CAUSES OF BANKRUPTCY AMONGST COMMERCIAL FARMERS IN SOUTH AFRICA: MANAGEMENT AND POLICY IMPLICATIONS

BY

DEON SMARTENRYK SWANEPOEL

Submitted in partial fulfilment of the

requirements for the degree of

MASTER OF SCIENCE IN AGRICULTURE

in the

Department of Agricultural Economics

University of Natal

Pietermaritzburg

February 1997

I certify that the work reported in this thesis is my own original work, except where specific acknowledgement is made.

D.S. SWANEPOEL

ABSTRACT

The number of commercial farms declared bankrupt in South Africa rose sharply over the period 1948 to 1994. Aggregate farm bankruptcies rose from 18 farms (0,016 percent of all farms) in 1948 to 389 farms in 1994 (0,632 percent of all farms). The number of bankrupt maize farms increased from 16 to around 150 farms per year over the period 1970 to 1994, while the number of bankrupt extensive beef farms increased from 12 to about 50 per year over the same period. The objective of this study is to analyse factors affecting bankruptcies of aggregate farm bankruptcy during 1948 to 1994 maize and extensive beef farm bankruptcy from 1970 to 1994.

Possible causes of farm bankruptcy include both business and financial risk factors. Business risk factors (inherent in a business and its operating environment, regardless of the way the business is financed) include drought, fluctuations in producer prices and changes in real government subsidies to agriculture. Financial risk factors (associated with debt financing) are reflected by variable real interest rates and the level of the aggregate farm debt/asset ratio. Principal components regression confirmed *a priori* theoretical expectations of farm bankruptcy determinants.

The aggregate farm bankruptcy rate was positively related to the lagged aggregate farm debt/asset ratio and lagged real interest rates (financial risk factors), but negatively related to a lagged drought index (lower index values reflected drought) and lagged real government subsidies to agriculture (business risk factors). Maize and extensive beef farm bankruptcies were negatively related to lagged annual rainfall (business risk factor), but positively related to the lagged aggregate farm debt/asset ratio and lagged real interest rates (financial risk factors). Lagged real maize and beef producer prices (business risk factors) were negatively related to bankruptcy among maize farmers. Beef farm bankruptcies rose with lower lagged real beef producer prices and higher lagged real stockfeed subsidies and transport rebates (business risk factors).

These results show that farm bankruptcy in South Africa is a dynamic process, with time lags between business and financial risk factors and ultimate farm bankruptcy. The aggregate, maize and extensive beef farm bankruptcy models also suggest that the rise in farm bankruptcies over time can partly be attributed to changes in agricultural price and macroeconomic policies.

ACKNOWLEDGEMENTS

I would like to acknowledge and express sincere thanks to the following people for their contribution to this study:

My supervisor, Professor G.F. Ortmann, Department of Agricultural Economics, University of Natal, for his excellence in his supervision and guidance throughout the study.

My co-supervisor, Mr M.A.G. Darroch, Senior Lecturer, Department of Agricultural Economics, University of Natal, for his constructive criticism and advice.

Colleagues in the Agricultural Policy Research Unit, Department of Agricultural Economics, University of Natal, for their friendship and support.

Dr M.C. Dent, Computing Centre for Water Research, University of Natal, for his recommendations.

Mr M.J. Cardo, for proof reading the draft.

My late father, my mother and brothers, for unwavering support in so many ways.

The Centre for Science Development, for financial assistance.

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

FIGURE **PAGE**

INTRODUCTION

The annual rate of bankruptcy amongst commercial farms in South Africa rose from approximately 0,016 percent of all farms in 1948 (18 farms) to 0,632 percent in 1994 (389 farms) (Directorate Agricultural Economic Trends, 1971 and 1995; Central Statistical Service, 1964, 1972, 1994 and 1995). The annual number of commercial maize and extensive beef farms declared bankrupt in South Africa also rose sharply in the period 1970 to 1994. Bankrupt maize farms increased from 16 to around 150 farms per year over this period, while bankrupt extensive beef farms increased from 12 to about 50 per year (Van Niekerk, 1995). In 1988, there were about 7 500 maize farms and 2 500 extensive livestock farms in the summer rainfall and cattle grazing regions of South Africa respectively (Central Statistical Service, 1988*a* and 1988*b*; Directorate Agricultural Statistics, 1996: 110). While the rate of bankruptcies is relatively low, the marked rise in the number of bankrupt farms, particularly since the early 1980s, is of concern.

Maize is the major field crop in South Africa comprising some 40 percent by value of all field crops, and about nine percent of the gross value of all agricultural products in 1994/95. Beef constituted approximately 37 percent of the gross value of animal products, and approximately 11 percent of the total gross value of agricultural production in 1994/95 (Directorate Agricultural Statistics, 1996). Therefore, maize and extensive beef farm bankruptcies impose major adjustment costs on the agricultural economy and give rise to demands for government assistance to alleviate financial stress for farmers. Farm failure is a costly process for individual farm operators (loss of employment) and for the rural economy. Farm capital assets are neither perfectly mobile nor perfectly fungible, therefore farm bankruptcy entails economic losses (Leathers and Chavas, 1986). Substantial government involvement generally arises when a large number of farming operations are threatened with bankruptcy. For example, nominal subsidies on farm carry-over debt in South Africa in 1992/93 totalled R2,7 billion (Directorate Financial Assistance, 1996). Given that farm debt is concentrated in the maize and extensive beef sectors (Volkskas Bank, 1988; Human, 1989), research into why these farmers fail can help to identify appropriate future policy and management measures to cope with farm failure.

Commercial farmers in South Africa experience both business and financial risk. Business risk refers to risk inherent in a business independent of the way the business is financed and is reflected in variability of net operating income. It arises from factors such as price variability in both output and input markets. Financial risk reflects added variability of net cash flows due to fixed financial obligations associated with debt financing (Gabriel and Baker, 1980). As no published local study has yet analysed causes of farm bankruptcy at an aggregate or product sector level, this study, using annual data for the period 1948 to 1994, considers sources of business and financial risk which may have caused farm bankruptcies in South Africa to rise.

The study is presented in the following format: Chapter 1 first defines bankruptcy terms and reviews the incidence and studies of farm bankruptcies in certain developed countries to put the local analysis into perspective. This chapter then examines past South African farm financial stress studies and aggregate, maize and extensive beef farm bankruptcy in South Africa. Past agricultural finance policy in South Africa is then reviewed. Chapter 2 outlines hypothesised determinants of farm bankruptcy in South Africa. These determinants are separated into business and financial risk factors. Chapter 3 presents the research methodology and results for the aggregate, maize and extensive beef farm bankruptcy models. The concluding section discusses management and policy implications of the results.

CHAPTER 1

LITERATURE REVIEW AND INCIDENCE OF FARM BANKRUPTCY

This chapter first defines farm bankruptcy terms. It then reviews past literature on farm bankruptcies, focusing on studies conducted in the developed world, to determine what factors influence farm bankruptcies. This overview of research into farm bankruptcy and factors influencing bankruptcy will put the local analysis into perspective. The third section outlines South African farm financial stress studies and the incidence of, and trends in, commercial farm bankruptcy in South Africa. A final section summarises past agricultural policy in South Africa.

1.1 Definition of farm bankruptcy terms

There are several terms used interchangeably in this study. Bankruptcy is defined by Barry *et al.* (1995: 557) as "a legal process of either reorganising an insolvent business or liquidating the business and distributing the sale proceeds to creditors". Similarly, Walker (1980: 111) defines bankruptcy as "the proceeding whereby the state, acting through an officer appointed for the purpose, takes the property of a debtor so that it may be realised and, subject to certain preferable claims and priorities, distributed ratably among his creditors".

Insolvency is defined by Walker (1980: 624) as "the state of inability to pay debts in full and by itself has no legal consequences. In England the filing of a declaration of inability to pay debts is an act of bankruptcy". Curzon (1979: 31) describes bankruptcy as "compulsory administration of the estate of an insolvent person (known as a bankrupt) by the court for the benefit of his creditors". According to Milton (1995), insolvency in South Africa is classed as an act of bankruptcy.

Sequestration is defined by Walker (1980: 1132) as the removal, by judicial authority, of property in possession of it, and includes the situation where "an insolvent's property is taken out of his hands in order that no creditor may secure an unfair preference, but so the whole may be administered by a trustee for the benefit of the whole body of creditors". This is commonly called 'bankruptcy'. In South Africa, farm sector bankruptcy data are given in terms of 'number of sequestrations', and aggregate data in terms of 'number of insolvencies'. Therefore, for the purposes of this study, these terms are used synonymously with 'number of bankruptcies'.

