generating normal or Gaussian random deviates called GGNML (See Appendix E).

GGNML also allows its output to be transformed into normal random deviates by working on the mean (M) and standard deviation (S) of a series. The formula used is

(3.3) X(I)=(Z(I)*S)+M, for I in (1,2,...,NR)

where: NR is the input number of random deviates to be generated.

Z(I) = the random deviate generated.

X(I) = the transformed value for the random deviate.

The expected value and the standard deviation (equations 3.1 and 3.2) of prices and yields (See Table 10) is used in the IMSL routine GGNML. In the simulation program (See Figure 13, Flowchart for Simulation Program), GGNML is a subroutine used in conjunction with a fortran program designed for this study (See Appendix G, Simulation Output, and Appendix F, Fortran Simulation Program). The simulation program is designed to generate 50 observations of price and yield for each crop for one year at a time.

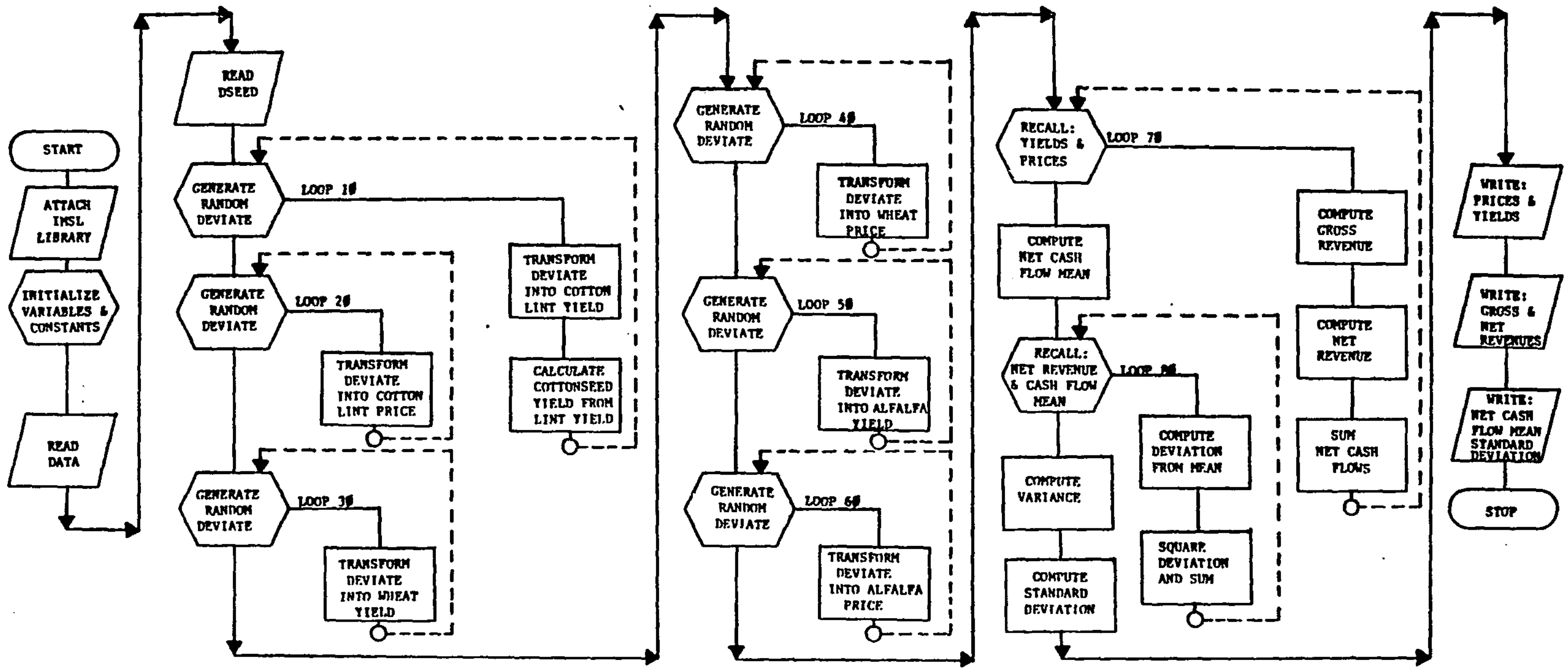

Figure 13. Flow Chart for Simulation Program.

The price and yield observations are used to determine 50 observations of gross income for the representative farm. The program also determines 50 observations of net revenue by subtracting the total cash outflow from each observation of gross income. The net revenue observations are used to compute the expected net revenue and the standard deviation of net revenue.

Examples of the output from the simulation program are in appendix G, and the results from the use of the program are detailed in the following chapter.

CHAPTER 4

ANALYSIS

Total risk, business risk, and financial risk measurements will be calculated according to the formulas:

(4.1) Total Risk (TR) = $SD/E(\$)-I$

(4.2) Business Risk (BR) = $SD/E(\$)$

(4.3) Financial Risk (FR) = $(SD/E(\$)-I)-SD/E(\$)$

where: SD = the standard deviation of net cash flows (assuming no leverage effects so that SD is the same with or without debt financing).

E($) = the expected net cash flow.

I = fixed debt servicing obligations (principle and interest payments).

The output from the simulation model is shown in its entirety in Appendix F. The initial values for SD and E($) have been used to calculate the measures of business risk (See Table 16). In 1975 BR is -2.65. This negative measure is a result of a negative expected net cash flow (although it could also have resulted from I being greater than E($) which will be discussed later in this chapter). The risk is great in absolute terms because the expected net cash flow is smaller than the standard deviation in 1975.

Table 16. Output Summary.

YEAR	E($)	SD	BR
1975	-18488	48955	-2.65
1976	106784	52241	.49
1977	241237	102385	.42
1978	124972	57648	.46
1979	184098	102715	.56
1980	142535	73074	.51
1981	188394	153226	.81
1982	235867	116666	.49

In other years the expected net cash flow is positive and larger than the standard deviation resulting in smaller measures of business risk. It is in the range of when E($) approaches zero (before I is subtracted) that the risk measures must be analyzed with caution. When E($) is negative, E($)-I has the effect of making TR, SD/E($)-I, a smaller number because the absolute value of E($)-I is getting larger. When E($) is positive and I is not greater than E($), E($)-I gets smaller causing TR, SD/E($)-I, to get larger. Whenever E($) or E($)-I is negative the TR will be negative.

There are a number of possible causes for the negative expected net cash flow in 1975. Relative production costs were higher in 1975 than in 1976. Also the price of cotton in 1975, as calculated on a three year moving average, was 39 cents per pound which is substantially less than the actual average price for 1975 which was 53 cents per pound. Another important consideration in 1975 and again in 1981 is the representative farm's historical cropping pattern. In those two years alfalfa costs were calculated on the basis of establishing the alfalfa stand, thus there was no revenue from the alfalfa acreage until the following season.

There are three types of debt (I) that the typical producer faces. There is production credit which is usually a very short term loan expected to be paid at the end of the growing season. Intermediate credit is used to finance machinery and equipment and is usually less than ten years. Long-term debt is usually incurred for the purpose of purchasing land.

What will be discussed first is how the three different types of debt individually affect the financial risk measure. Then various combinations of the different types of debt will be examined. At this point, I = 0, therefore BR = TR.

Production Debt Measurements

Table 17 shows the total cash outflows on which the expected net cash flow, E($), was calculated. These cash outflows are the basis of production credit in this study. The interest payments, I, in this table are calculated using the average loan rates of the Production Credit Association which were listed in Table 3 and are based on a loan schedule of nine months. The principle amounts on which interest is calculated are shown at two levels. The

50 percent column shows the interest charged for each nine month period for borrowing 50 percent of the cash outflows. The 90 percent column reflects the interest charged for borrowing 90 percent of the cash outflows.

Table 18 reflects the levels of TR, BR, and FR associated with using the interest payments on production credit as I in equations 4.1, 4.2, and 4.3. This is assuming that the producer has no debt outstanding other than his production debt. For both levels of debt the pattern appears the same (See Figure 14). FR in 1975 is at the highest level for the study period. In 1976 FR drops sharply and remains low through 1977. From 1978 through 1981, FR increases then declines to approximately half the 1981 level in 1982. Though the FR measured at both levels of debt follow the same general pattern it is easily seen that the magnitude of the higher debt level is disproportional to the lower debt level.

The negative measures in 1975 for TR and BR imply a negative net cash flow. FR is high in 1975 but this isn't a reflection of just the cash flow being negative. When our expected net cash flow is negative we might assume that as a result FR measures are going to be relatively higher because no matter how we finance we will still have a negative cash flow. We will never get a negative measure for FR because it is a mathematical impossibility. When there is no debt financing TR=BR and once debt is added TR becomes greater

Table 17. Interest Payments on Production Credit.

YEAR	TOTAL CASH OUTFLOWS	50 PERCENT LOAN	90 PERCENT LOAN
1975	248658	8559	15407
1976	359209	11409	20537
1977	377039	11439	20589
1978	365272	12457	22423
1979	529647	22047	39685
1980	563982	28394	51108
1981	555928	32582	58647
1982	572250	32828	59092

Table 18. Financial Risk Measurements Using Production Credit Debt.

50 PERCENT DEBT LEVEL				90 PERCENT DEBT LEVEL			
YEAR	TR	BR	FR	YEAR	TR	BR	FR
1975	-1.81	-2.65	.84	1975	-1.44	-2.65	1.21
1976	.55	.49	.06	1976	.61	.49	.12
1977	.45	.42	.03	1977	.46	.42	.04
1978	.51	.46	.05	1978	.56	.46	.10
1979	.63	.56	.07	1979	.71	.56	.15
1980	.64	.51	.13	1980	.80	.51	.29
1981	.98	.81	.17	1981	1.18	.81	.37
1982	.57	.49	.08	1982	.66	.49	.17

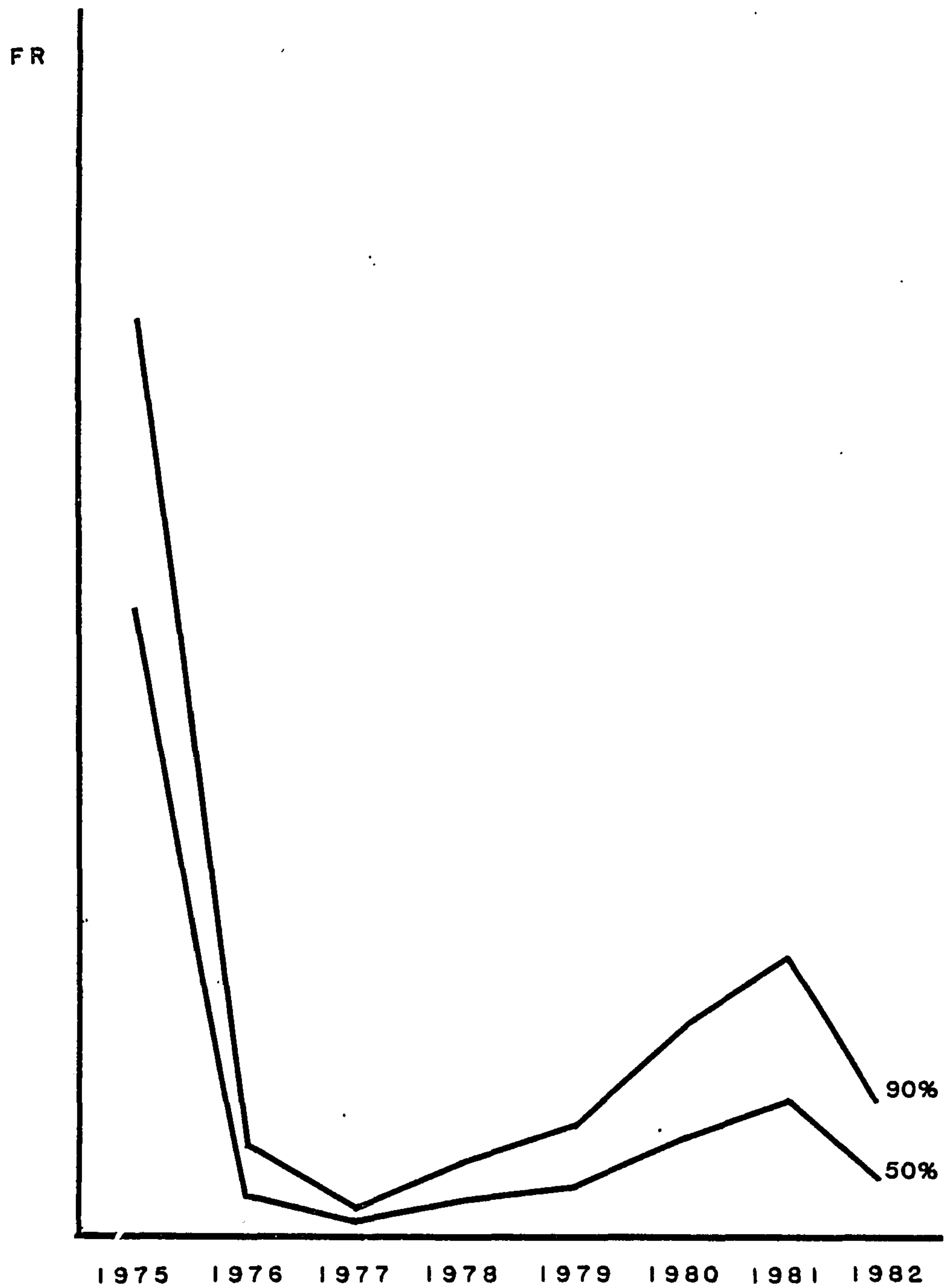

Figure 14. Financial Risk Measurements for Production Debt.

than BR whether the cash flow is positive or negative. BR is greater than FR for all the years except for 1975 when FR was greater. In terms of risk, the financial risk was more important than business risk in 1975.

Intermediate Debt Measurements

In determining the intermediate debt levels the current replacement cost of the wells and the machinery complement was first calculated for each year. In Table 19, three levels of debt have been computed based on the assumption that the producer needs to refinance the equivalent of 5%, 10%, and 20% of the current value of his machinery and equipment each year in order to keep the farm equipment up-to-date and operational. The levels of debt are calculated on an eight year fully amortized repayment schedule and is refinanced at the new interest rate each year. In this case, I includes payments for both principle and interest.

Table 20 shows the FR measurements for the various intermediate debt levels on machinery and equipment. Here, as in the previous case with production credit, there is a general wavelike pattern for all three levels of debt which increases in magnitude as the level of debt payments increases (See Figure 15). FR in 1975 is relatively high, then it declines sharply in 1976 to 1977. For the next four years it increases then in 1982 it sharply declines.

Table 19. Intermediate Debt Assumptions (in Dollars).

	1975	1976	1977	1978	1979	1980	1981	1982
Current Replacement Cost for Machinery Complement	249,410	282,410	325,100	364,960	395,280	425,610	485,590	553,580
Annual Payment for 8 Year Amortization								
20% Level	8,726	9,592	10,864	12,730	15,308	16,660	21,236	23,524
10% Level	4,363	4,796	5,432	6,365	7,654	8,300	10,618	11,762
5% Level	2,182	2,398	2,716	3,183	3,827	4,150	5,309	5,881
Current Replacement Cost for Wells	246,470	283,520	508,010	559,110	625,600	628,750	737,330	765,970
Annual Payment for 8 Year Amortization								
20% Level	8,624	9,628	16,976	19,504	24,226	24,524	31,981	32,549
10% Level	4,312	4,814	8,488	9,752	12,113	12,262	15,991	16,275
5% Level	2,156	2,407	4,244	4,876	6,057	6,131	7,996	8,137
Total Annual Payment for Intermediate Debt								
20% Level	17,350	19,220	27,840	32,234	39,534	41,184	53,217	56,073
10% Level	8,675	9,610	13,920	16,117	19,767	20,592	26,609	28,037
5% Level	4,338	4,805	6,960	8,059	9,884	10,296	13,305	14,018

Table 20. Financial Risk Measurement Using Intermediate Debt.