The definition of financial stress is also important, as extreme financial stress leads to farm bankruptcy. Brake (1983) deems financial stress to be a cash flow concept, but it is possible for a financially healthy farm to experience periodic short-term liquidity problems. Financial stress over the long-term is characterised by a negative real return to equity. A negative return will deplete net worth over time, resulting in eventual termination of the business (Boesson *et al.*, 1990).

1.2 Farm bankruptcies in some developed countries

During the post-World War II period, farm bankruptcies in the United States (US) increased from 3,8 failures per 100 000 farms in 1949 to 26,3 in 1978 (Shepard and Collins, 1982). The farm bankruptcy rate in 1978 approached the rate prevailing in the 1930s. In 1985, one-third of commercial farms in the US with sales of more than $50 000 were either technically insolvent or facing serious financial problems which could lead to insolvency (Shepard, 1986).

Shepard and Collins (1982) studied aggregate US farm sector bankruptcy data over the period 1910 to 1978, and attempted to establish broad classes of variables in order to answer the question "Why do farmers fail?". An econometric model was formulated with the annual rate of farm bankruptcy as the dependent variable. Independent variables included real net farm income, average farm size, leverage, real interest rates, non-farm bankruptcy rates, real government support payments and liquidity. Analysis of aggregate time series data suggests that independent variables explained much of the variation in US farm bankruptcy rates and, prior to World War II, the farm bankruptcy rate appeared to be linked with financial risk (leverage), while postwar bankruptcy was associated with business risk factors (variation in farm incomes and farm size). Pressure has been placed on US farm incomes since World War II due to falling food prices caused by relatively greater technology-induced productivity increases compared to increases in demand. As farm size increased, economies of scale needed to be achieved, hence overheads and risk were also raised. Agricultural support payments since World War II did not induce, defer or reduce farm failures.

Rucker and Alston (1987) investigated the link between farm failures and government intervention in the US in the 1930s. Owing to a lack of data in the 1980s, no empirical work has been conducted on the effects of federal and state policies on failure rates in the US. However, Rucker and Alston (1987) estimated the effects on farm bankruptcy rates during the 1930s of (1) commodity programmes of the Agricultural Adjustment Administration, (2) the expanded role of the federal government in the agricultural credit market, and (3) moratorium legislation passed by 25 states in the early 1930s. The 1920s and 1930s saw farm failure rates higher than in the 1980s. Estimates indicate that each programme was important in reducing farm failures, and in total between 146 000 and 278 000 farms were saved from failure. Therefore, their empirical results were consistent with the hypothesis that government programmes successively alleviated farm financial stress in the 1930s. Also, government programmes imposed direct costs and less apparent efficiency costs on the economy.

A multidimensional measure of agricultural financial stress in the US was developed by Shonkwiler and Moss (1993). By examining the common variation in financial stress indicators, they were able to compare the level of financial stress in the 1980s with that of the 1930s. In their study, four factors (inflation rate, unemployment rate, ratio of debt payments to farm equity, and the current rate of return on farm assets) were combined to form a single measure of farm stress using factor analysis. Both the 1930s and the 1980s were associated with indexes substantially less than zero, indicating severe financial stress.

In Canada, the number of farm bankruptcies increased substantially in all regions of the country, from 125 in 1979 to 551 in 1984 and then remained high at 440 in 1986 (Chan and

Rotenberg, 1988). Chan and Rotenberg (1988) examined determinants of financial stress and the incidence of bankruptcy in the Canadian agricultural sector. They found that (1) regional effects do not play an important role in explaining farm bankruptcies across Canada, and (2) aggregate financial data are useful in analysing trends in the incidence of farm bankruptcy. Empirical work identified financial leverage and energy-related expenses as key causes of farm loan arrears and ultimate bankruptcy in Canada during 1979 to 1986.

In Chan and Rotenberg's (1988) study, there was a time lag between entering financial stress and ultimate farm failure. It appeared to take up to four years for financially stressed farms to go bankrupt. Farm failures increased with the level of loan arrears in the previous year. Loan arrears two years earlier were negatively related to farm failure. This may indicate the structure of farm assistance programmes and other institutional provisions.

For the United Kingdom (UK), Harrison and Tranter (1994) report 50 bankruptcies of self-employed individuals in agriculture in 1980 and 277 in 1993. They attribute the prime cause of the deterioration in farming income to adverse movements in the industry's terms of trade (product prices relative to input prices), especially on capital inputs. The number of farm bankruptcies were, however, lower in 1993 compared to 1992. Despite large expenditures on agricultural support in the European Union, farmers continue to fail. Davies (1996) found that the annual rate of insolvency in agriculture in England and Wales from 1969 to 1986 was negatively related to the current price of land, but positively related to the land price two years previously. Past Common Agricultural Policy price supports, which were capitalised into higher land values that encouraged farmers to use more debt, were thus partly responsible for higher insolvency. The implication of this study is that not all farm failures can be attributed to poor management.

In New Zealand, Johnston and Frengley (1990) observed that the percentage of all farms that were identified as high-debt farms (equity less than 50 percent) increased from six percent in 1984 to approximately 24 percent in 1986. About 10 percent of high-debt farms, equivalent to about two percent of all sheep and beef farms, had zero or negative equities in 1987.

Therefore, all the developed countries reviewed showed an increasing trend in farm bankruptcies in the late 1970s, continuing through to the 1980s. The next section reviews past farm financial stress in South Africa and the incidence of farm bankruptcy in the commercial farming sector.

1.3 Farm bankruptcies in South Africa

1.3.1 South African farm financial stress studies

De Jager and Swanepoel (1994) used a logit model to distinguish between producers in the Northern Springbok Flats who had failed financially and those who were financially successful during 1990. Failed farmers had (1) higher directly allocatable costs, (2) relatively higher levels of carry-over debt (proportion of production debt received from co-operatives which is not repaid and so carried forward to the next production season), (3) higher arrears on instalments on long-term loans (liquidity problems), (4) less land as collateral, (5) lower gross farm incomes in relation to long-term debt, and (6) bought land in the 1980s. In addition to an insolvent farm being labelled a failure, a farmer would also be classified as having failed financially if consolidation or settlement arrangements had been negotiated with the Department of Agriculture.

Van Zyl *et al.* (1987*a*) found that the initial farm solvency position, nominal interest rates and inflation all affected the survival of 'typical' Western Transvaal and North-Western Transvaal Bushveld farms. Van Zyl *et al.* (1987*b*) used multiple regression analysis to identify how drought, general economic conditions and structural inflation affect the debt burden of the agricultural sector. The real debt burden of agriculture was highly responsive to changes in a drought index, volume of field crop production, real gross national product (GNP), the ratio of input to output prices and interest rates in the period 1970 to 1985. A change in any of these factors would lead to a proportionately larger change in real total debt burden.

Leslie and Darroch (1993) allocated financial stress into income and debt components for selected Natal and Eastern Orange Free State (EOFS) farms. Leverage ratios and interest rates were compared for farms experiencing financial stress (negative long-term real return to equity) with a target leverage ratio and interest rate for those farms which were financially successful (positive long-term rate of return to equity). They reported that successful farms had higher rates of return to assets and equity and lower costs of debt than unsuccessful farms. Rates of return to assets on successful farms exceeded costs of debt, implying positive use of leverage. Reliance on dryland cropping enterprises could explain why financially stressed EOFS farms were less successful than their Natal counterparts. The Natal farms relied on livestock enterprises for an average of 81 percent of their total income while dairy enterprises comprised 61 percent. Given that a dairy enterprise has a relatively consistent cash flow, *ceteris paribus*, financial stress should be less prevalent for this group. Successful EOFS farms were more diversified than the unsuccessful EOFS farms, probably comprising of a better mix of summer and winter crops. However, some financially stressed EOFS farms were also more diversified, indicating that poor financial management ability may have led to financial problems. This could indicate poor financial managerial ability. Leslie and Darroch (1993) emphasise that an understanding of the relationship between return on assets, interest rates and leverage is critical when deciding what proportion of debt a farm can safely utilise.

1.3.2 Incidence and trends in South African farm bankruptcy: 1948-1994

Figure 1.1 shows the rate of farm bankruptcies in South Africa from 1948 to 1994 using aggregate data. The number of bankruptcies in year t is expressed as a percentage of the total number of farms in year t. This gives a relative measure of farm bankruptcy because farm numbers fluctuate due to several reasons, such as, voluntarily exit from farming. No census data were available for the number of farms in 1966, 1970, 1977, 1982, 1984, 1989, 1993 and 1994. For these missing data, the mean of the adjacent years was taken as a reasonable proxy, and for 1993 and 1994 the number of bankruptcies for 1992 was used (Du Toit, 1996).

The aggregate bankruptcy rate has increased since the mid-1950s with notable rises in 1962 and 1978, a large increase from 1984 to 1987 and then another major rise from 1989 to 1991, continuing to 1994. Possible explanations for the marked rise since the early 1980s

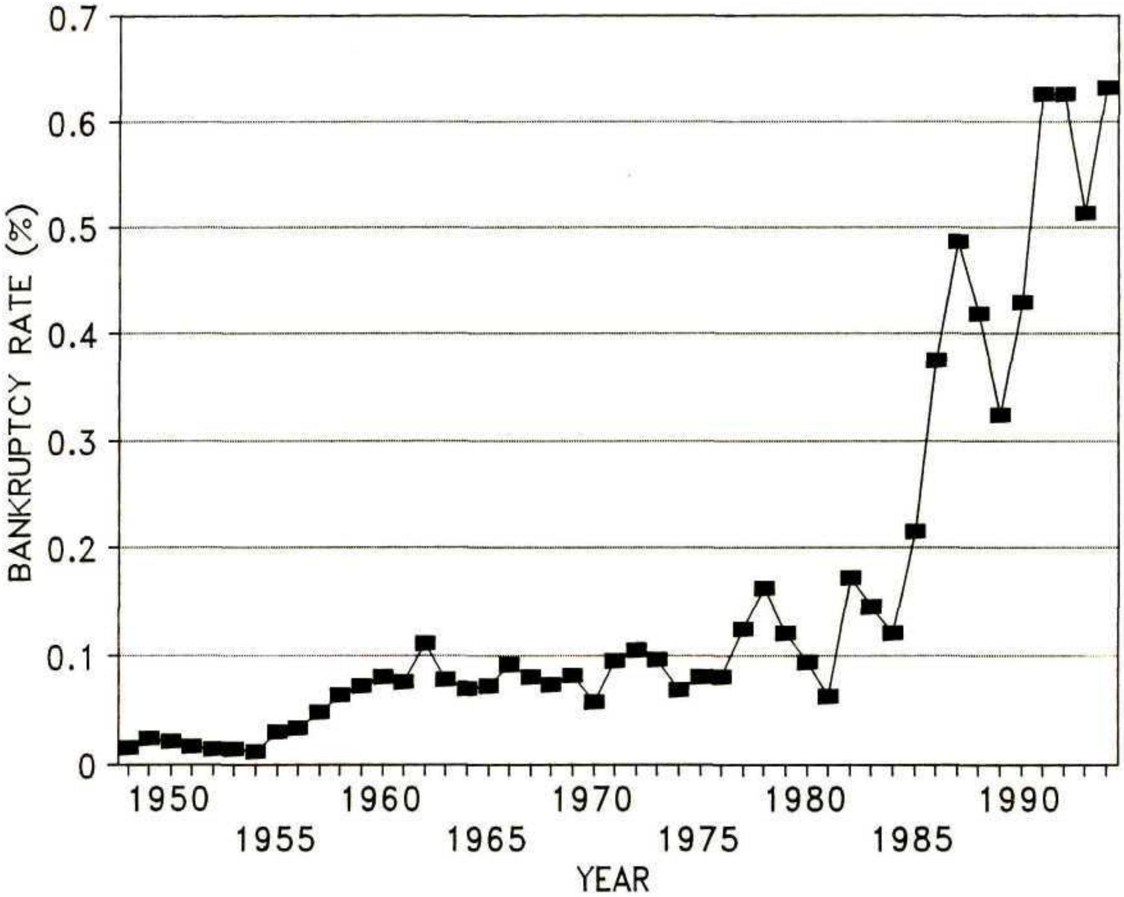

Figure 1.1 Aggregate farm bankruptcy rate in South Africa: 1948-1994 (Directorate Agricultural Economic Trends, 1971 and 1995; Central Statistical Service, 1964, 1972, 1994 and 1995).

include periodic droughts (1983, 1984 and in the 1990s) and an increase in real interest rates. The farm bankruptcy rate shows greater variation since 1980 compared to the period 1948 to 1970.

In Figure 1.2, trends in annual maize and extensive farm bankruptcies in South Africa are shown during 1970 to 1994 for the areas defined by the Directorate Agricultural Statistics (1996: 110) as summer rainfall and cattle grazing areas respectively (no annual data on the total number of maize and beef farms in the designated areas were available). Maize farm bankruptcies rose from 16 in 1970 to 206 farms by 1986 and then fluctuated around the 150 farm level. Bankrupt extensive beef farms followed a similar pattern, rising from two farms in 1971 to 62 farms in 1987, fluctuating around the 50 farm level during 1988 to 1992, and then falling to 35 farms in 1994. The absolute number of extensive beef farm bankruptcies was lower than that of maize farm bankruptcies. Extensive beef farm bankruptcies appear to lag one period behind the maize farm bankruptcies. Changes in government policy (for example, on interest rates) may have affected the farm sectors differently.

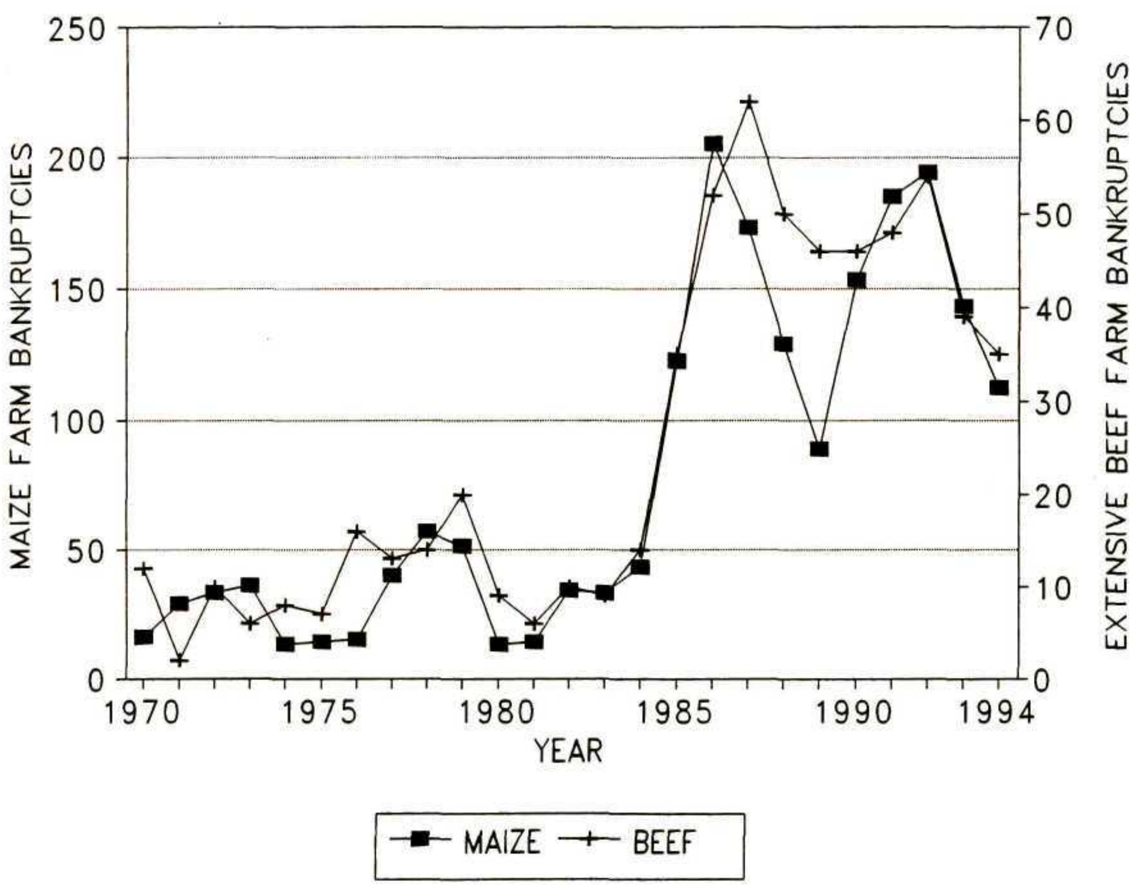

Figure 1.2 Maize and extensive beef farm bankruptcy trends in South Africa: 1970-1994 (Directorate Agricultural Economic Trends, 1995; Central Statistical Service, 1994 and 1995; Van Niekerk, 1995).

Before analysing the determinants of farm bankruptcy, it is appropriate to briefly describe the role of the Land Bank and other sources of farm finance in the past. The system of farm financing in South Africa has undergone major changes since the 1980s and this appears to have had an effect on farm bankruptcy.

1.3.3 Past agricultural finance policy in South Africa

The Land and Agricultural Bank of South Africa was established in 1912 to provide for the special financing needs of agriculture. A further development in the financing of agriculture was the creation of control boards and agricultural co-operatives in the 1930s (Johnson, 1989; Jacobs, 1985). Credit was lent by the Land Bank direct to farmers and to farmers via these co-operatives at relatively low interest rates.