	5% LEVEL			10% LEVEL			20% LEVEL		
	TR	BR	FR	TR	BR	FR	TR	BR	FR
1975	-2.14	-2.65	.51	-1.80	-2.65	.84	-1.34	-2.65	1.31
1976	.51	.49	.02	.54	.49	.05	.60	.49	.11
1977	.43	.42	.01	.45	.42	.03	.48	.42	.06
1978	.49	.46	.03	.53	.46	.07	.62	.46	.16
1979	.59	.56	.03	.63	.56	.07	.71	.56	.15
1980	.55	.51	.04	.60	.51	.09	.72	.51	.21
1981	.88	.81	.07	.95	.81	.14	1.13	.81	.32
1982	.53	.49	.04	.56	.49	.07	.65	.49	.16

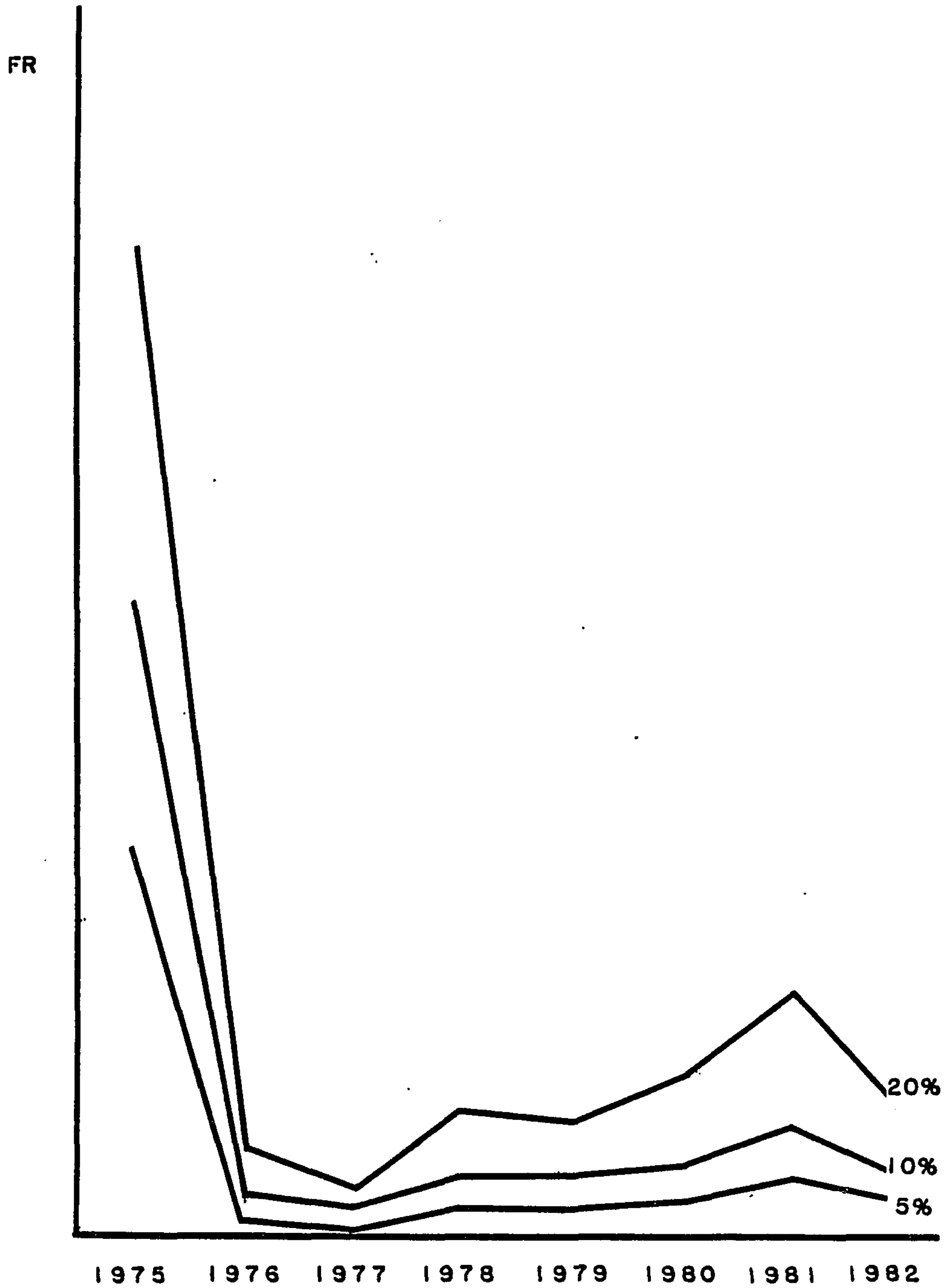

Figure 15. Financial Risk Measurements for Intermediate Debt.

The actual measures of FR increase as more debt is loaded into I. BR is greater than FR in all the study years except for 1975 when FR was greater. Careful examination of Table 20 shows that as the debt is increased financial risk increases in importance. In 1982 FR decreases from the 1981 level. This is a result of the expected net cash flow being much greater than the previous years along with the fact that the standard deviation of E($) is relatively smaller. The expected net cash flow was affected by relatively high cotton and wheat yields in 1982 along with high prices for those two commodities.

Long Term Debt Measurements

Long-term annual debt payments are based on a 20 year fully amortized loan schedule using the 1975 Federal Land Bank interest rates. The payments are also a function of the cost per acre for the 1399 acre farm and the level of the owner's equity. The value of the farm acreage in 1975 was based on a conversation with Mr. John Born of the Pinal County Treasurer's Office. The acreage value ranged from $300 to $400 per acre. The assumption here is that the producer refinanced his old mortgage in 1975. The two land values shown may underestimate the actual cost of land in 1975, but a land owner need not refinance at the maximum value of his land. Table 21 reflects the annual payments for a 20 year fully amortized loan which are based on a 50% level of equity and a 30% level of equity for the two

Table 21. Annual Long-Term Debt Payments on 1399 Acres.

$300 Per Acre		$400 Per Acre	
50% Equity	30% Equity	50% Equity	30% Equity
$22,483	$31,476	$29,977	$41968

extremes of the acreage value range. Annual payments include both interest and principle.

Table 22a examines the financial risk measurement using long-term debt payments calculated at the two levels of equity and for the $300 per acre land value. Table 22b reflects the financial risk associated with a land value of $400 per acre at the two equity levels. These two tables are based on the assumption that the producer has no outstanding debt other than long-term debt.

The I value used, to calculate the risk values in tables 22a and 22b, was fixed in 1975 and remained constant over the 8 year study period. Comparing the FR in these two tables with the FR measures of the previous tables (See Tables 18 and 20) in which I continued to increase over time, shows that the general wavelike pattern is different (See Figures 16 and 17) and seems to fluctuate more in line with the business risk measures. As a result of the fixed payments, FR in 1979 decreased from its 1978 level then increased in 1980. While FR decreased in 1979 the decrease is slightly offset by an increase in BR which resulted in an overall increase in TR for that year. FR decreased again in 1980. The FR measurements from production credit and

Table 22a. Financial Risk Measurement Using Long-Term Debt.

$300 Per Acre							
50% Equity Level				30% Equity Level			
YEAR	TR	BR	FR	YEAR	TR	BR	FR
1975	-1.19	-2.65	1.46	1975	-.98	-2.65	1.67
1976	.62	.49	.12	1976	.69	.49	.20
1977	.47	.42	.05	1977	.49	.42	.07
1978	.56	.46	.10	1978	.62	.46	.16
1979	.64	.56	.08	1979	.67	.56	.11
1980	.61	.51	.10	1980	.66	.51	.15
1981	.92	.81	.11	1981	.98	.81	.17
1982	.53	.49	.04	1982	.57	.49	.08

Table 22b. Financial Risk Measurement Using Long-Term Debt.

$400 Per Acre							
50% Equity Level				30% Equity Level			
YEAR	TR	BR	FR	YEAR	TR	BR	FR
1975	-1.01	-2.65	1.64	1975	-.81	-2.65	1.84
1976	.68	.49	.19	1976	.81	.49	.32
1977	.48	.42	.06	1977	.51	.42	.09
1978	.60	.46	.14	1978	.69	.46	.23
1979	.67	.56	.11	1979	.72	.56	.16
1980	.65	.51	.14	1980	.73	.51	.22
1981	.97	.81	.16	1981	1.05	.81	.24
1982	.57	.49	.08	1982	.60	.49	.11

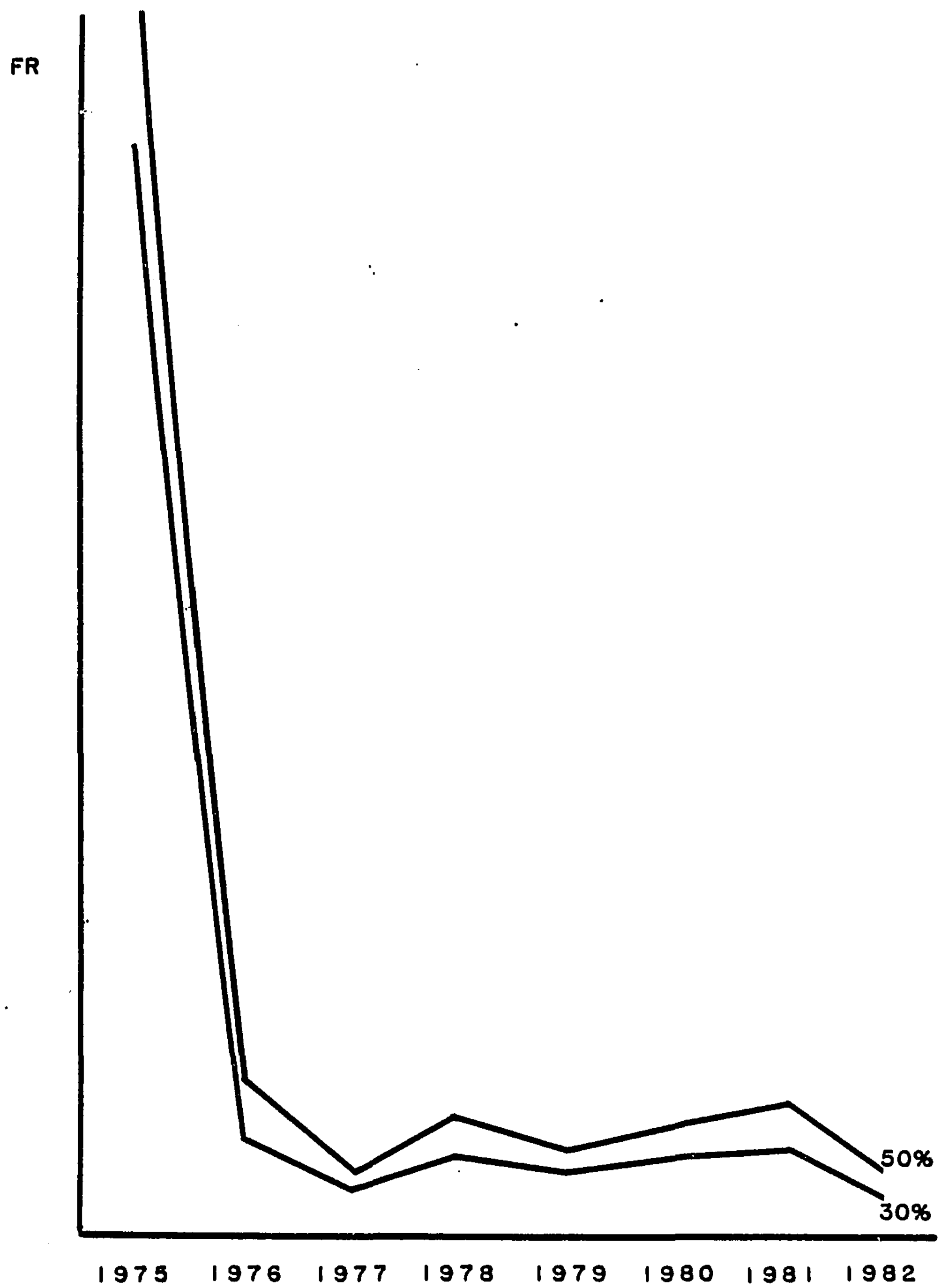

Figure 16. Financial Risk Measurements for Long-Term Debt (Land valued at $300 per acre).

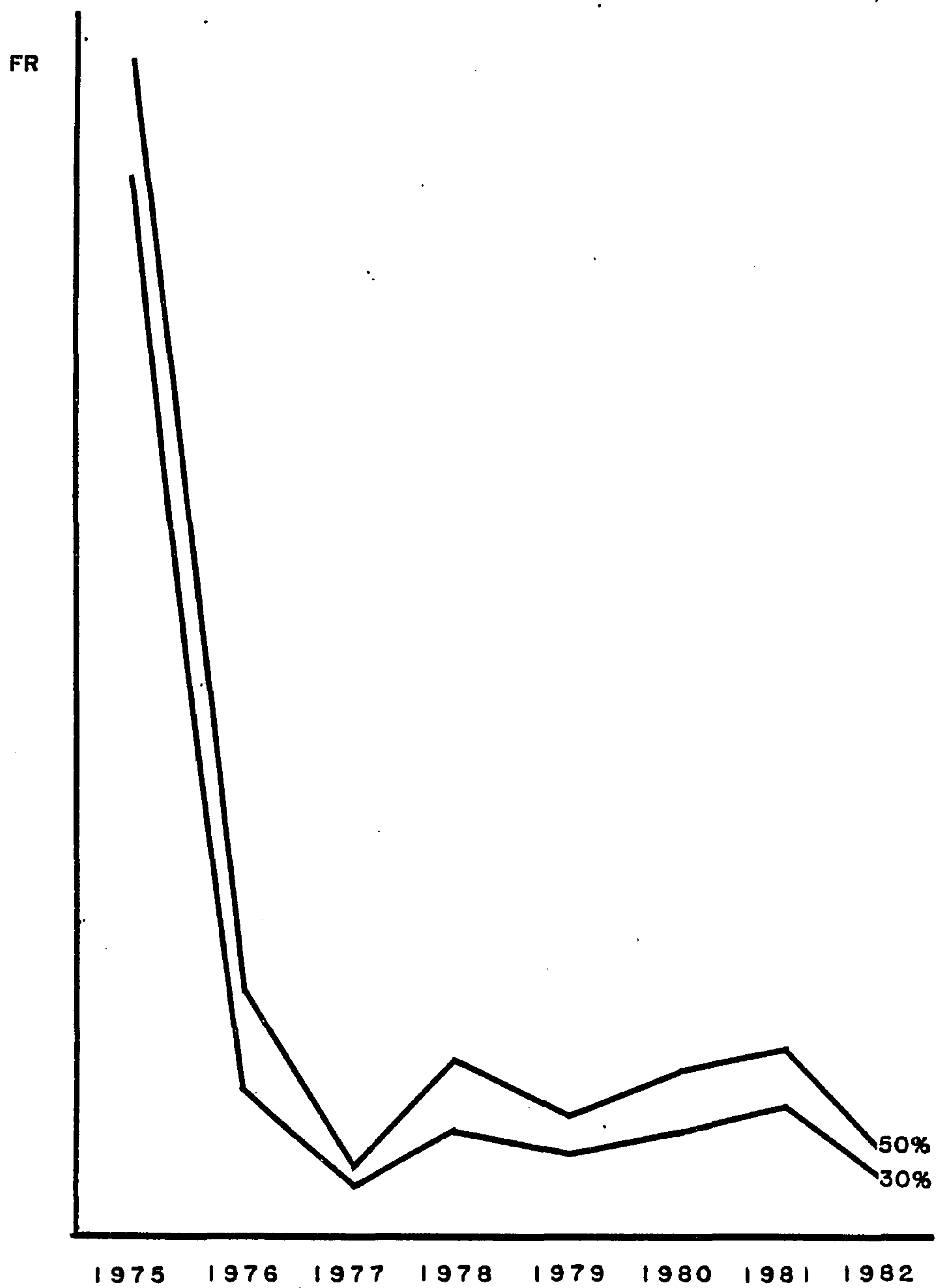

Figure 17. Financial Risk Measurements for Long-Term Debt (Land valued at $400 per acre).

intermediate credit continued to increase over that same period. The difference is illustrated in greater magnitude in Figure 17 where the fixed debt payments are larger. As with the previous cases, FR is greater than BR in 1975.