The De Kock Commission found the pattern of agricultural financing through the Land Bank to have undesirable consequences for monetary policy implementation (Human, 1989; Johnson, 1989). This is because the system of allowing Land Bank bills, debentures and advances to qualify as liquid assets, resulted in the activities of the Land Bank exerting a strong influence on the increase in monetary aggregates and hence the level and structure of interest rates.

The practice whereby the Reserve Bank provided part of the Land Bank's funds with which agricultural co-operatives were supplied with short-term credit was phased out before 1985. The provision of credit to the Land Bank then took place at market-related interest rates via the issue of negotiable credit instruments (Jacobs, 1985). Also, since mid-1982, market-related interest rates were increasingly applied in the economy (Jacobs, 1984).

Land Bank debentures were also no longer considered to be liquid assets after 1 August 1988. Land bank bills qualify under more restrictive conditions. The status change in these instruments meant that certain sources of Land Bank financing became more expensive than in the past. This adjustment is reflected in higher financing costs since 1988 which are ultimately borne by the farmer (Human, 1989). In South Africa, agricultural debt is becoming increasingly short-term, resulting in monetary policy having an increasing impact on farmers who must borrow capital. In the changing agricultural financing system of South Africa, higher demands will be made on the financial management skills of farmers (Human, 1989; Jacobs, 1985).

Recent financial aid to commercial farmers in South Africa consisted of a number of different aid packages, the most important being an interest subsidy on carry-over debt in 1992/93 of R2,7 billion (Directorate Financial Assistance, 1996). Other financial assistance schemes included interest subsidies on production credit, long-term loans at financial institutions, farm bonds and consolidated agricultural debt, loans for purchase of production means, subsidies on farm bond and consolidated agricultural debt interest, subsidies for flood disaster and fire damage, stockfeed purchases and incentives, and subsidies for prevention of sequestration.

Important financing and assistance in terms of special relief schemes included; Special Section 34 seasonal loans to drought-stricken sugar growers in 1980, 1983, 1992 and 1993; drought relief schemes (summer rainfall areas) from 1978 to 1981, from 1983 to 1987, and in 1988 (summer and winter rainfall areas); flood relief schemes in 1988; drought relief schemes (winter rainfall areas) in 1989; financing purchase of breeding stock in drought stricken areas in 1992; and mortgage bond emergency aid scheme for pineapple growers in the Eastern Cape in 1994 (Land Bank, various years).

Reviews of relevant studies conducted in developed countries and South Africa identify some determinants of farm financial stress and bankruptcy. Chapter 2 builds on past research and specifies farm bankruptcy variables which may be relevant to the South African situation.

CHAPTER 2

DETERMINANTS OF FARM BANKRUPTCY

This chapter outlines hypothesised determinants of commercial farm bankruptcy in South Africa. Determinants are separated into business and financial risk factors.

2.1 Business risk factors

2.1.1 Product and input prices

Success or failure in farming is closely linked to prevailing trends in output and input prices. Farmers are usually debtors and this makes them vulnerable to a decline in farm product prices (Tomek and Robinson, 1991: 179; Tweeten, 1985: 78). Variable product and input prices can impact on farm failure rates by producing wide fluctuations in farm income (liquidity effects). Lower real net farm income is likely to increase bankruptcy rates (Shepard and Collins, 1982). Reliable net farm income data for the maize and beef farm sectors were not available, hence product prices were used as proxy for net farm income. Real input prices since 1970 have remained relatively stable (Directorate Agricultural Statistics, 1996). A negative relationship between real producer prices and farm bankruptcy is expected. In this analysis, producer prices are adjusted to real terms using the Consumer Price Index (CPI) (1990=100). Real world prices of both beef and maize showed a similar declining trend to real beef and maize prices in South Africa (International Monetary Fund, 1995; Directorate Agricultural Statistics, 1996), with the South African prices lagging approximately one period behind world prices. This indicates pressure from world prices on local agricultural policy pricing decisions.

In South Africa, an added risk dimension affecting maize farm incomes would be the fall in real maize producer prices since the 1987/88 marketing year when Maize Board pricing policy changed and losses on export sales were reflected in lower fixed real net maize producer prices (Faminow and Laubscher, 1991). The Board administered a single-channel pool price maize marketing system until 1995, whereby farmers had to market maize grain via the Board or its agents. The real producer price of maize set by the Maize Board in South Africa declined from R350/ton to R290/ton between 1987/88 and 1993/94.

Maize farmers in the summer rainfall area derive some 30 percent of gross farm income from beef cattle (Central Statistical Service, 1992) which can be sold to provide liquidity in times of financial stress. A negative relationship between real maize and beef producer prices and maize farm bankruptcy is thus expected. In the cattle grazing areas, maize grain is not an important feed input (Directorate Agricultural Economics, 1994: 175). Winter feed supplementation for beef in this type of extensive system is normally in the form of hay (Hatch, 1994: 126). Therefore, maize price is not included as a determinant of extensive beef farm bankruptcy.

2.1.2 Drought

In order to study the effect of drought on farm bankruptcies, it is necessary to define the term 'drought'. In this study, a meterological drought (when rainfall is abnormally low) will be classed as an agricultural drought (when soil moisture is depleted to the extent that crop yields are reduced considerably) (Dent *et al.*, 1987). Drought is expected to increase bankruptcies by reducing net cash flows. Farm earnings can impact on farm failure rates because of possible wide farm income fluctuations (liquidity effects). Lower real farm incomes appear to coincide with increases in bankruptcy rates (Shepard and Collins, 1982). Particularly severe drought conditions occurred in the summer rainfall and extensive beef areas in 1982, 1990, 1991 and 1992 (CCWR, 1996). Deviations of total production from trend give an indication of random weather shocks for South Africa as a whole. The weather variable is estimated by the residuals obtained from a regression of annual total agricultural production volume index on time shown in Figure 2.1. Random variations in production are due mainly to agro-climatic reasons (Islam and Subramanian, 1989). These residuals are expected to be negatively correlated with aggregate farm bankruptcy.

For the farm sector analyses (maize and extensive beef sectors), annual rainfall figures (calendar year totals) were used. Drought maps were overlaid on economic data maps, and mean rainfall data for *homogeneous* relative drought severity regions were calculated in the relevant areas (Zucchini and Adamson, 1984; CCWR, 1996). This procedure was undertaken to ensure that the rain gauge totals were not anomalous for the defined summer rainfall and cattle grazing areas. As actual rainfall decreases, farm bankruptcy is expected to increase.

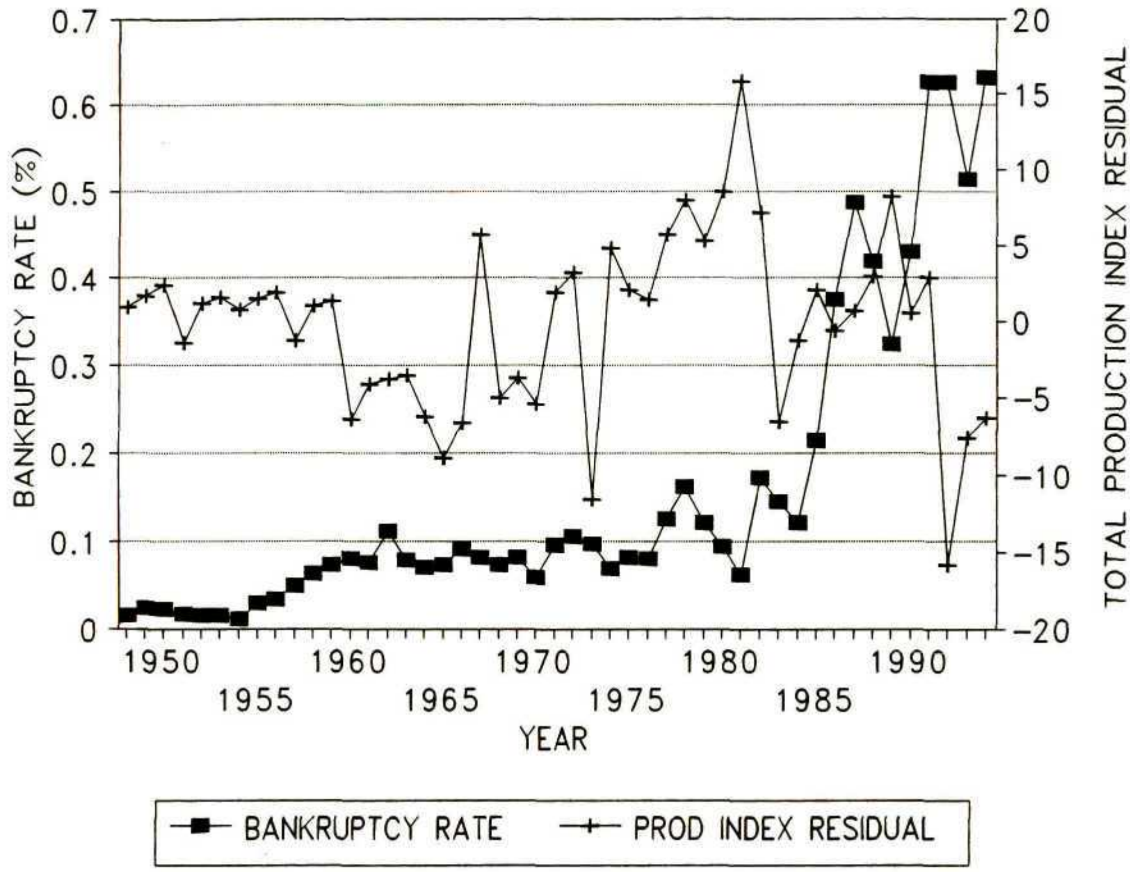

Figure 2.1 Aggregate farm bankruptcy rate and total production index residuals in South Africa: 1948-1994 (Directorate Agricultural Economic Trends, 1971 and 1995; Central Statistical Service, 1964, 1972, 1994 and 1995).