Combined Debt Measurements

The financial risk measurements derived from combining intermediate debt and production debt (assuming no long-term debt) reveal three things. One is that the same general pattern observed in the individual FR measurements of these two types of debt is not changed (compare figures 14 and 15 with figure 18). FR is high in 1975 and decreases in 1976 and 1977. During 1978 through 1981, FR steadily increases then it declines to less than half the 1981 level in 1982 (See Table 23). The second thing revealed is that the FR associated with the individual debt levels cannot be summed to arrive at their combined level of FR. The cause of this phenomenon lies in the principle of increasing risk which causes a disproportionate increase in the FR measurements as higher debt levels are loaded into I. The third thing revealed is that FR is now greater than BR not only in 1975, but also in 1980. This seems to indicate that as more debt is incurred financial risk increases in importance.

Combining levels of all three debt types reveals the most interesting measurements of FR. Both tables 24 and

Table 23. Financial Risk Measurement Using 10% Level of Intermediate Debt and Two Levels of Production DEBT.

	50% DEBT LEVEL				90% DEBT LEVEL		
YEAR	TR	BR	FR	YEAR	TR	BR	FR
1975	-1.37	-2.65	1.28	1975	-1.15	-2.65	1.50
1976	.61	.49	.12	1976	.68	.49	.19
1977	.47	.42	.05	1977	.50	.42	.08
1978	.60	.46	.14	1978	.67	.46	.21
1979	.72	.56	.16	1979	.82	.56	.26
1980	.78	.51	.27	1980	1.03	.51	.52
1981	1.19	.81	.38	1981	1.49	.81	.68
1982	.67	.49	.18	1982	.78	.49	.29

Table 24. Financial Risk Measurement Using 30% Equity For Long-Term Debt, 10% Level For Intermediate Debt and 90% Production Debt.

	$300 PER ACRE				$400 PER ACRE		
YEAR	TR	BR	FR	YEAR	TR	BR	FR
1975	-0.66	-2.65	1.99	1975	-0.58	-2.65	2.07
1976	1.16	.49	.67	1976	1.51	.49	1.02
1977	.58	.42	.16	1977	.62	.42	.20
1978	1.05	.46	.59	1978	1.30	.46	.84
1979	1.10	.56	.54	1979	1.24	.56	.68
1980	1.86	.51	1.35	1980	2.53	.51	2.02
1981	2.14	.81	1.33	1981	2.50	.81	1.69
1982	.99	.49	.50	1982	1.09	.49	.60

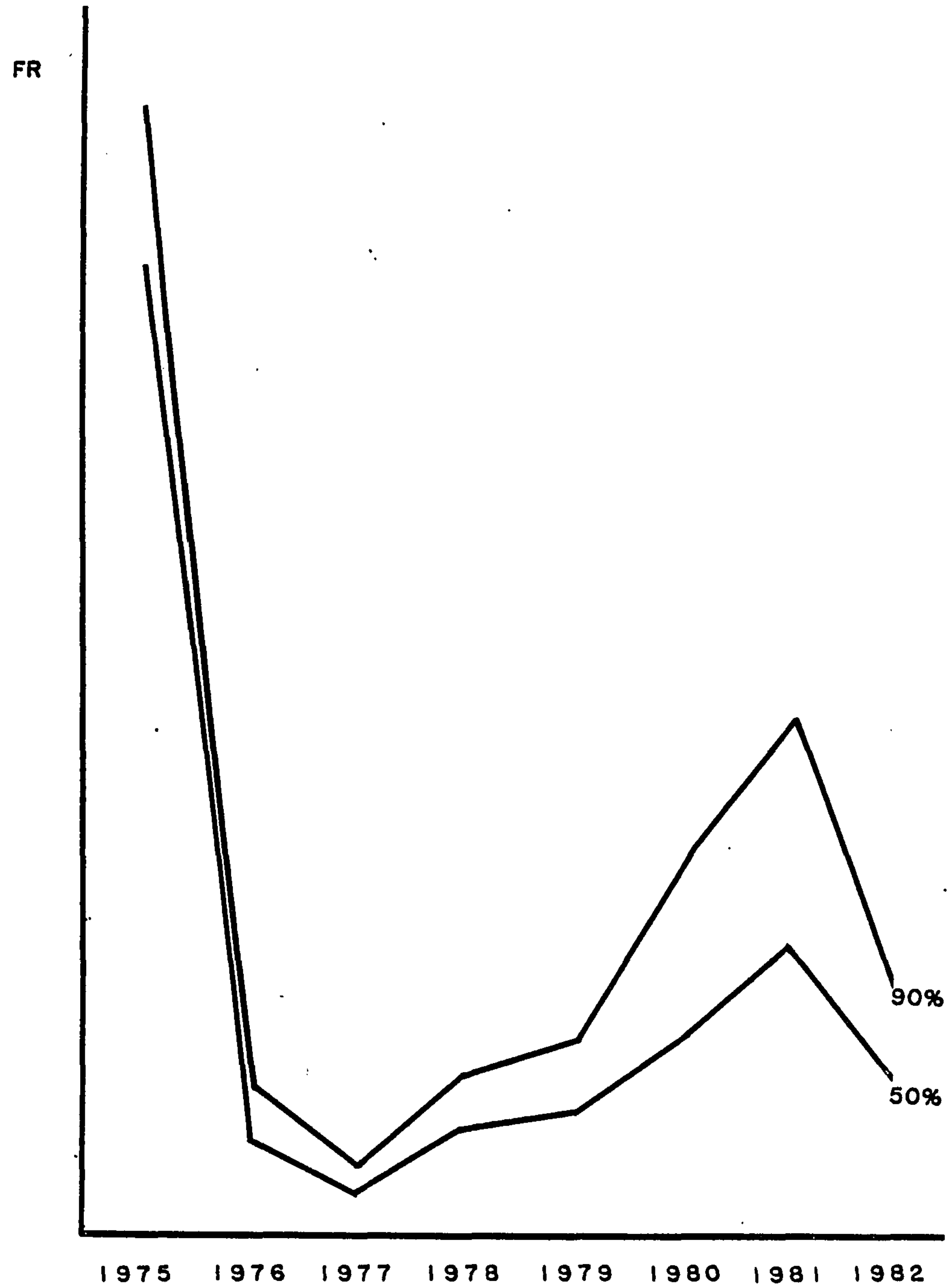

Figure 18. Financial Risk Measurements for Production and 10% Intermediate Debt.

25 show FR measurements that reflect the representative farm in a scenario in which the farm is highly in debt and the debt is increasing over time. This assumption is consistent with the Arizona trend (See Figure 5).

Table 24 measures FR using a 10% level for intermediate debt, a 90% level of production debt, and a 30% equity level for land purchased at $300 per acre. Here the general pattern of FR over time is not consistent with any of the previous patterns (See Figure 19). FR is high in 1975 and then declines through 1976 and 1977. In 1978, FR increases again but then declines in 1979. In 1980, FR increases sharply then declines in 1981 and declines further in 1982. The previous patterns did not decline in 1979 but continued to increase until 1981, then FR declined in 1982. Table 24 (under the $300 per acre assumption) shows that FR is now greater than BR in 1975, 1976, 1978, 1980, 1981, and 1982. Under the $400 per acre assumption, FR is greater than BR in every year except 1977.

Table 25 shows FR measurements under the maximum debt assumptions for both of the land cost values, a 90% level of production debt, and the 20% intermediate debt level. This table was calculated on the assumptions of 30% equity in long-term debt, a 20% level of intermediate debt, and a 90% level of production debt. Figure 20 reflects an extreme volatility in the FR measurements which was not apparent in previous examples. The general pattern of

Table 25. Financial Risk Measurements Using 30% Equity For Long-term Debt, 20% Level For Intermediate Debt and 90% Production Debt.

	$300 PER ACRE				$400 PER ACRE		
YEAR	TR	BR	FR	YEAR	TR	BR	FR
1975	-0.59	-2.65	2.06	1975	-0.53	-2.65	2.12
1976	1.47	.49	.98	1976	2.08	.49	1.59
1977	.63	.42	.21	1977	.68	.42	.26
1978	1.48	.46	1.02	1978	1.78	.46	1.32
1979	1.40	.56	.84	1979	1.63	.56	1.07
1980	3.89	.51	3.84	1980	8.83	.51	8.32
1981	3.40	.81	2.59	1981	4.43	.81	3.62
1982	1.31	.49	.82	1982	1.48	.49	.99

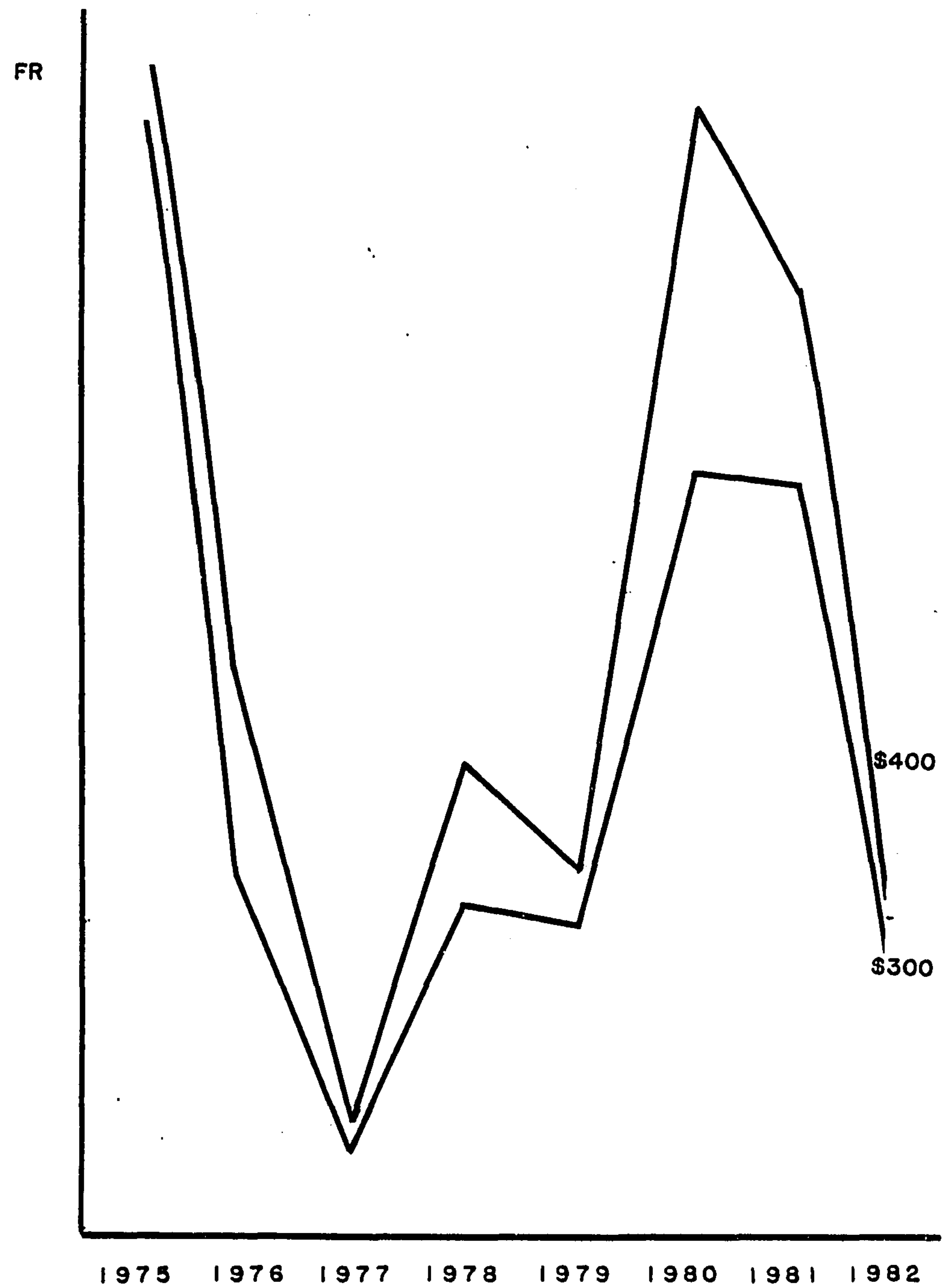

Figure 19. Financial Risk Measurements for Combined Debt Levels (10% Intermediate and 50% Production Debt).

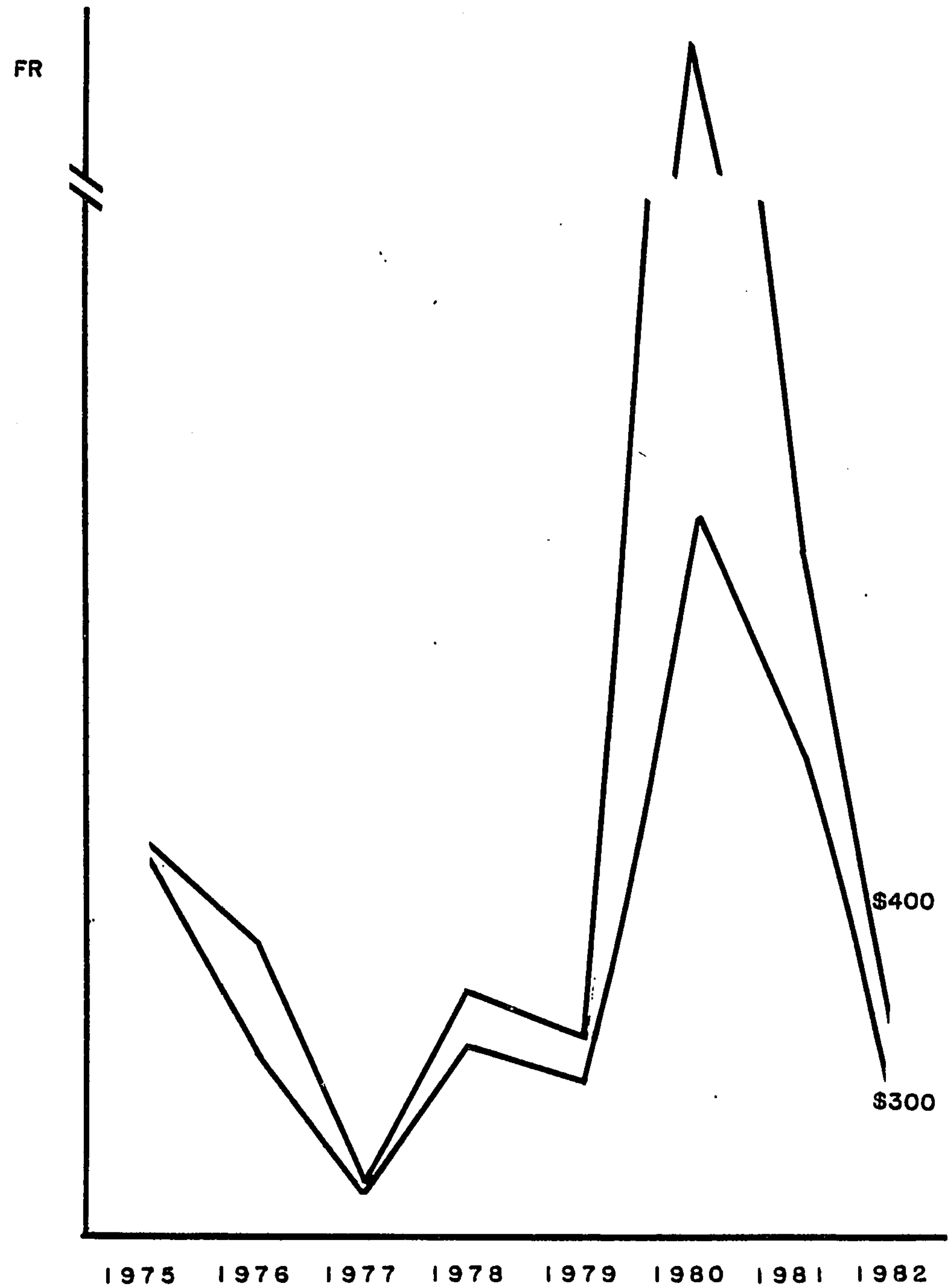

Figure 20. Financial Risk Measurements for Combined Debt Levels (20% Intermediate and 90% Production).

increases and decreases in FR is the same as in Figure 19, however the magnitude of those changes are much greater in Figure 20. The very high FR associated with 1980 (8.32) under the $400 per acre column is not as apparent in any of the previous examples even under the $300 per acre assumption in the same table. Under this maximum debt scenario FR is highly volatile. A look at the TR in Table 25, under the $400 per acre assumption, reveals that TR is also very volatile. TR was negative in 1975 then it increased to a high positive level in 1976. In 1977 TR is lower than the 1976 level. In 1978, TR is up again only to decline to a lower level in 1979. In 1980, TR increases to its highest level for the study period (See Figure 21). In 1981, TR is half the 1980 level and it continues to decrease through 1982. As with the previous cases, the decline of FR in 1982 was a result of high yields and high prices for upland cotton and wheat.

A regression analysis testing a relationship of FR being a function of the standard deviation (SD) of net cash flows indicates no significant relationship (See Figure 22) at the .05 confidence level.

Gabriel and Baker (1980) concluded in their empirical analysis that in the aggregate farmers make financial adjustments leading to a decreased (increased) financial risk in response to a rise (fall) in business risk. Though this risk balancing activity may hold true in

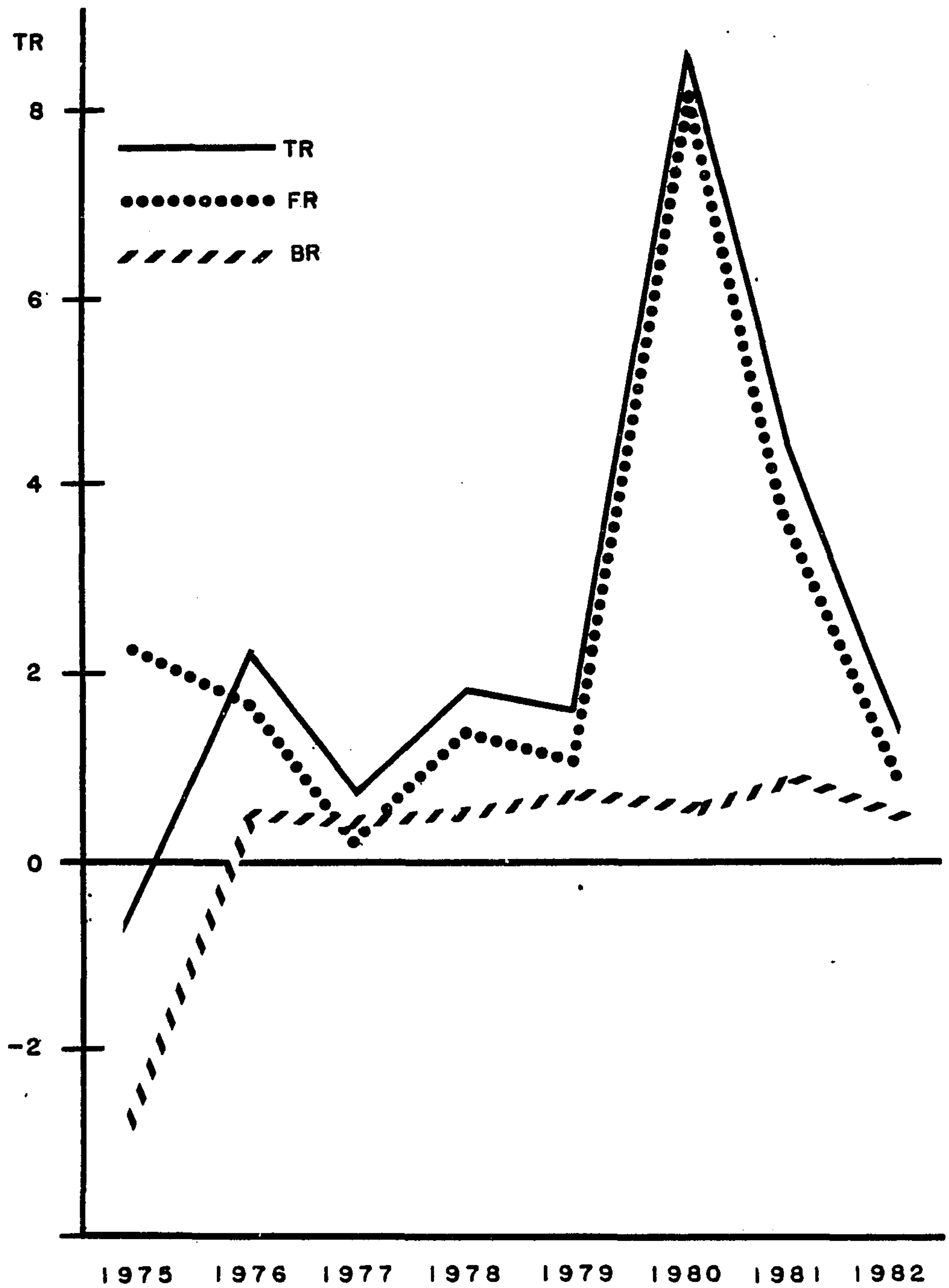

Figure 21. Measurements of TR, BR and FR over the Study Period.

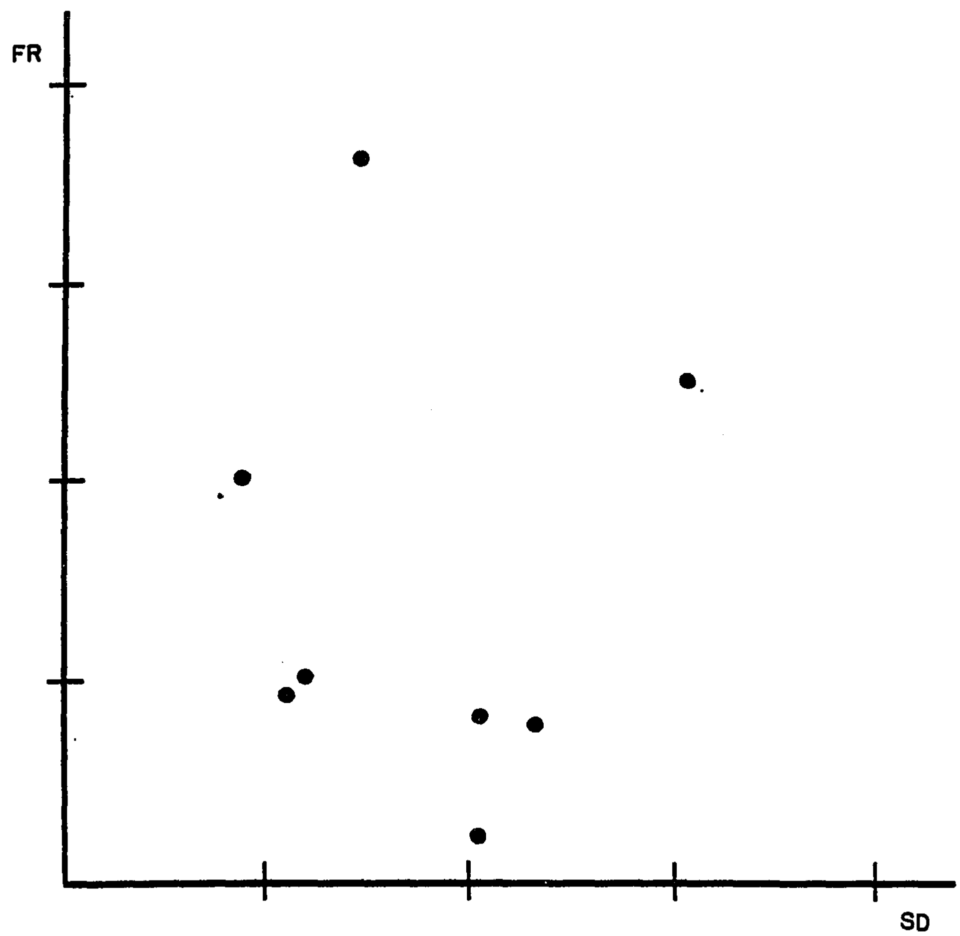

Figure 22. Financial Risk Measurement as a Function of the Standard Deviation of Net Cash Flow.

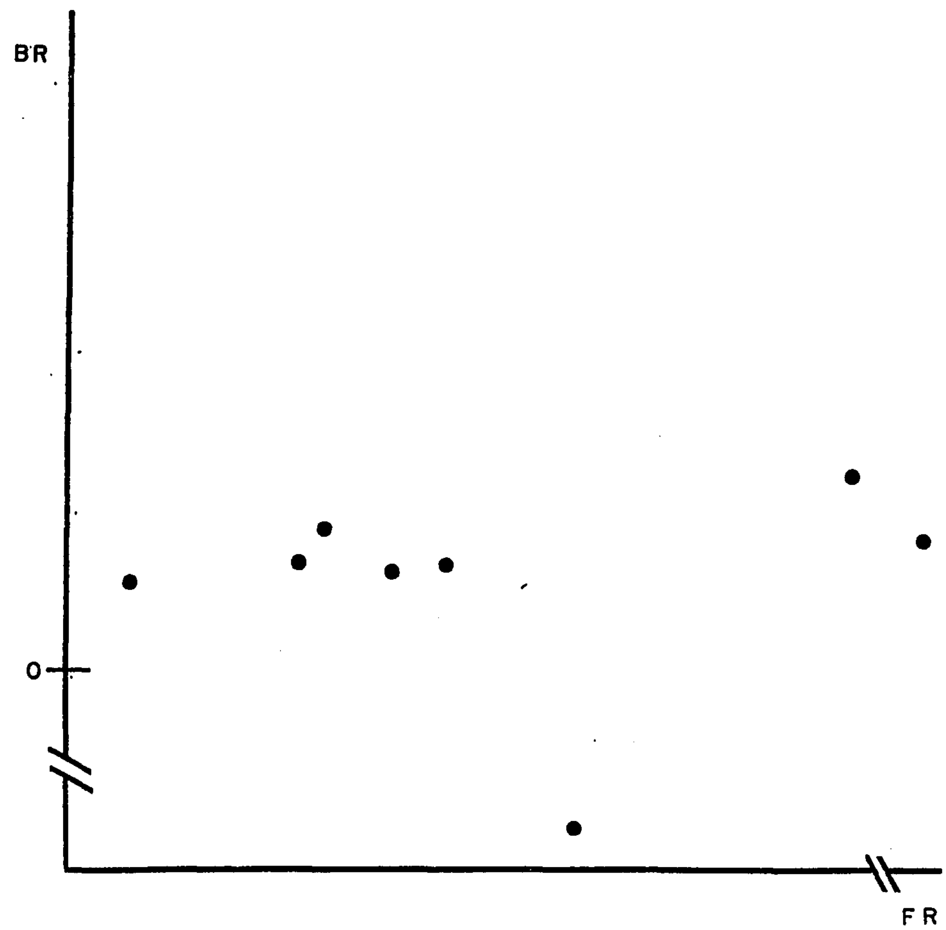

Figure 23. Financial Risk Measurement as a Function of Business Risk.

the aggregate and may also hold true on a micro level for some individual farmers, my empirical results do not substantiate this. Regression analysis testing a relationship between FR and BR shows no significance at the .05 confidence level. Arizona net farm income and FR also show no significant relationship at the .05 confidence level. Further regression analysis shows no significant relationship between FR and BR, nor any trend between the risk measures over the study period (See Appendix H, Regression Analysis).

Using the data in the maximum debt situation in Table 25 and then plotting the BR and FR measurements (See Figure 23) shows that the relationship between BR and FR appears to be as variable as the standard deviation of net cash flows, net farm income or the expected net cash flow.

CHAPTER 5

SUMMARY AND CONCLUSIONS

In summary I want to first recall the principle of increasing risk which states that risk will become greater at an increasing rate as the relative amount of non-equity capital verses equity capital in a business increases. This principle is evident in each of the scenarios described in chapter four and is easily seen in figures 14 through 20 where financial risk measurements are illustrated and compared to increasing debt levels. As higher debt levels are loaded into I there is a disproportionate increase in the financial risk and total risk measurements indicating an exponential relationship between debt and TR and BR via the principle of increasing risk.

The methods developed in this study were done in an expressed attempt to avoid a negative expected net cash flow, E($). As it happened this attempt failed. The result of this failure was that some important considerations have come to light which only help to point out a previous lack of understanding concerning the empirical relationships between total risk and business risk and financial risk on a micro level.

None of the previous literature has discussed the negativity aspects of the risk measures and their effects on total risk (TR) and business risk (BR) when the expected net cash flow, E($), is less than the fixed debt payments, I, or when I is greater than E($). Examining Table 25 for the year 1975 (under the $400 per acre columns) shows that TR = -0.53, BR = -2.65, and FR = 2.12. An examination of the FR column shows that in 1980 and 1981 FR is greater than the 1975 level. A risk averse individual (one who prefers less risk rather than more) comparing a choice of investments would choose the 1975 option if his decision was based on the FR measure because the FR measure is the smallest. What would happen here is that that person would be assuring himself a negative return on his investment because in 1975 our expected net cash flow, E($), is negative. That decision is not rationale, but one can see how the individual would be misled if his decision were based solely on the FR measurements. FR may be higher in 1980 and 1981 but one them would be prefered over the 1975 option because the cash flows are positive.

If we were to take the absolute value of the risk measures, for 1975, TR = 0.53 and BR = 2.65. Then TR - BR would result in FR = -2.12. This is not a good measure because of the counter logical nature of having a TR being less than BR. We would also have to decide as to what kind of measure is a negative FR. It could mean that our expected net cash flow is negative or it could also mean that I was greater than E($) which results in a negative FR.