In Figure 2.1, major negative deviations from the trend occurred in 1973, 1983 and 1992, reflecting drought conditions. From about the mid-1960s to 1981, there appears to be an upward trend in the total production index residuals. From 1981 onwards, a decline in this trend is evident, corresponding with a sharp increase in the farm bankruptcy rate; adverse weather conditions appeared to increase the farm bankruptcy rate. These negative total production index residuals partly reflect the impact of drought on intensive crop production practices and cattle grazing areas.

2.1.3 Agricultural Policy

Government support, such as drought relief schemes, can improve farm liquidity by reducing current liabilities and hence the prospects of short-term survival (Standard Bank, 1994). Rucker and Alston (1987) found that government programmes successfully alleviated farm financial stress in the 1930s in the US. Decreased government support has possible costs; if, for example, future farm policy is more market orientated with reduced credit programmes, then private lenders and farmers are likely to feel the effects of future farm recessions more acutely (Drabenstott, 1983). Gabriel and Baker (1980) suggest that policies reducing business risk increase financial risk through greater borrowing, *ceteris paribus*. They propose that business risk and financial risk are trade-offs in a farmer's risk behaviour. Therefore, a decline in business risk would lead to the acceptance of a greater financial risk, thus reducing the effects of diminished risk on total risk.

Featherstone *et al.* (1988) and Collins (1985) suggest that risk-reducing and income-augmenting agricultural policies (for example, the Commodity Credit Corporation loan programmes in the US) increase the optimal leverage ratio. This increases the variance of the rate of return on equity. Risk-reducing and income-augmenting farm policies may increase the probability of partial or total equity losses by the farmer due to a policy-induced leverage increase. Credit programmes that increase credit availability may augment the policy-related leverage increases, raising debt use and the likelihood of farm failure.

Stockfeed purchase subsidies paid to extensive beef farmers in South Africa since 1965 may have promoted more intensive production in higher risk production areas. Stockfeed transport rebates to these farmers could have caused production over time to relocate away from areas where beef had a comparative advantage in production (Nieuwoudt, 1985). Therefore, a positive relationship is anticipated between bankruptcy and lagged real stockfeed purchase subsidies and transport rebates. Annual subsidies were adjusted to real terms using the change in the CPI (1990=100) (Directorate Agricultural Statistics, 1996). It is paradoxical that policies intended to make farming less risky, may have led to more risk for farmers in the long-term (Featherstone *et al.*, 1988).

Pasour (1990: 193) highlights some important effects of subsidised credit. The immediate effect is to reduce real interest rates and increase credit use in agriculture. The reduction in real interest rates has led to increased production and a trend towards larger and more highly mechanised farms. Subsidised credit is harmful to non-users of this credit because it increases output, decreases product prices and increases land prices. In Federal credit programmes, there is no standard measure of performance to assess their success. As a result of having no profit bench-mark, there is no objective procedure to determine how much credit should be used in agriculture. Incentive and information problems arise when credit decisions are made through the collective-choice process.

If farm policy reduced financial hardship in the agricultural sector, then an inverse relationship between farm bankruptcy rates and the portion of farm income from government supports is expected. If government supports respond mainly to adverse economic conditions in the agricultural sector, farm supports will tend to be greatest in years of high agricultural bankruptcy. It is possible that government supports in one year may forestall bankruptcies in the same year, delaying bankruptcies to later years. Therefore, a positive relationship is expected between bankruptcy rates and lagged support levels in the long-term.

In the aggregate farm bankruptcy models, government subsidies to agriculture are approximated by the amount of financial support allocated for wheat (bread subsidies), maize (distribution margin, import losses and partial redemption of loans), dairy, fertilisers and stockfeed (purchases, transport rebates and incentives for reduction of stock under different disaster drought assistance schemes) (Directorate Agricultural Economic Trends, 1971 and 1995; Directorate Agricultural Statistics, 1996). This proxy is used because no aggregate subsidy data for agriculture are available prior to 1984 (MacVicar, 1996; Steenkamp, 1996).

In Figure 2.2, real government agricultural subsidies rose between 1948 and 1955, fell in the late 1950s and rose again from about 1960. They fluctuated around R800 million for the period 1970 to 1983, and then increased to a peak of some R1 100 million in 1984. From 1985 to 1994, real subsidies fell from R1 100 million to R100 million, while the aggregate bankruptcy rate increased markedly. Shepard and Collins (1982) found a significant positive relationship for the period 1910 to 1940 between US government support payments and farm bankruptcy (government reacted to economic hardship during the 1930s Depression). However, after World War II, a negative relationship suggested that the US government changed economic conditions facing farmers. Agricultural support payments since World War II did not induce, defer or reduce farm bankruptcies. They suggest that policy makers may have been more successful in changing, rather than reacting to, agricultural economic conditions.

When data on subsidies from 1984 to 1994 for interest payments on carry-over debt,

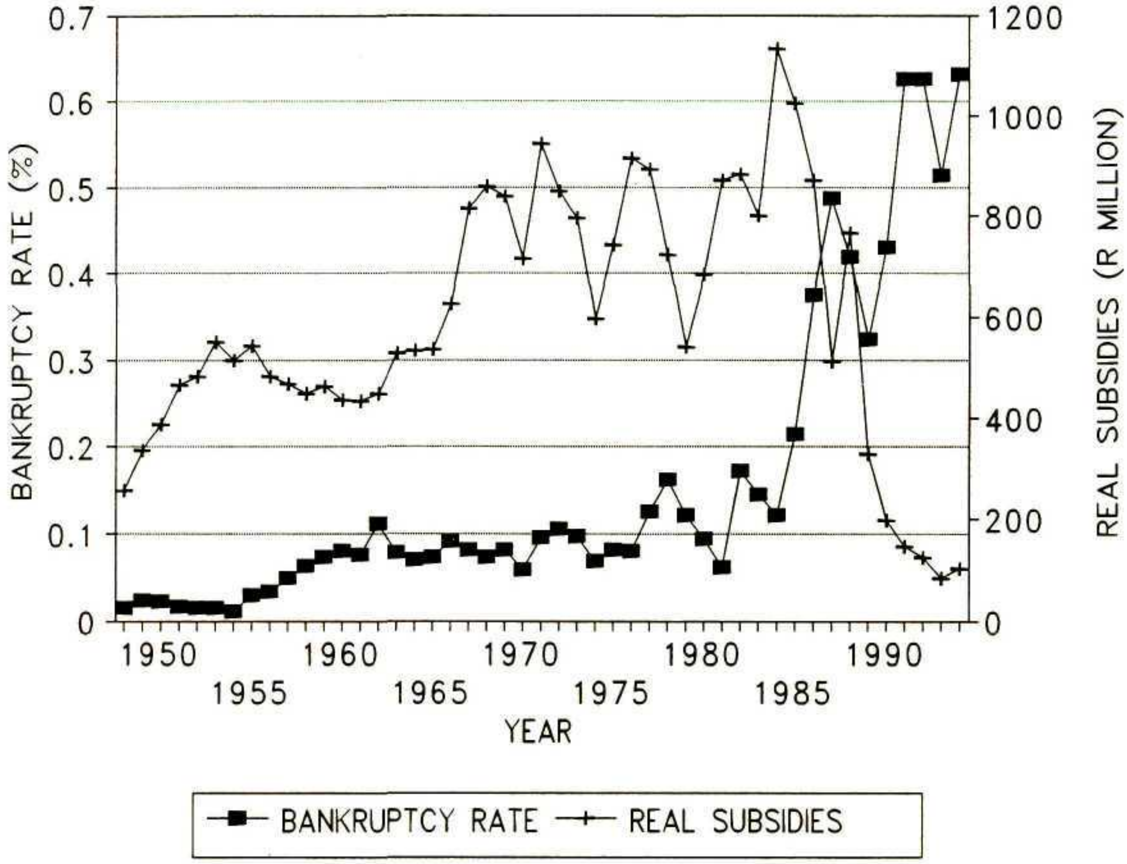

Figure 2.2 Aggregate farm bankruptcy rate and real agricultural subsidies in South Africa: 1948-1994 (Directorate Agricultural Economic Trends, 1971 and 1995; Central Statistical Service, 1964, 1972, 1994 and 1995).