As a result of the negativity problem arising from either E($) being negative or when I>E($), the measures of risk as defined must be analyzed with caution. The measures may be good for comparing relative risk in investment portfolios, however they do not and it should not be implied that they can stand alone. The measures must be looked at together with the expected net cash flow (is it positive or negative?) and along with the standard deviation of the net cash flow which reflects the relative variability of E($).

One of the other relationships between the risk measures, which had not been previously tested, is the relative importance between business risk and financial risk. Under relatively low levels of debt, business risk considerations are more important than financial risk considerations. This thesis has proved, in terms of risk, that financial risk can become much more important than business risk especially to those producers who's operations are highly leveraged.

In chapter four it was shown that Gabriel and Baker's risk balancing hypothesis that said in the aggregate farmers make financial adjustments leading to a decreased (increased) financial risk in response to a rise (fall) in business risk does not hold true under the assumptions set forth in this thesis. As such their hypothesis is not much help in policy planning because of the unpredictability of the risk measurements.

Policies aimed at minimizing the standard deviation (or the variance) of net cash flows or maximizing the expected net cash flows will have the effect of reducing all the risk measures. The best overall policies would be those aimed at minimizing the commodity price fluctuations as these will result in minimizing all the risk measures. It seems that most policies are presently aimed at maximizing the net expected cash flows through welfare kinds of policies. As a result of financial risk becoming more important than business risk, under highly leveraged or those heavily in debt operations, future research may want study questions that will affect financial risk rather than focusing on the business risk aspects.

APPENDIX A

GNP IMPLICIT PRICE DEFLATOR
(U.S. Dept. of Commerce)

Year	Index
1972	100.00
1973	105.80
1974	116.02
1975	127.18
1976	132.34
1977	140.05
1978	150.42
1979	163.42
1980	178.64
1981	195.51
1982	206.88

The GNP implicit price deflator is an index used to determine consumer prices in terms of constant dollars. The base year for the index is 1972.

The procedure to determine real prices, as referred to in Chapter 1, is as follows: First, the figure to be deflated and the relevant year is noted. For example, nominal wheat price equaled $158.70 in 1981. Second, divide the wheat price in 1981 by the GNP index number for 1981, $158.70/195.51 = .8117. Now, multiply the result by 100. .8117 times 100 = $81.17. $81.17 is the price of wheat in real terms in 1981.

APPENDIX B

REGRESSION ANALYSIS FOR CHAPTER ONE

Equation: Y = a + Bx

Hypothesis: Ho B equals 0

H1 B does not equal 0

T = 1.833 at .05 confidence level, 9 d. f.

T computed = slope/standard error of the slope.

Linear model for Nominal Net Farm Income (U.S. figures)

Intercept = 24.9564

Slope = -.1155

Standard error of slope = .5254

T computed = .2198 Accept Ho

Linear model for Real Net Farm Income (U.S. figures)

Intercept = 25.4345

Slope = -1.3255

Standard error of slope = .4263

T computed = 3.1095 Accept H1

Linear model for Real Estate Debt (U.S. figures)

Intercept = 22878.7

Slope = 5863.89

Standard error of slope = 348.645

T computed = 16.8191 Accept H1

Linear model for Non-Real Estate Debt (U.S. figures)

Intercept = 14448.2

Slope = 5639.61

Standard error of slope = 336.779

T computed = 16.7457 Accept H1

Linear model for Nominal Outstanding Debt (U.S. figures)

Intercept = 36668.4

Slope = 11503.5

Standard error of slope = 747.099

T computed = 15.4223 Accept H1

Linear model for Real Outstanding Debt (U.S. figures)

Intercept = 54111.4

Slope = 2646.21

Standard error of slope = 132.784

T computed = 19.9287 Accept H1

Linear model for Arizona Net Farm Income (Nominal)

Intercept = 231.12

Slope = 14.4873

Standard error of slope = 10.4309

T computed = 1.3889 Accept Ho

Linear model for Arizona Net Farm Income (Real)

Intercept = 242.007

Slope = -3.3139

Standard error of slope = 7.8553

T computed = .4219 Accept Ho

Linear model for Arizona Outstanding Debt (Nominal)

Intercept = 444.873

Slope = 102.036

Standard error of slope = 12.9644

T computed = 7.8705 Accept H1

Linear model for Arizona Outstanding Debt (Real)

Intercept = 614.491

Slope = 15.4182

Standard error of slope = 5.6376

T computed = 2.7349 Accept H1

Linear model for Arizona Real Estate Debt

Intercept = 239.327

Slope = 40.3091

Standard error of slope = 3.8985

T computed = 10.3398 Accept H1

Linear model for Arizona Non-Real Estate Debt

Intercept = 203.727

Slope = 63.5454

Standard error of slope = 8.5020

T computed = 7.4742 Accept H1

Linear model for Upland Cotton Yields, Pinal County

Intercept = 980.782

Slope = 15.9909

Standard error of slope = 13.8426

T computed = 1.1552 Accept Ho

Linear model for Upland Cotton Prices, Pinal County (Nominal Terms)

Intercept = 38.1473

Slope = 2.8391

Standard error of slope = .8356

T computed = 3.3978 Accept H1

Linear model for Upland Cotton Prices, Pinal County (Real)

Intercept = 40.956

Slope = -.4828

Standard error of slope = .6365

T computed = .7586 Accept Ho

Linear model for Alfalfa Yields, Pinal County

Intercept = 4.7418

Slope = .1855

Standard error of slope = .0432

T computed = 4.2974 Accept H1

Linear model for Alfalfa Prices, Pinal County (Nominal)

Intercept = 44.668

Slope = 4.2347

Standard error of slope = .7396

T computed = 5.726 Accept H1

Linear model for Alfalfa Prices, Pinal County (Real)

Intercept = 49.9105

Slope = -.3137

Standard error of Slope = .5796

T computed = .5413 Accept Ho

Linear model for Wheat Yield, Pinal County

Intercept = 3764.36

Slope = 92

Standard error of slope = 18.9327

T computed = 4.8593 Accept H1

Linear model for Wheat Prices, Pinal County (Nominal)

Intercept = 81.5618

Slope = 5.2655

Standard error of slope = 2.2252

T computed = 4.8358 Accept H1

Linear model for Wheat Prices, Pinal County (Real)

Intercept = 89.8878

Slope = -1.8805

Standard error of slope = 1.7295

T computed = 1.0873 Accept Ho

APPENDIX C

MACHINERY COMPLEMENT

Power

Code	Quantity	Item
05	2	80 PTO HP Wheel Tractor
06	2	100 PTO HP Wheel Tractor
20	4	1/2 Ton Truck AT AC PSB SB RAD
29	1	Combine PL20 190 BU HS PSB CC
30	2	COT PKR HS HDC BC PC JD 9910

Implements

Code	Quantity	Item
03	1	V-Ripper 5 shank
09	1	Cultipacker 13 foot
11	1	Cultivator 4 row rolling
18	2	Disk offset 13.5 foot
30	1	Harrow 3 section
31	1	Float 12 x 36 foot
32	1	Landplane 12 x 45 foot
34	1	Lister 7 bottom
37	1	Moldboard plow 5-16 2 way
38	1	Mulcher power 4 row
41	1	Spring-tooth renovator 16 foot
48	1	Grain drill 14 foot

Code	Quantity	Item
49	1	Planter drill type 4 row
65	1	Module builder
75	1	Rood 3 row w/basket cleaner
83	1	Fertilizer broadcaster towed
86	1	Rowbuck 10 foot
88	1	Blade scraper 10 foot
93	1	Stalk cutter 4 row flail

APPENDIX D

1976 MACHINERY CALENDAR OF OPERATIONS

Upland Cotton 409 Acres

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
POWER													
4	13	5	80	226	74	74	112				136	144	864
6	269	41	68	78			10			10	109	337	922
20													24,540
30										256	501	245	1,002
IMPLEMENT													
11				136	74	74	102						386
18	102			10			10			10	68	170	370
31			29	29									58
32	58											58	116
34	41	41											82
37	68											68	136
38			68	68									136
49			51	51									102
75											136	136	272
83	8											8	16
87	5	5		10			10						30
93											41	41	82

Wheat 710 Acres

POWER	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
4	98										14	112	224
6					18	237					182	182	619
20												Miles	21,300
29					118	118							236
IMPLEMENT													
18					18	237							255
33											93	93	186
48	89											89	178
83											14	14	28
87	9											9	18

Alfalfa Cubes 200 Acres

POWER	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
4										5			5
5										4			4
20													8,000
IMPLEMENT													
41										4			4
48										5			5

Totals

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
POWER													
4	111	5	80	226	74	74	112			5	150	256	1,097
5										4			
6	269	41	68	78	18	237	10			10	291	519	1,541
20											miles		53,840
29					118	118							236
30										256	501	245	1,002
IMPLEMENT													
11				136	74	74	102						386
18	102			10	18	237	10			10	68	170	625
31			29	29									58
32	58											58	116
33											93	93	186
34	41	41											82
37	68											68	136
38			68	68									136
41										4			
48	89									5		89	183
49			51	51									102
75											136	136	272
83	8										14	22	
87	14			10			10						34
93											41	41	82

APPENDIX E

IMSL PROGRAM ROUTINE GGNML

```
IMSL ROUTINE NAME   - GGNML

PURPOSE             - NORMAL OR GAUSSIAN RANDOM DEVIATE GENERATOR

USAGE               - CALL GGNML (DSEED,NR,R)

ARGUMENTS    DSEED  - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
                        ASSIGNED AN INTEGER VALUE IN THE
                        EXCLUSIVE RANGE (1.D0, 2147483647.D0).
                        DSEED IS REPLACED BY A NEW VALUE TO BE
                        USED IN A SUBSEQUENT CALL.
             NR     - INPUT NUMBER OF DEVIATES TO BE GENERATED.
             R      - OUTPUT VECTOR OF LENGTH NR CONTAINING THE
                        NORMAL (0,1) RANDOM NUMBERS.

PRECISION/HARDWARE  - SINGLE/ALL

REQD. IMSL ROUTINES - GGUBS,MDNRIS,MERFI,UERTST,UGETIO

NOTATION            - INFORMATION ON SPECIAL NOTATION AND
                        CONVENTIONS IS AVAILABLE IN THE MANUAL
                        INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
```

Algorithm

GGNML generates pseudo-random normal (0,1) deviates by transforming uniform deviates to normal deviates using the inverse normal routine MDNRIS.

Given DSEED and NR, GGUBS is called to generate NR uniform random numbers in the exclusive range (0,1). Then IMSL routine MDNRIS is called NR times to transform each of the numbers to a normal (0,1) deviate. That is, the uniform random deviates generated by GGUBS are transformed to normal (0,1) deviates using the inverse normal probability distribution function MDNRIS.

Random normal (M,S^2) deviates may be obtained by transforming GGNML output according to Y(I)=(R(I))S+M, for I in (1,2,...,NR).

Selected GGNML test results follow. With sample size of 136,000, and 400 equiprobable categories, a chi-squared goodness of fit test gave these probabilities of rejecting normality (P) in error, for the seeds noted. Standardized statistics (S) are also noted.

DSEED	P	S
123457.D0	.64	-.38
325.D0	.21	.80
92705.D0	.56	-.19
31859.D0	.77	-.73

For example, in the above, for the first seed, one would reject normality with .64 probability of error. The chi-squared statistic, adjusted by its mean (399) and divided by its standard deviation [SQRT(798)] is -0.38.

Kolmogorov-Smirnov tests were also performed on GGNML results, for samples of size 1000. Four tests were performed for each seed noted below. Results are probabilities of rejecting the null hypothesis of normality in error.

DSEED	Test 1	Test 2	Test 3	Test 4
123457.D0	.13	.95	.58	.87
325017.D0	.41	.45	.56	.33

For example, the seed 123457.D0 was used to initiate a series of four tests. First 1000 normal deviates were produced and tested, then a second thousand were produced, tested, and so on. The probability associated with the first test is 0.13.

Example

In this example, 100 normal random numbers are generated by making one call to GGNML with NR=100 and input DSEED=123457.D0.

Input:

```
INTEGER          NR
REAL             R(100)
DOUBLE PRECISION DSEED
NR    =  100
DSEED =  123457.D0
CALL GGNML (DSEED,NR,R)
   :
   :
END
```

Output:

```
DSEED   =   801129707.D0
R(1)    =  .18279E01
  :
  :
R(100)  = -.32377E00
```

APPENDIX F

FORTRAN SIMULATION PROGRAM

```
      PROGRAM SIMUL (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      DIMENSION Z1(50),Z2(50),Z3(50),Z4(50),Z5(50),Z6(50),
     1X1(50),X2(50),X3(50),X4(50),X5(50),X6(50),X7(50),
     2REV(50),NREV(50)
      REAL    REV,CYMEAN,CYSTD,CPMEAN,CPSTD,COSP,COTA,WYMEAN,
     1WYSTD,WPMEAN,WPSTD,WHTA,AYMEAN,AYSTD,APMEAN,APSTD,ALFA,
     2VCOST,NREV,STD,STDN,VAR,VARY,TNCF,CFMEAN
      INTEGER      YEAR,NR
      DOUBLE PRECISION DSEED
      READ (5,100) CYMEAN,CYSTD,CPMEAN,CPSTD,COSP,COTA,
     1WYMEAN,WYSTD,WPMEAN,WPSTD,WHTA,AYMEAN,AYSTD,APMEAN,
     2APSTD,SLFA,VCOST,YEAR
      NE     =  50
      NR     =  50
      DSEED = 1234579.DO
      CALL GGNML (DSEED,NR,Z1)
      DO 10 I=1,NE
      X1(I)=(Z1(I)*CYSTD)+CYMEAN
      X7(I)=X1(I)*1.71875
   10 CONTINUE
      CALL GGNML (DSEED,NR,Z2)
      DO 20 I=1,NE
      X2(I)=(Z2(I)*CPSTD)+CPMEAN
   20 CONTINUE
      CALL GGNML (DSEED,NR,Z3)
      DO 30 I=1,NE
      X3(I)=(Z3(I)*WYSTD)+WYMEAN
   30 CONTINUE
      CALL GGNML (DSEED,NR,Z4)
      DO 40 I=1,NE
      X4(I)=(Z4(I)*WPSTD)+WPMEAN
   40 CONTINUE
      CALL GGNML (DSEED,NR,Z5)
      DO 50 I=1,NE
      X5(I)=(Z5(I)*AYSTD)+AYMEAN
   50 CONTINUE
      CALL GGNML (DSEED,NR,Z6)
      DO 60 I=1,NE
      X6(I)=(Z6(I)*APSTD)+APMEAN
   60 CONTINUE
```

```
      DO 70 I=1,NE
      REV(I)=(X1(I)*X2(I)*COTA)+(X7(I)*COSP*COTA)+(X3(I)*
     1X4(I)*WHTA)+(X5(I)*X6(I)*ALFA)
      NREV(I)=(REV(I)-VCOST)
      TNCF=(TNCF+NREV(I))
   70 CONTINUE
      CFMEAN=TNCF/NE
      DO 80 I=1,NE
      VARY=(NREV(I)-CRMEAN)**2
      VAR=VAR+VARY
   80 CONTINUE
      STD=VAR/(NE-1)
      STDN=SQRT(STD)
  100 FORMAT (F4.0,F3.0,F5.4,F4.3,F4.3,F3.0,F6.4,F5.4,F6.2,
     1F5.2,F3.0,F4.2,F3.2,F5.2,F5.2,F3.0,F6.0,I4)
      WRITE (6,99)  YEAR
   99 FORMAT (1H1,25X,"FOR THE YEAR:",5X,I4,/)
      WRITE (6,157) CYMEAN,CYSTD,CPMEAN,CPSTD,COSP,COTA,
     1WYMEAN,WYSTD,WPMEAN,WPSTD,WHTA,AYMEAN,AYSTD,APMEAN,
     2APSTD,ALFA,VCOST
  157 FORMAT (1H0,10X,"CYMEAN = ",F5.0,5X,"CYSTD = ",F4.0,
     15X,"CPMEAN = ",F5.4,5X,"CPSTD = ",F4.3,/,10X,"COSP = ",
     2F4.3,5X,"COTA = ",F4.0,5X,"WYMEAN = ",F6.4,5X,
     3"WYSTD = ",F5.4,/,10X,"WPMEAN = ",F6.2,5X,"WPSTD = ",
     4F5.2,5X,"WHTA = ",F4.0,5X,"AYMEAN = ",F4.2,/,10X,
     5"AYSTD = ",F3.2,5X,"APMEAN  =  ",F5.2,5X,"APSTD = ",
     6F5.2,5X,"ALFA = ",F4.0,/,10X,"VCOST = ",F6.0,/)
      WRITE (6,199)
      WRITE (6,1000) (X1(I),I=1,NE)
  199 FORMAT (1H0,10X,"COTTON YIELD OBSERVATIONS"/)
 1000 FORMAT (10(10X,5F12.2/))
      WRITE (6,299)
      WRITE (6,2000) (X2(I),I=1,NE)
  299 FORMAT (1H0,10X,"COTTON PRICE OBSERVATIONS"/)
 2000 FORMAT (10(10X,5F12.2/))
      WRITE (6,399)
      WRITE (6,3000) (X3(I),I=1,NE)
  399 FORMAT (1H0,10X,"WHEAT YIELD OBSERVATIONS"/)
 3000 FORMAT (10(10X,5F12.2/))
      WRITE (6,499)
      WRITE (6,4000) (X4(I),I=1,NE)
  499 FORMAT (1H0,10X,"WHEAT PRICE OBSERVATIONS"/)
 4000 FORMAT (10(10X,5F12.2/))
      WRITE (6,599)
      WRITE (6,5000) (X5(I),I=1,NE)
  599 FORMAT (1H0,10X,"ALFALFA YIELD OBSERVATIONS"/)
 5000 FORMAT (10(10X,5F12.2/))
```

```
      WRITE (6,699)
      WRITE (6,6000) (X6(I),I=1,NE)
  699 FORMAT (1H0,10X,"ALFALFA PRICE OBSERVATIONS"/)
 6000 FORMAT (10(10X,5F12.2/))
      WRITE (6,759)
      WRITE (6,6800) (REV(I),I=1,NE)
  759 FORMAT (1H0,10X,"GROSS REVENUE"/)
 6800 FORMAT (10(10X,F12.2/))
      WRITE (6,779)
      WRITE (6,6900) (NREV(I),I=1,NE)
  779 FORMAT (1H0,10X,"NET REVENUE"/)
 6900 FORMAT (10(10X,5F12.2/))
      WRITE (6,799)
      WRITE (6,7000) CFMEAN,STDN
  799 FORMAT (1H0,10X,"EXPECTED NET CASH FLOW",10X,
     1"STANDARD DEVIATION"/)
 7000 FORMAT (15X,F11.2,19X,F12.4)
      STOP
      END
```