production credit, farm bonds, emergency drought schemes and prevention of sequestrations are added to the subsidy data (*REAL COMB SUBSIDIES* in Figure 2.3), the same declining trend in real government subsidies emerges in Figure 2.3, except in 1992/93 (Directorate Financial Assistance, 1996). Real total subsidies declined from R1 300 million in 1984 to R394 million in 1994. This decline was interrupted in 1992/93 by real total subsidies of some R2,1 billion, due mainly to a substantial rise in interest subsidies on farm carry-over debt. The fall in aggregate, maize and beef farm bankruptcies in 1993 (Figures 1.1 and 1.2) was probably due to a drought relief package (carry-over debt subsidy and loan guarantee scheme instalment) in 1992/93 totalling some R3,0 billion in nominal terms (Directorate

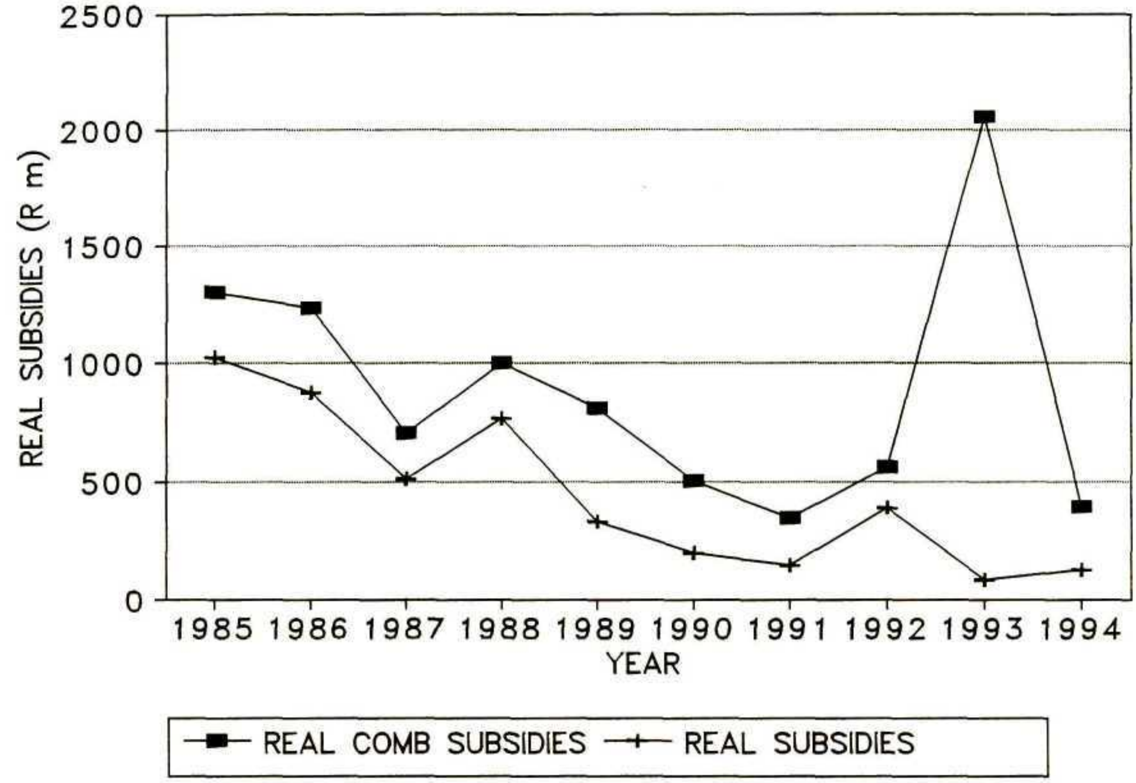

Figure 2.3 Real agricultural subsidies in South Africa: 1985-1994 (Directorate Agricultural Statistics, 1996; Directorate Financial Assistance, 1996).

Financial Assistance, 1996).

In their study, Rucker and Alston (1987) concluded, firstly, that there is no model of the *optimal* level of farm failures, so it cannot be determined whether the government relief programmes of the Great Depression corrected a 'market failure' or interfered with a properly functioning market process; secondly, it was not determined if the government programmes of the 1930s had benefits extending beyond that decade.

2.2 Financial risk factors

2.2.1 Real interest rates

Expected real interest rates are a critical explanatory variable for investment decisions as they represent the real cost of borrowing (Mishkin, 1988). In high real interest rate periods, farmers (particularly those with high leverage levels) are less able to afford additional credit. Theory suggests a positive relationship between real interest rates and bankruptcy rates (Shepard and Collins, 1982).

Murdock and Leistritz (1988: 48) identify both direct and indirect effects of high nominal and real interest rates on agriculture. The direct effects include an increase in interest payments due from indebted farmers, and a negative impact on land values. Indirect effects include a higher value of the local currency, as high interest rates in local markets attract capital from abroad.

High real interest rates transfer wealth from debtors to creditors, placing farmers who are net debtors at a disadvantage (Tweeten, 1985: 100). In addition, interest rates affect agriculture directly through cost and stock effects (Devadoss, 1985: 18; Rausser, 1988: 150). A higher real interest rate will increase finance charges, and therefore the cost of production will, in turn, decrease farm supply (cost effect). An increase in the real interest rate will raise the cost of holding stocks causing farmers to run down inventories (stock effect). This reflects the increased opportunity cost of non-farm investment in interest-bearing assets (Rausser, 1985: 220; Hughes *et al.*, 1985).

When real interest rates are expected to be relatively high, farmers should shift from debt to retained earnings to finance expansion (Drabenstott, 1983). In these periods of tight money and high interest rates, lenders are less willing to extend loan terms and farmers are less able to afford additional credit. Low interest rates assist potential bankrupts who acquire credit to see them through difficult times and prevent foreclosure. High nominal interest rates create cash flow problems but not necessarily low returns because land values appreciate with inflation that led to the high nominal interest rates for farmers (Tweeten, 1985: 100).

High real interest rates add to farm expenses and reduce real wealth by increasing the rate of discount on expected future earnings of durable farm resources, resulting in declining collateral for loans. The influence of interest rates on investment projects depends on the timing and magnitude of future cash flows. As a consequence of discounting, raising the interest rate will increase the rate of earnings on reinvesting the payments and favours those investments with larger payments coming in sooner (Barry *et al.*, 1995: 277). Changes in expectations about interest rates affect any decision where the returns are spread over time. Net present value represents the addition to farmer wealth resulting from the project; a reduction (increase) in interest rate should increase (decrease) farm sector wealth (Dodson and Covey, 1993).

In response to the De Kock Commission's recommendation in 1983, monetary policy became more market-orientated and market-related interest rates were increasingly applied to agriculture. This subjected the farming sector to a 'double' increase in interest rates; firstly, from a decline in subsidised interest rates, and secondly, due to the imposition of positive real interest rates for the economy as a whole. More market-related rates imply greater expected interest rate volatility and higher financial risk.

Overdraft interest rates from commercial banks are used as a proxy for market interest rates in Figure 2.4. Nominal interest rates were obtained from the South African Reserve Bank (various years) and adjusted to real terms using the change in the CPI (1990=100) (Directorate Agricultural Economic Trends, 1971 and 1995).