Note: The DSEED number is changed for each year. The following list shows the DSEED number for each year the simulation program was used.

YEAR	DSEED #
1975	1234579.
1976	1234581.
1977	1234577.
1978	1234575.
1979	1234573.
1980	1234571.
1981	1234569.
1982	1234567.

APPENDIX G

SIMULATION OUTPUT

FOR THE YEAR: 1975

CYMEAN = 1095. CYSTD = 43. CPMEAN = .3890
CPSTD = .083 COSP = .051 COTA = 257.
WYMEAN = 1.9700 WYSTD = .0915 WPMEAN = 94.60
WPSTD = 36.07 WHTA = 502. AYMEAN = 4.90
AYSTD = .20 APMEAN = 50.32 APSTD = 11.19
ALFA = 0. VCOST = 248658.

COTTON YIELD OBSERVATIONS

1113.00	1129.82	1091.01	1134.56	1065.07
1085.58	1071.86	1045.18	1033.83	1061.91
1107.16	1099.88	1080.28	968.59	1107.23
1122.00	1160.26	1005.81	1152.84	1009.00
1085.97	1053.71	1058.00	1079.27	1144.16
1059.32	1156.26	1107.97	1031.54	1056.11
1183.84	1116.77	1167.66	1116.55	1064.21
1035.34	1071.27	1095.14	1163.49	1089.68
1006.99	1165.65	1079.00	1071.63	1050.53
1091.19	1169.61	1138.13	1219.16	1079.22

COTTON PRICE OBSERVATIONS

.36	.41	.35	.32	.64
.34	.30	.41	.33	.38
.43	.36	.32	.36	.42
.33	.37	.51	.47	.26
.38	.47	.36	.47	.19
.26	.28	.42	.39	.36
.48	.38	.51	.30	.43
.27	.35	.37	.43	.41
.39	.39	.26	.51	.37
.27	.34	.36	.38	.38

WHEAT YIELD OBSERVATIONS

1.89	2.13	1.94	2.00	1.96
1.79	1.91	1.96	1.98	1.85
1.93	1.95	1.99	2.04	2.05
1.95	2.00	1.98	2.10	2.03
2.03	2.03	1.91	2.04	2.09
1.94	1.92	2.06	1.92	2.00
1.81	2.13	1.97	2.03	2.03
1.98	2.04	1.87	1.92	2.12
2.02	2.01	1.93	2.05	2.05
2.04	2.02	1.82	2.14	2.05

WHEAT PRICE OBSERVATIONS

80.31	136.59	174.37	32.84	151.65
93.32	60.23	63.33	77.13	37.33
67.96	113.41	48.03	103.27	85.75
59.71	118.89	62.10	73.74	133.10
104.30	137.05	106.37	146.82	102.36
139.39	76.39	62.78	90.61	126.47
60.05	74.71	210.20	108.45	97.78
54.79	91.48	135.60	125.71	92.37
101.36	94.45	94.71	68.89	99.32
152.03	73.10	143.29	175.79	42.72

ALFALFA YIELD OBSERVATIONS

4.83	4.94	4.65	4.95	4.98
5.01	4.92	4.76	[illegible]	5.13
4.77	4.97	4.89	4.70	5.04
5.48	4.90	5.12	5.13	4.62
4.85	4.86	4.91	5.34	4.74
5.24	4.93	4.91	4.64	5.25
4.93	4.83	4.70	4.75	4.89
4.71	4.77	4.70	4.95	5.04
4.89	5.22	5.18	4.57	4.89
5.12	4.87	5.12	4.94	4.74

ALFALFA PRICE OBSERVATIONS

53.94	40.70	39.13	50.45	68.47
66.63	31.56	51.26	22.68	48.03
50.29	48.48	70.90	51.34	45.95
39.56	47.70	47.32	69.69	20.87
45.43	42.23	31.91	62.77	44.01
55.93	42.03	50.82	27.17	57.21
39.58	58.81	55.60	43.40	42.70
53.76	47.51	61.43	49.13	59.29
45.65	53.22	43.61	27.78	54.88
46.68	58.78	60.64	18.47	37.21

GROSS REVENUE

203988.16	290641.60	292548.75	152647.44	349152.51
204238.74	164818.93	196133.25	186994.91	161650.32
214556.61	237742.99	162144.37	217702.51	231903.60
179193.23	256475.44	216138.95	243289.45	225975.17
237472.21	290434.03	224039.96	303625.10	188233.94
230643.50	182443.74	208821.78	214567.37	248452.16
226409.71	214322.62	388001.51	244481.36	240171.74
150840.10	214615.43	257003.62	277030.23	237489.01
225995.37	238148.48	187072.94	236595.14	226374.56
254700.90	201819.39	261730.51	334668.31	174344.72

NET REVENUE

-44669.84	41983.60	43890.75	-96010.56	100494.51
-44419.26	-83839.07	-52524.75	-61663.09	-87007.68
-34101.39	-10915.01	-86513.63	-30955.49	-16754.40
-69464.77	7817.44	-32519.05	-5368.55	-22682.83
-11185.79	41776.03	-24618.04	54967.10	-60424.06
-18014.50	-66214.26	-39836.22	-34090.63	-205.84
-22248.29	-34335.38	139343.51	-4176.64	-8486.26
-97817.90	-34042.57	8345.62	28372.23	-11168.99
-22662.63	-10509.52	-61585.06	-12062.86	-22283.44
6042.90	-46838.61	13072.51	86010.31	-74313.28

NET CASH FLOW MEAN STANDARD DEVIATION

-18488.27 48954.5853

*E
[No changes]

.SDS IMSL.076
Editing IMSL.076
*P1130:2500

FOR THE YEAR: 1976

CYMEAN = 1021. CYSTD = 167. CPMEAN = .4677
CPSTD = .055 COSP = .060 COTA = 409.
WYMEAN = 2.0285 WYSTD = .1230 WPMEAN = 111.60
WPSTD = 11.57 WHTA = 710. AYMEAN = 5.20
AYSTD = .36 APMEAN = 58.13 APSTD = 9.53
ALFA = 200. VCOST = 359209.

COTTON YIELD OBSERVATIONS

1090.92	752.63	1346.28	1127.68	937.59
1194.96	974.06	1013.05	994.10	797.26
969.25	1056.45	701.78	775.52	1117.77
1158.23	922.54	717.17	1097.95	852.46
909.32	1038.61	966.78	890.97	1048.69
912.10	813.29	1263.06	1236.92	1056.98
1162.28	890.93	1012.36	1153.82	1113.00
1127.99	1044.43	654.78	1263.15	869.05
1027.04	1250.06	1161.70	1161.62	1001.51
1067.67	893.12	1068.30	1039.24	897.39

COTTON PRICE OBSERVATIONS

.53	.48	.51	.51	.50
.49	.40	.45	.38	.48
.47	.45	.43	.33	.48
.43	.56	.40	.50	.42
.46	.48	.55	.49	.39
.60	.57	.50	.37	.54
.47	.50	.57	.52	.46
.45	.51	.53	.50	.45
.57	.40	.51	.56	.48
.51	.39	.38	.59	.44

WHEAT YIELD OBSERVATIONS

1.96	2.18	2.22	2.35	2.12
1.91	2.16	2.04	2.07	1.86
1.94	2.18	2.09	2.05	1.84
1.88	2.23	2.28	1.98	1.77
2.22	1.97	1.95	2.06	2.24
2.12	1.92	1.97	2.08	1.96
2.14	1.95	2.14	1.86	2.03
1.98	2.12	2.01	2.01	2.07
2.17	2.05	2.01	1.87	2.13
2.06	2.35	1.92	2.02	2.12

WHEAT PRICE OBSERVATIONS

104.65	121.34	103.37	109.94	113.98
119.20	109.38	111.47	113.27	116.45
118.54	116.12	125.02	77.16	110.43
133.37	114.61	110.67	100.85	116.94
124.54	116.11	121.85	103.82	118.60
115.24	121.88	110.41	88.35	118.42
124.53	101.66	115.05	111.97	123.03
113.50	122.40	117.34	105.73	101.74
112.09	111.90	117.73	124.81	93.97
124.57	100.93	100.87	124.44	118.50

ALFALFA YIELD OBSERVATIONS

5.44	6.00	4.69	5.20	5.07
5.00	5.30	4.97	5.26	5.39
5.11	5.09	5.08	5.31	5.20
5.14	4.74	4.98	5.07	4.78
4.87	5.18	5.15	4.77	5.33
5.74	5.64	5.63	5.20	5.49
5.00	4.83	4.95	5.20	5.10
4.82	5.38	4.60	4.94	5.49
4.94	5.54	5.58	5.35	4.90
5.00	5.14	4.86	5.56	5.16

ALFALFA PRICE OBSERVATIONS

61.25	49.99	63.28	74.74	60.20
64.95	56.01	70.05	56.14	45.45
71.32	45.47	48.50	63.12	69.14
56.38	67.42	66.90	46.95	65.55
51.26	47.39	67.21	55.85	62.34
52.00	65.59	45.09	68.61	53.00
59.49	66.10	43.70	51.23	64.15
52.01	62.42	61.44	62.06	47.93
82.72	71.37	51.71	59.00	47.18
59.95	50.58	45.43	55.57	63.41

GROSS REVENUE

496691.78	426147.95	561632.67	542240.21	463356.26
514210.22	428780.59	461628.03	419872.08	391862.43
463794.14	465320.20	387622.01	318018.89	483804.80
486648.60	495167.81	392988.20	461229.84	393278.28
456867.12	459518.42	494740.60	420713.11	464660.73
495068.98	464930.82	518022.93	441446.16	499872.73
520799.27	423818.50	494631.14	496020.08	496957.96
462396.29	515194.81	393552.68	52287?.00	398918.27
536592.23	499999.10	515460.98	546265.01	427607.54
508148.76	401809.09	390415.93	535060.54	442989.07

NET REVENUE

137482.78	66938.95	202423.67	183031.21	104147.26
155001.22	69571.59	102419.03	60663.08	32653.43
104585.14	106111.20	28413.01	-41190.11	124595.80
127439.60	135958.81	33779.20	102020.84	34069.28
97658.12	100309.42	135531.60	61504.11	105451.73
135859.98	105721.82	158813.93	82237.16	140663.73
161590.27	64609.50	135422.14	136811.08	137748.96
103187.29	155985.81	34343.68	163663.00	39709.27
177383.23	140790.10	156251.98	187056.01	68398.54
148939.76	42600.09	31206.93	175851.54	83780.07

NET CASH FLOW MEAN	STANDARD DEVIATION
106783.92	52240.9053

*F
[No changes]

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SOS IMSL.077
Editing IMSL.077
*P113012500
                          FOR THE YEAR:     1977

          CYMEAN = 1023.     CYSTD = 169.     CPMEAN = .5380
         CPSTD = .101    CDSF = .060    COTA = 580.
         WYMEAN = 2.0785      WYSTD = .1700     WPMEAN = 120.33
         WPSTD = 12.97    WHTA = 500.    AYMEAN = 5.73
         AYSTD = .71     APMEAN = 67.60    APSTD =  6.97
         ALFA = 200.     VCOST = 377039.

          COTTON YIELD OBSERVATIONS

              1093.75     1034.82     1304.07     1243.41      866.79
              1355.34      881.46     1145.41     1120.91      958.52
              1194.09     1025.70     1113.63     1275.60     1025.12
              1099.96     1062.82      569.41      843.33     1229.45
              1057.94     1162.18      663.94     1021.45      869.06
               847.44     1131.17      939.55      902.54     1153.80
               854.90      861.24      993.00     1064.48     1145.00
               991.55      692.42     1407.29     1323.53     1121.54
              1034.14     1388.43     1249.18     1157.35     1196.33
               943.63     1109.38      776.91     1002.89     1016.20

          COTTON PRICE OBSERVATIONS

                  .63         .58         .64         .58         .48
                  .71         .44         .62         .52         .49
                  .67         .50         .45         .60         .58
                  .47         .66         .60         .70         .67
                  .53         .38         .63         .81         .70
                  .43         .46         .55         .79         .63
                  .45         .46         .67         .40         .69
                  .63         .64         .73         .59         .63
                  .35         .66         .50         .67         .46
                  .51         .52         .59         .67         .57

          WHEAT YIELD OBSERVATIONS

                 1.89        1.73        2.21        1.98        1.90
                 2.28        2.15        2.04        2.07        1.85
                 2.04        2.29        2.06        1.67        2.11
                 2.19        1.99        1.88        2.07        2.08
                 2.11        1.94        1.96        2.33        2.26
                 2.35        2.05        2.02        2.33        1.67
                 1.97        2.15        1.94        2.02        2.38
                 2.21        2.21        2.26        1.86        1.97
                 2.09        2.20        1.95        2.08        2.26
                 2.37        2.05        2.32        2.06        2.24

          WHEAT PRICE OBSERVATIONS

               117.64      142.40      128.45      125.12      113.70
               110.63      138.29      136.27      101.26      118.70
               128.45      128.92      114.25      108.87      115.20
               115.80      136.71      136.93      116.59       97.08
               115.11      104.36      118.49      123.67      118.47
               107.55      131.78      138.43      136.71      137.02
               119.35      116.57      116.42      130.62      110.82
               127.29      104.17       99.52      113.74      129.23
               124.70      119.89      113.54      123.71       97.68
                93.65      116.12      125.19      104.36      117.90

          ALFALFA YIELD OBSERVATIONS

                 7.35        5.07        4.73        6.08        6.92
                 4.93        5.66        5.15        4.99        4.51
                 4.82        6.55        5.92        6.11        4.24
                 5.85        6.64        5.63        5.53        4.51
                 5.98        5.51        5.89        6.48        6.30
                 7.17        5.18        5.01        6.10        4.91
                 6.40        5.89        4.68        6.86        5.89
                 5.10        6.40        5.28        7.12        6.16
                 6.12        4.66        7.25        5.61        6.19
                 5.62        5.63        5.83        5.39        7.28

          ALFALFA PRICE OBSERVATIONS

                69.83       61.56       69.58       56.14       64.13
                58.34       70.90       61.01       69.30       72.21
                57.86       72.92       72.93       65.34       73.98
                76.90       81.87       80.43       73.37       62.37
                66.31       64.72       63.33       64.51       76.61
                59.54       70.77       79.08       61.07       60.86
                73.00       72.37       63.90       63.98       72.52
                82.13       59.68       55.65       63.02       66.46
                70.89       63.67       63.91       67.73       61.51
                60.93       64.66       68.52       69.55       68.14

          GROSS REVENUE

            679867.20   593895.17   773945.95   684949.15   489622.72
            826577.13   507376.34   685338.74   575952.97   506016.31
            721029.35   603453.47   559549.68   690888.45   589727.17
            582928.01   715628.40   453391.81   594270.20   711718.79
            588494.37   499316.41   472784.00   766909.74   636048.21
            471613.46   574673.95   573091.10   699326.64   664928.87
            486891.15   489902.92   616144.36   528042.00   746575.26
            647341.50   491553.26   848019.40   730564.01   685827.30
            490410.57   806114.40   640318.72   725135.17   580399.41
            513120.45   594586.17   535151.91   634320.12   630092.73

          NET REVENUE

            302828.20   216856.17   396906.95   307910.15   112583.72
            449538.13   130337.34   308299.74   198913.97   128977.31
            343990.35   226414.47   182510.68   313849.45   212688.17
            205889.01   338589.40    76352.81   217231.20   334679.79
            211455.37   122277.41    95745.00   389870.74   259009.21
             94574.46   197634.95   196052.10   322287.64   287889.87
            109852.15   112863.92   239105.36   151003.00   369536.26
            270302.50   114514.26   470980.40   353525.01   308788.30
            113371.57   429075.40   263279.72   348096.17   203360.41
            136081.45   217547.17   158112.91   257281.12   253053.73

          NET CASH FLOW MEAN          STANDARD DEVIATION

                241237.49                 102384.7828
*F
[No changes]
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1                    FOR THE YEAR:     1978

0         CYMEAN =  993.     CYSTD = 144.     CPMEAN = .5857
         CPSTD = .056      COSP = .047      COTA = 485.
         WYMEAN = 2.1485      WYSTD = .0635      WPMEAN = 107.93
         WPSTD = 21.44      WHTA = 389.      AYMEAN = 6.20
         AYSTD = .52      APMEAN = 70.61      APSTD =  5.65
         ALFA = 200.      VCOST = 365272.

0        COTTON YIELD OBSERVATIONS

              1053.28      902.48      971.50     1311.96      818.00
              1006.54      814.11      959.43      941.47      986.50
               788.04      981.27      744.46     1150.75      955.80
              1035.55      896.26     1319.15      947.89     1092.58
              1088.73      964.43     1135.53     1042.88      988.97
               804.78     1012.92      595.40      958.74      948.31
               933.33     1046.49     1181.43      993.73      914.43
              1099.26     1094.68      984.22     1289.47     1324.89
               726.67      696.07      980.09      909.06     1009.07
               857.83      968.37      918.83     1183.63     1033.65

0        COTTON PRICE OBSERVATIONS

                  .55         .61         .57         .52         .59
                  .60         .54         .46         .60         .54
                  .51         .56         .53         .51         .61
                  .55         .56         .59         .49         .63
                  .58         .56         .55         .53         .65
                  .54         .56         .58         .58         .55
                  .59         .68         .65         .62         .54
                  .59         .57         .59         .62         .49
                  .60         .55         .61         .65         .49
                  .61         .60         .74         .57         .63

0        WHEAT YIELD OBSERVATIONS

                 2.05        2.06        2.10        2.24        2.21
                 2.19        2.04        2.12        2.13        2.06
                 2.15        2.13        2.12        2.10        2.12
                 2.05        2.29        2.18        2.05        2.10
                 2.13        2.18        2.10        2.07        2.20
                 2.15        2.16        2.22        2.16        2.13
                 2.15        2.12        2.23        1.96        2.09
                 2.00        2.20        2.16        2.24        2.16
                 2.12        2.21        2.07        2.10        2.23
                 2.08        2.08        2.20        2.26        2.21

0        WHEAT PRICE OBSERVATIONS

               107.39       68.63      106.98       93.09      117.13
               147.88      116.98      112.70      128.18      129.60
                92.70      125.46      110.14      124.63       96.04
               111.17       71.29      114.24      107.47       91.07
                77.98       98.96       94.08       95.26       96.74
               104.23       96.35      116.10       98.10      158.04
               123.84      106.93      123.32      130.46      139.43
                95.04      122.20       92.54      126.39       60.20
               118.52      106.56       80.40      147.58      109.47
                79.87      106.32      101.41       92.12      124.22

0        ALFALFA YIELD OBSERVATIONS

                 6.35        6.59        5.67        6.60        5.85
                 6.27        6.05        5.72        7.02        5.79
                 7.03        5.60        6.52        5.84        5.90
                 5.63        5.92        5.24        6.88        4.84
                 6.20        5.97        6.42        6.51        6.02
                 4.50        6.82        6.62        5.93        5.91
                 5.52        6.66        7.28        6.42        6.45
                 5.78        6.06        6.03        5.99        6.47
                 7.04        5.74        5.34        6.68        5.03
                 5.10        6.13        5.85        5.37        6.56

0        ALFALFA PRICE OBSERVATIONS

                72.40       65.68       62.07       71.97       73.11
                66.92       67.92       75.59       65.56       62.40
                72.99       63.97       71.88       66.04       67.52
                72.78       71.35       71.18       72.55       69.89
                70.93       69.82       70.48       75.17       70.86
                71.40       64.02       68.92       68.12       72.08
                69.07       74.08       78.33       68.20       67.18
                68.31       76.59       66.75       61.52       62.71
                59.53       81.33       68.01       84.59       73.97
                80.91       77.77       67.37       66.21       79.47

0        GROSS REVENUE

            502093.95   445737.62   463112.09   556923.30   454198.77
            544010.42   419568.88   428990.42   508700.87   473102.73
            406442.39   482773.28   404473.32   509642.52   480219.22
            487574.33   428809.20   603786.85   449250.65   516715.10
            509874.92   464470.60   514988.41   484476.06   520513.58
            394812.30   483205.05   381495.44   471145.53   507477.76
            484219.11   574604.72   630747.22   529045.77   475009.04
            512938.73   542155.09   477522.16   620120.51   504017.89
            419899.39   398809.06   464537.14   556428.07   450631.68
            435563.66   502221.99   533312.30   524123.80   569696.04

0        NET REVENUE

            136821.95    80465.62    97840.09   191651.30    88926.77
            178738.42    54296.88    63718.42   143428.87   107830.73
             41170.39   117501.28    39201.32   144370.52   114947.22
            122302.33    63537.20   238514.85    83978.65   151443.10
            144602.92    99198.60   149716.41   119204.06   155241.58
             29540.30   117933.05    16223.44   105873.53   142205.76
            118947.11   209332.72   273475.22   163773.77   109737.04
            147666.73   176883.09   112250.16   254848.51   138745.89
             54627.39    33537.06    99265.14   191156.07    85359.68
             70291.66   136949.99   168040.30   158851.80   204424.04

0        NET CASH FLOW MEAN          STANDARD DEVIATION

               124971.78                57647.5344
*F
[No changes]
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FOR THE YEAR: 1979

CYMEAN = 1001. CYSTD = 130. CPMEAN = .6000
CPSTD = .038 COSP = .047 COTA = 864.
WYMEAN = 2.1300 WYSTD = .0795 WPMEAN = 104.27
WPSTD = 22.90 WHTA = 222. AYMEAN = 6.10
AYSTD = .69 APMEAN = 71.39 APSTD = 4.41
ALFA = 200. VCOST = 529647.

COTTON YIELD OBSERVATIONS

1055.41	620.73	1192.31	808.49	782.75
834.06	711.49	787.29	618.85	1038.20
936.65	977.65	961.37	1107.75	929.50
1019.57	1174.14	1251.17	1037.38	1041.29
1176.87	784.37	1054.94	1099.03	1108.80
775.98	958.23	1067.33	1025.25	1257.50
1007.08	848.54	961.20	970.44	1120.24
843.78	999.26	1233.06	1378.81	916.86
1013.44	792.65	731.18	1098.45	909.76
753.71	876.36	1012.04	955.02	1083.96

COTTON PRICE OBSERVATIONS

.63	.62	.65	.61	.64
.58	.57	.57	.63	.55
.58	.58	.56	.60	.62
.58	.64	.59	.56	.61
.60	.60	.62	.58	.64
.58	.59	.58	.66	.62
.65	.62	.64	.58	.60
.58	.65	.54	.62	.58
.55	.62	.66	.64	.64
.69	.63	.58	.64	.68

WHEAT YIELD OBSERVATIONS

2.30	2.05	2.16	2.14	2.14
2.15	2.12	2.08	2.10	2.03
2.15	2.23	2.08	2.12	2.01
2.10	2.16	2.08	2.16	2.29
2.07	2.03	2.07	2.08	2.18
2.03	2.17	2.11	2.06	2.18
2.18	2.00	2.15	2.16	2.11
2.07	2.19	2.08	2.18	2.22
2.05	2.25	1.93	2.24	2.24
2.09	2.22	2.16	2.12	2.22

WHEAT PRICE OBSERVATIONS

107.83	76.33	87.37	127.51	60.38
116.96	99.06	91.29	109.14	87.93
119.22	127.08	120.62	97.00	87.56
120.20	84.23	94.30	102.82	98.19
[illegible]	108.10	71.28	142.61	81.38
116.34	122.62	97.16	120.22	72.04
70.80	108.71	80.10	68.55	111.58
127.36	97.76	99.57	92.59	92.93
119.40	102.12	133.46	94.36	55.73
82.50	108.15	76.79	95.56	78.15

ALFALFA YIELD OBSERVATIONS

5.60	5.87	5.47	6.88	6.18
7.43	5.76	5.38	6.53	5.90
6.66	5.87	6.81	6.64	6.17
6.47	6.45	6.31	5.96	7.36
5.19	5.69	6.54	6.27	7.14
4.72	6.18	5.97	7.00	6.03
5.86	4.82	6.96	5.90	6.65
5.59	7.36	6.07	6.49	6.40
5.48	5.75	5.27	5.54	5.70
6.26	6.00	7.19	6.67	6.13

ALFALFA PRICE OBSERVATIONS

72.78	67.51	71.60	66.64	63.25
70.51	78.72	70.84	74.72	70.28
68.35	70.97	70.27	63.96	74.56
70.17	66.30	66.05	71.08	73.35
72.72	71.94	73.84	68.44	66.49
81.30	72.15	75.34	71.22	63.57
59.99	73.81	71.73	69.91	74.85
73.73	72.31	70.84	75.99	74.06
69.91	73.16	69.65	71.16	68.51
74.54	70.93	61.64	75.53	69.71

GROSS REVENUE

781374.52	492054.58	870788.83	632051.13	593188.18
636299.25	538109.15	561096.70	527728.39	686066.64
681181.41	708457.90	679397.68	778043.26	694877.05
776917.72	852380.03	850591.77	712719.86	780505.55
821303.84	593593.96	768958.08	783357.97	821701.26
570465.20	707430.92	748310.76	812259.87	877458.50
737065.89	633648.59	734259.22	671868.59	807633.44
623257.73	785191.80	796562.98	979794.33	660969.43
684575.93	612379.82	599737.01	809946.70	674492.26
635373.09	677378.42	704769.06	737717.66	832476.42

NET REVENUE

251727.52	-37592.42	341141.83	102404.13	63541.18
106652.25	8462.15	31449.70	-1918.61	156419.64
151534.41	178810.90	149750.68	248396.26	165230.05
197270.72	322733.03	320944.77	183072.86	250858.55
291656.84	63946.96	239311.08	253710.97	291554.26
40818.20	177783.92	218663.76	282612.87	347811.50
207418.89	104001.59	204612.22	142221.59	277986.44
93610.73	255544.80	266915.98	450147.33	131322.43
154928.93	82732.82	70090.01	280299.70	144845.26
105726.09	147731.42	175122.06	208070.66	302829.42

NET CASH FLOW MEAN	STANDARD DEVIATION
184098.37	102714.6434

*E
[No changes]

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 SOS IMSL.089
Creating IMSL.089
00100   $
$F
[No changes]

.SOS IMSL.080
Editing IMSL.080
$P1130:2500
   1                         FOR THE YEAR:     1980

   0          CYMEAN =  986.      CYSTD = 115.     CPMEAN = .6130
             CPSTD = .059     CDSP = .048     COTA = 743.
             WYMEAN = 2.1100     WYSTD = .0460     WPMEAN = 103.47
             WPSTD = 21.53     WHTA = 440.     AYMEAN = 6.00
             AYSTD = .62     APMEAN = 73.99     APSTD =  8.51
             ALFA = 200.     VCOST = 563982.