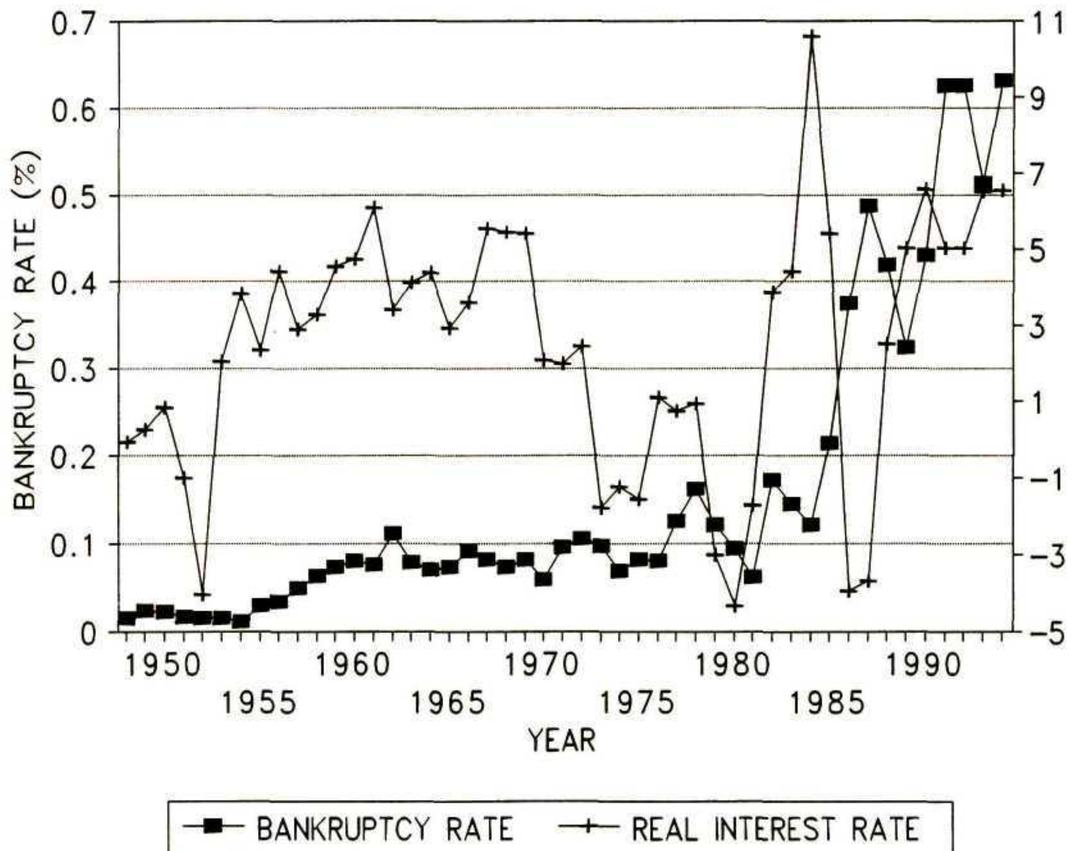

Figure 2.4 Aggregate farm bankruptcy rate and real interest rates in South Africa: 1948-1994 (Directorate Agricultural Economic Trends, 1971 and 1995; Central Statistical Service, 1964, 1972, 1994 and 1995; South African Reserve Bank, various years).

In 1953, the real interest rate rose and positive real interest rates were maintained until 1972. The aggregate bankruptcy rate increased from the mid-1950s onwards. Real interest rates generally followed an upward movement from 1949 to the end of the 1960s. Real interest rates showed relative stability in the 1960s. From the 1970s, short-term interest rates showed greater variability and more frequent changes in direction. The main reasons for this change were due to the implementation of new money market instruments and market-related rates. Previously, short-term interest rates had been adjusted administratively to reflect broad changes in market conditions (De Kock Commission, 1985: 107).

Nominal interest rates did not keep pace with high rates of inflation in the 1970s, resulting in negative real interest rates during part of this period. Negative real interest rates reached a maximum in 1980 (almost the same magnitude as in 1952 - with the relatively high rate of inflation during the time of the Korean War - also resulting in negative real interest rates) (De Kock Commission, 1985: 116). From 1973 to 1975 real interest rates were negative. In the period 1978 to 1980, negative real interest rates were associated with a decrease in the bankruptcy rate. Annual real overdraft interest rates fell from two percent to around -1,5 percent between 1970 and 1975, rose to one percent over the period 1976 to 1978 and fell to -4,5 percent by 1980. De Kock Commission recommendations for more market-orientated commercial and Land Bank interest rates led to historically high real overdraft interest rates of between five and 10 percent during 1983 to 1985, while positive real rates of up to 6,5 percent have continued since 1988.

Farmers are making more use of outside capital, resulting in the agricultural sector being more sensitive to interest changes than in previous years. An increase in real interest rates is likely to raise farm bankruptcy rates.

2.2.2 Debt/asset (leverage) ratio

The aggregate farm debt/asset (leverage) ratio (total farm debt as a percentage of total farm assets) shows the solvency and risk-bearing ability of farmers. Leverage can be used to analyse income or debt service capacity by relating returns on assets to the service requirements on existing liabilities (Jolly *et al.*, 1985). Farmers with substantial net worth or equity have the potential to borrow additional funds to meet short-term needs (Murdock and Leistritz, 1988: 78). This increases the probability that highly leveraged farmers will face difficulties in servicing debt (Chan and Rotenberg, 1988). Increasing financial leverage increases the variation of expected returns on equity and the potential for loss of equity capital, and reduces liquid credit reserves. Furthermore, variations in interest rates magnify these financial risks as leverage increases (Barry *et al.*, 1995: 169). The ratio of debt to net cash income has increased over time, implying that a higher proportion of income must be used to service debt. This creates cash flow stress (Lins and Duncan, 1980). Leverage and bankruptcy of commercial farmers are expected to be positively related.

Brake (1983) highlighted two new components of financial stress in 1981 to 1983 compared to previous periods of stress in the US: (1) The expected ability to borrow periodically on capital gains disappeared with the reality of asset value decreases (less collateral), and (2), more importantly, the cash flow required to service previous debt commitments became substantially larger with rapidly rising nominal interest rates. These were also two new components in the South African farm financial stress situation.

Trends in both the aggregate farm debt/asset ratio and farm bankruptcy rate are similar from 1948 to 1994, as shown in Figure 2.5. Both increased for the period 1954 to 1994, with a large rise in the debt/asset ratio at the start of the 1980s, peaking in 1985 and then remaining relatively high until 1994. There appears to be a strong positive correlation between the bankruptcy rate and leverage ratio from 1970 to 1985. High bankruptcy rates during 1991 to 1994 corresponded with high leverage levels.

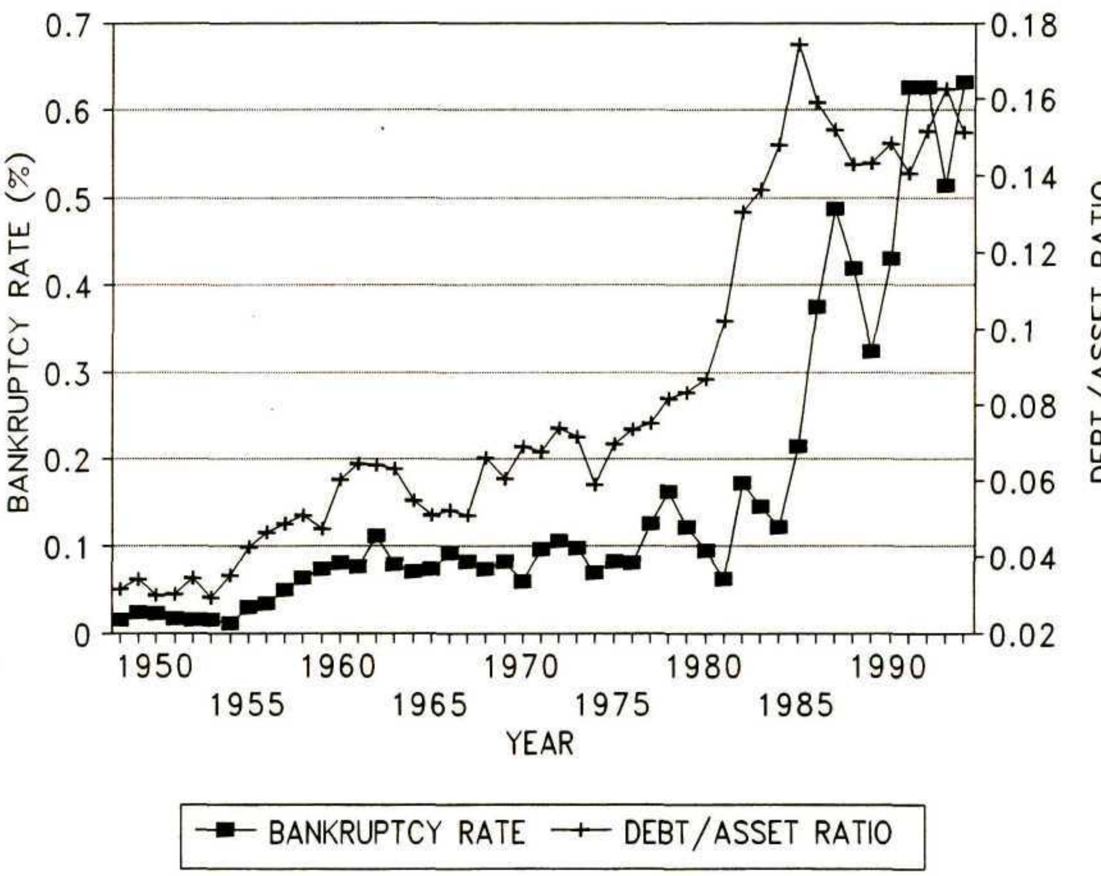

Figure 2.5 Aggregate farm bankruptcy rate and the aggregate farm debt/asset ratio in South Africa: 1948-1994 (Directorate Agricultural Trends, 1971 and 1995; Central Statistical Service, 1964, 1972, 1994 and 1995).