   0          COTTON YIELD OBSERVATIONS

                  1034.13     1059.51      962.26      867.80     1224.76
                  1033.94     1146.72     1043.80     1028.16     1061.14
                   998.51      953.84     1052.45     1054.77      882.58
                   985.25     1005.19     1184.01     1101.97      982.54
                   822.04     1037.95      981.08     1142.87      841.32
                  1245.11      883.83      953.04     1060.69     1007.27
                  1045.65     1013.96     1107.60      929.68      941.17
                   973.52      900.80      971.56      739.67      994.09
                   789.85      831.39     1007.35      914.32     1163.22
                  1122.98     1137.10     1068.87     1089.69     1113.11

   0          COTTON PRICE OBSERVATIONS

                      .57         .66         .60         .48         .55
                      .72         .57         .60         .71         .72
                      .61         .59         .53         .67         .65
                      .58         .58         .56         .57         .61
                      .61         .65         .55         .61         .66
                      .59         .62         .57         .60         .56
                      .57         .61         .66         .71         .65
                      .51         .60         .63         .65         .61
                      .63         .52         .57         .67         .64
                      .58         .72         .63         .58         .55

   0          WHEAT YIELD OBSERVATIONS

                     2.17        2.07        2.04        2.07        2.08
                     2.10        2.16        2.07        2.08        2.05
                     2.13        2.10        2.06        2.13        2.15
                     2.13        2.09        2.16        2.07        2.14
                     2.02        2.12        2.07        2.10        2.13
                     2.13        2.15        2.18        2.16        2.05
                     2.19        2.14        2.09        2.08        2.13
                     2.11        2.15        2.19        2.12        2.07
                     2.20        2.02        2.17        2.12        2.19
                     2.11        2.12        2.11        2.19        2.17

   0          WHEAT PRICE OBSERVATIONS

                   110.83       84.49      146.94      100.51       97.41
                   100.86       81.76      149.09       94.65      110.71
                    88.77      129.60      149.54      143.64       83.44
                   139.59       94.46       67.55      114.86      107.52
                   106.53      121.22      129.93      110.53       57.65
                   144.01       91.07       76.83       84.62       82.05
                    96.49      113.08      104.97       85.05       93.52
                    90.73       62.60      108.97      121.76      108.29
                   121.92      100.81      114.64      114.61      103.76
                    88.70      112.62      125.74      102.02      102.26

   0          ALFALFA YIELD OBSERVATIONS

                     6.66        7.12        5.49        7.09        6.63
                     5.83        5.55        5.27        6.04        6.09
                     6.22        6.18        7.15        5.72        6.53
                     5.63        5.19        5.49        6.95        6.91
                     5.71        5.53        6.55        5.95        6.01
                     4.95        5.50        5.06        6.01        6.20
                     6.21        5.58        6.53        5.24        6.74
                     5.58        6.05        6.14        5.13        6.22
                     5.88        5.89        5.43        6.15        6.08
                     5.41        5.92        6.22        6.05        5.65

   0          ALFALFA PRICE OBSERVATIONS

                    76.64       66.45       90.24       78.11       71.71
                    75.83       75.86       62.52       71.05       79.14
                    82.03       81.30       67.15       84.09       67.87
                    64.46       78.37       78.11       69.77       84.60
                    78.80       77.37       86.62       78.78       79.70
                    72.26       55.37       68.17       77.03       73.43
                    76.52       78.10       65.05       71.88       69.42
                    60.98       69.75       77.37       77.26       71.25
                    78.74       70.49       71.18       89.37       80.83
                    75.26       56.50       79.57       72.58       80.07

   0          GROSS REVENUE

                707930.47   755527.87   719821.97   565931.26   755128.47
                796001.64   720786.11   731943.35   780440.68   827435.82
                698351.64   695292.60   712277.84   817603.77   648394.32
                688725.19   663358.61   718261.78   739713.48   722350.15
                605985.09   766470.66   695396.97   788243.76   611889.47
                828516.56   609917.10   604603.75   712042.68   648767.89
                694618.14   712891.98   795267.71   700528.96   692749.39
                591121.07   607600.82   714874.43   593456.28   699495.09
                630693.63   542189.67   676815.51   727418.16   824147.86
                718392.77   852476.89   783947.14   723207.15   711825.97

   0          NET REVENUE

                143948.47   191545.87   155839.97     1949.26   191146.47
                232019.64   156804.11   167961.35   216458.68   263453.82
                134369.64   131310.60   148295.84   253621.77    84412.32
                124743.19    99376.61   154279.78   175731.48   158368.15
                 42003.09   202488.66   131414.97   224261.76    47907.47
                264534.56    45935.10    40621.75   148060.68    84785.89
                130636.14   148909.98   231285.71   136546.96   128767.39
                 27139.07    38618.82   150892.43    29474.28   135513.09
                 66711.63   -21792.33   112833.51   163436.16   260165.86
                154410.77   288494.89   219965.14   159225.15   147843.97

   0          NET CASH FLOW MEAN          STANDARD DEVIATION

                    142534.59                73073.7977
$E
[No changes]
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SDR IMSL.081
Editing IMSL.081
*P1130:2500

FOR THE YEAR: 1981

CYMEAN = 1032. CYSTD = 167. CPMEAN = .6657
CPSTD = .085 COSP = .056 COTA = 792.
WYMEAN = 2.1765 WYSTD = .1160 WPMEAN = 120.57
WPSTD = 23.07 WHTA = 395. AYMEAN = 5.97
AYSTD = .59 APMEAN = 81.07 APSTD = 13.28
ALFA = 0. VCOST = 555928.

COTTON YIELD OBSERVATIONS

1101.88	1021.77	1252.88	911.19	1261.72
905.12	1187.94	960.67	936.87	1223.18
1158.88	968.12	767.16	1099.03	794.30
1005.93	905.26	1294.56	793.40	969.60
915.12	944.77	946.82	761.84	994.79
1283.57	576.97	796.64	1255.89	873.31
1226.05	787.58	958.50	901.47	1225.06
1172.74	1332.70	1287.83	727.27	1170.99
1052.97	839.32	842.56	1149.87	1089.78
1138.32	1092.89	1462.37	930.14	1439.54

COTTON PRICE OBSERVATIONS

.71	.75	.80	.66	.65
.69	.62	.69	.57	.75
.70	.63	.53	.59	.73
.62	.73	.49	.64	.63
.66	.86	.69	.71	.71
.65	.71	.57	.78	.70
.68	.60	.73	.68	.88
.73	.82	.58	.71	.71
.58	.65	.68	.74	.67
.69	.58	.80	.72	.62

WHEAT YIELD OBSERVATIONS

2.29	2.11	2.17	2.30	2.34
2.12	2.09	2.05	2.08	2.03
2.27	2.33	1.95	2.31	2.20
1.85	1.96	2.15	2.26	2.16
2.30	1.92	2.08	2.21	2.22
2.10	2.35	2.16	2.17	2.17
2.07	2.16	1.87	2.33	2.31
2.23	2.27	2.23	2.15	2.18
2.27	2.04	2.27	2.12	2.45
2.23	2.11	2.15	2.16	2.34

WHEAT PRICE OBSERVATIONS

133.05	106.21	134.44	81.66	136.18
100.59	150.57	131.39	90.70	75.53
136.25	155.44	101.58	124.20	93.38
96.66	119.69	137.13	140.54	136.42
108.08	74.91	133.08	108.75	147.06
104.24	138.10	143.30	127.08	105.62
130.76	137.44	151.48	110.59	72.51
169.14	130.70	138.62	108.77	146.21
145.67	117.02	120.41	85.16	178.07
109.90	137.00	175.47	176.09	142.42

ALFALFA YIELD OBSERVATIONS

5.94	6.06	5.54	5.01	5.34
6.50	5.38	5.18	5.70	6.33
5.95	6.62	5.17	6.62	5.07
6.56	5.96	6.45	5.90	6.69
6.04	5.42	6.68	5.72	5.14
5.09	6.65	6.28	5.23	6.45
6.73	5.93	6.31	6.53	7.24
5.61	5.23	6.27	5.89	6.14
6.21	6.04	5.56	7.20	6.51
6.36	5.89	5.71	5.61	5.02

ALFALFA PRICE OBSERVATIONS

85.16	69.22	78.57	71.32	90.27
90.04	70.90	89.12	103.46	59.80
78.04	67.17	54.22	88.77	88.34
96.18	72.89	72.48	67.17	65.20
92.71	90.42	67.39	68.65	76.47
94.92	79.76	87.25	92.00	98.83
71.21	86.65	90.59	78.92	92.60
78.51	57.25	95.31	79.32	53.73
59.82	54.99	77.53	79.41	74.94
76.17	83.79	80.23	58.14	68.55

GROSS REVENUE

822274.83	769968.57	1006153.30	618333.65	867028.38
650260.45	794521.27	706637.33	570893.70	881012.09
854201.28	697945.44	457953.87	708762.20	599046.65
642519.49	681597.94	717664.30	585552.67	671527.43
643664.54	769730.73	697282.98	579535.64	766159.74
843237.82	494522.83	543504.29	976464.56	641205.72
862791.94	549059.42	738461.99	657126.81	1008941.16
919870.35	1080998.96	814897.89	558860.46	875736.59
697963.67	591786.69	622510.63	830868.31	830654.88
805033.49	695982.19	1149536.26	712237.88	953617.52

NET REVENUE

266346.83	214040.57	450225.30	62405.65	311100.38
94332.45	238593.27	150709.33	14965.70	325084.09
298273.28	142017.44	-97974.13	152834.20	43118.65
86591.49	125669.94	161736.30	29624.67	115599.43
87736.54	213802.73	141354.98	23607.64	210231.74
287309.82	-61405.17	-12423.71	420536.56	85277.72
306863.94	-6868.58	182533.99	101198.81	453013.16
363942.35	525070.96	258964.89	2932.46	319808.59
142035.67	35858.69	66582.63	274940.31	274726.88
249105.49	140054.19	593608.26	156309.88	397689.52

NET CASH FLOW MEAN: 188393.92
STANDARD DEVIATION: 153226.0117

*F
[No changes]

TY IMSL.082
1 FOR THE YEAR: 1982

0 CYMEAN = 1205. CYSTD = 159. CPMEAN = .6610
CPSTD = .093 COSP = .053 COTA = 750.
WYMEAN = 2.2650 WYSTD = .0925 WPMEAN = 141.90
WPSTD = 15.55 WHTA = 210. AYMEAN = 6.33
AYSTD = .12 APMEAN = 86.95 APSTD = 5.30
ALFA = 120. VCOST = 572250.

0 COTTON YIELD OBSERVATIONS

1271.53	1078.15	1162.99	1129.49	1369.79
1430.91	1302.78	1522.01	1434.86	789.23
830.80	1127.16	1162.43	1239.86	1504.97
1155.84	1393.14	1435.76	1126.03	1082.57
1167.60	1436.36	1023.66	1066.57	1297.44
1391.95	1350.11	1323.28	979.42	1321.75
953.34	1223.88	1341.70	1019.99	1166.36
1035.95	1287.85	1174.69	946.42	966.37
952.14	1046.36	1280.70	1099.32	1136.05
1242.18	1156.02	1085.21	1300.30	1018.05

0 COTTON PRICE OBSERVATIONS

.57	.77	.65	.79	.71
.61	.61	.75	.62	.72
.76	.62	.47	.67	.74
.62	.59	.75	.65	.57
.65	.59	.51	.76	.70
.66	.74	.49	.63	.55
.79	.82	.72	.58	.60
.67	.66	.71	.71	.80
.71	.75	.75	.73	.62
.79	.62	.60	.59	.66

0 WHEAT YIELD OBSERVATIONS

2.33	2.23	2.39	2.26	2.29
2.17	2.30	2.13	2.16	2.15
2.37	2.24	2.39	2.15	2.22
2.22	2.32	2.57	2.23	2.18
2.30	2.26	2.19	2.34	2.28
2.36	2.12	2.43	2.16	2.35
2.24	2.16	2.31	2.28	2.15
2.39	2.34	2.24	2.20	2.34
2.29	2.19	2.31	2.09	2.08
2.37	2.05	2.21	2.41	2.41

0 WHEAT PRICE OBSERVATIONS

153.79	135.68	140.89	147.74	123.00
165.40	147.88	137.07	158.32	138.73
131.70	174.44	139.02	126.18	118.05
135.77	147.13	141.10	162.91	165.25
113.04	131.54	142.75	173.76	151.54
142.24	132.38	144.54	117.47	135.82
172.31	158.91	133.39	140.70	150.75
143.93	134.21	170.10	155.23	125.45
163.66	139.04	133.59	139.05	141.20
137.86	150.64	134.57	150.77	127.59

0 ALFALFA YIELD OBSERVATIONS

6.18	6.21	6.25	6.20	6.41
6.24	6.17	6.15	6.19	6.49
6.28	6.18	6.23	6.30	6.28
6.30	6.48	6.29	6.56	6.46
6.42	6.19	6.54	6.23	6.38
6.17	6.34	6.28	6.39	6.54
6.22	6.39	6.37	6.35	6.16
6.26	6.38	6.43	6.44	6.36
6.48	6.38	6.27	6.29	6.17
6.28	6.31	6.09	6.06	6.44

0 ALFALFA PRICE OBSERVATIONS

88.57	82.19	93.14	90.98	80.65
94.22	92.60	85.14	87.53	85.36
99.69	86.82	92.06	87.69	82.10
88.47	92.25	92.04	98.53	84.74
93.90	92.78	85.22	88.80	97.86
83.92	93.96	80.49	95.65	84.84
92.24	88.85	85.32	86.54	84.46
91.12	90.75	78.79	83.30	89.22
85.58	89.87	85.87	95.02	92.56
81.52	81.28	82.59	88.99	88.07

0 GROSS REVENUE

769326.70	818240.74	790414.02	882241.03	939682.57
846815.61	828580.95	1083421.97	899021.45	606336.52
670351.07	744920.00	629023.46	831469.11	1051272.99
743168.47	855986.56	1054113.08	782325.18	681402.66
776668.22	863887.52	590296.70	833069.90	914448.15
915007.90	970730.55	711780.91	657848.25	769398.30
781510.95	976003.18	947168.18	647578.98	735193.23
730215.20	859611.53	849769.98	707353.27	775447.47
717523.65	790934.35	941161.35	810710.51	734503.23
950518.75	744366.29	687469.62	803454.01	704111.63

0 NET REVENUE

197076.70	245990.74	218164.02	309991.03	367432.57
274565.61	256330.95	511171.97	326771.45	34086.52
98101.07	172670.00	56773.46	259219.11	479022.99
170918.47	283736.56	481863.08	210075.18	109152.66
204418.22	291637.52	18046.70	260819.90	342198.15
342757.90	398480.55	139538.91	85598.25	197148.30
209260.95	403753.18	374918.18	75328.98	162943.23
157965.20	287361.53	277519.98	135103.27	203197.47
145273.65	218684.35	368911.35	238460.51	162253.23
378268.75	172116.29	115219.62	231204.01	131861.63

0 NET CASH FLOW MEAN STANDARD DEVIATION

235867.28 116666.2028

APPENDIX H

REGRESSION ANALYSIS FOR CHAPTER FOUR

Equation: Y = a + Bx

Hypothesis: Ho B equals 0

H1 B does not equal 0

T = at .05 confidence level, 7 d.f.

T computed = slope/standard error of the slope

Linear Model for FR = f(Arizona net farm income)

Intercept = .578287

Slope = 5.88471E-03

Standard error of the slope = 7.16236E-03

T comp = .82 Accept Ho

Linear Model for FR = f(SD)

Intercept = 2.66304

Slope = -2.84947E-06

Standard error of the slope = 2.87038E-05

T comp = .10 Accept Ho

Linear Model for FR = f(time) from Table 22b

Intercept = 1.00929

Slope = .311548

Standard error of the slope = .411611

T comp = .757 Accept Ho

Linear Model for FR = f(TR) from Table 22b

Intercept = .471506

Slope = -.0408761

Standard error of the slope = .0645821

T comp = -.633 Accept Ho

Linear Model for FR = f(Time) from Table 25

Intercept = 1.00929

Slope = .311548

Standard error of the slope = .411611

T comp = .757 Accept Ho

Linear Model for FR = f(TR) from Table 25

Intercept = .170965

Slope = .859239

Standard error of the slope = .12679

T comp = 6.777 Accept H1

Linear Model for TR = f(BR) from Table 25

Intercept = 2.38834

Slope = 1.16818

Standard error of the slope = .929583

T comp = 1.257 Accept Ho

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