Farm sector leverage in South Africa rose from 0,06 in 1970 to a peak of 0,17 in 1985 and remained around 0,15 in 1994. These relatively 'safe' aggregate leverage levels mask the distribution of farm debt, which was concentrated in the summer rainfall and cattle grazing areas over this period (Central Statistical Service, 1972 and 1994; Volkskas Bank, 1988; Human, 1989).

Fiscal policy has probably played a role in debt accumulation. Favourable accelerated depreciation allowances on machinery investment, negative real interest rates in the early 1980s and drought in the early 1980s and 1990s are likely to have encouraged use of more debt. Investing in equipment and land was an attractive alternative to paying income tax. This probably encouraged borrowing from farm co-operatives and commercial banks and brought about a level of mechanisation that was economically unsustainable.

Higher real interest rates would reduce asset values and increase the leverage ratio, thereby reducing solvency and increasing the potential for bankruptcy. This interaction is incorporated in the models of maize and beef farm bankruptcy specified later. A real return problem occurs when interest rates remain high and disinflation removes capital gains as a compensating return (Tweeten, 1985: 87). A high ratio of debt to assets becomes a low return problem when interest rates exceed total rates of return on assets for an extended period. Highly leveraged farms are likely to experience cash flow problems because the rate of return to assets is less than the interest rate that must be paid (Murdock and Leistritz, 1988: 78). Realising this problem, local lenders now place more emphasis on farmer repayment capacity than on farmer collateral. Farmers must now have the ability to cover expected production costs, fixed costs, existing commitments (capital and interest) and personal expenditures from farm and non-farm income (Louw, 1995).

2.3 Other factors

2.3.1 Non-farm bankruptcies

The non-farm bankruptcy rate reflects general economic conditions which may spill over into the agricultural sector (Shepard and Collins, 1982). A positive relationship is expected between farm and non-farm failure rates. However, non-farm bankruptcies are not a direct cause of farm bankruptcies because certain factors, such as real interest rates, will affect both sectors.

2.3.2 Economies of size

Larger machinery and equipment, together with increases in value of farmland and in farm size, raise the capital required to operate a farm (Hughes *et al.*, 1985). This makes farms, particularly those which are highly leveraged, more vulnerable to bankruptcy. In US agriculture there has been a concurrent change in capital structure and a shift in size (Shepard and Collins, 1982). While improved technology and scale in agriculture potentially raise profits in the short-run, they ultimately raise overheads and risk. This makes farmers more vulnerable to year-to-year shortfalls in income, potentially raising failure rates (farm expansion through increased use of debt capital has increased financial vulnerability). Cross-sectional data are needed to analyse the relationship between farm size and farm bankruptcy as the relationship is not known *a priori*.

2.3.3 Exchange rate

Dushmanitch and Darroch (1990) identified depreciation of the exchange rate and higher domestic inflation as raising prices for South African imports of capital equipment, fuels, fertilisers and chemicals. Exchange rates have different effects on different farm sectors depending on the degree of imports and exports. The effect of changing exchange rates on farm bankruptcy is not known *a priori*, and there is a close interrelationship between interest rates and spot and forward exchange rates (De Kock Commission, 1985: A11). Therefore, the exchange rate was not considered as one of the possible determinants of farm bankruptcy in this study.

2.3.4 Inflation rate

Shonkwiler and Moss (1993) recognise inflation as having different effects on individuals, depending on the mix of financial and physical assets and their position as net debtors and creditors. Starleaf *et al.* (1985) found that farmers have been net beneficiaries of unanticipated increases in the inflation rate. An unanticipated increase in the rate of general price inflation benefits those whose money incomes are flexible (farmers), for example, varying prices received for produce, at the expense of those whose money incomes are fixed. Unanticipated inflation transfers real wealth from creditors to debtors but does not have a large effect on total real wealth (Tweeten, 1985: 100). Variables considered in the bankruptcy models were deflated using the CPI (1990=100).

2.3.5 Principal-agent relationship (moral hazard and adverse selection)

In a credit relationship the lender (the principal) contracts with the borrower (the agent) to productively utilise and repay with interest the lender's funds. During the course of the loan contract, the borrower is expected to comply with the objectives of the lender so that these objectives can be optimally obtained. There are two vital questions (Barry *et al.*, 1995: 197): firstly, is the borrower a greater risk than believed when the loan contract was drawn up (an adverse selection problem)? Secondly, will the borrower take on greater risks during the term of the loan contract than anticipated by the lender when the contract was established (a moral hazard problem)? The more prevalent these problems are, the greater the expected rate of bankruptcy. It is not possible to build this factor into the farm bankruptcy models on an aggregate basis, as this information is not available.

2.4 Time lag before bankruptcy

There is likely to be a time lag between the incidence of business and financial risk factors and ultimate farm bankruptcy. For example, drought and higher interest rates in one year will affect borrowers' future ability to meet debt repayments, as they reduce present income (and possibly savings) and raise the commitments against future income (Rucker and Alston, 1987). Similarly, Chan and Rotenberg (1988) found that a time lag occurred between entering financial stress and ultimate failure, with up to four years before an increase in loan arrears was fully reflected in bankruptcy statistics. Lagged proxy variables for business and financial risk in the farm bankruptcy models estimated in Chapter 3 are used to indicate that the bankruptcy process is dynamic.

Past research and economic theory identify product prices, adverse weather conditions, real interest rates and the aggregate farm debt/asset ratio as possible quantifiable determinants of bankruptcy amongst commercial farmers in South Africa. These variables are considered in the econometric models developed in the following chapter.

CHAPTER 3

RESEARCH METHODOLOGY AND RESULTS

Factors affecting aggregate farm bankruptcy from 1948 to 1994, and bankruptcy of aggregate, maize and extensive beef farmers during the period 1970 to 1994 were estimated from time series data using ordinary least squares (OLS) regression and principal component analysis. Regional sequestration data were obtained for the summer rainfall and cattle grazing areas over this period for all farms exceeding 50 hectares, and exclude farm companies and close corporations (Van Niekerk, 1995). Data used in the models are presented in the Appendix.

Penson (1987) notes that the more aggregated the financial statements used to calculate farm sector data, the more biased their interpretation will be. He also points out the importance of focusing on general trends in financial stress rather than on the specific level of a particular ratio.

This chapter develops the various models, and interpretation of the empirical results are discussed under 'Implications and Conclusions'.

3.1 Aggregate farm bankruptcy model: 1948-1994

The preliminary model for the analysis is given by equation **(1)**:

$$BANKR = \beta_0 + \beta_1\, POL + \beta_2\, RINT + \beta_3\, LEV + \beta_4\, TPIR + e_t \qquad (1)$$

where BANKR = annual rate of total farm bankruptcies (calculated as the ratio of the number of aggregate bankruptcies to the number of farms in that year); POL = lagged government policy variable proxy as defined in Section 2.1.3; RINT = lagged real commercial bank overdraft interest rate (reflecting naive expectations); LEV= lagged farm sector leverage ratio; TPIR = lagged drought index, and e_t = disturbance term. Correlation coefficients were used to identify the appropriate length of lag for the explanatory variables.

3.1.1 Correlation coefficients

A correlation matrix of the variables considered for the aggregate model is presented in Table 3.1. All coefficient signs agree with *a priori* expectations. Double natural logarithmic specification increased significance of the coefficients of the variables. LBANKR (rate of total farm bankruptcies logged) is negatively correlated to LPOL1 (logged government policy variable lagged one year) and LTPIR2 (logged total agricultural production index residuals two years prior), and positively related to LLEV1 (logged leverage variable lagged one year) and LRINT2 (logged real interest rate two years prior).

Table 3.1 Correlation coefficients between variables of the aggregate farm bankruptcy model, 1948-1994.

	LBANKR	LPOL1	LRINT2	LLEV1	LTPIR2
LBANKR	1,0000				
LPOL1	-0,2807*	1,0000			
LRINT2	0,3427**	-0,1459	1,0000		
LLEV1	0,9397***	-0,1389	-0,2389	1,0000	
LTPIR2	-0,2106	0,2452	-0,1876	-0,1216	1,0000

Note: ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels respectively.

3.1.2 Regression model

The following OLS model was estimated for the aggregate farm bankruptcy model (SPSS, 1995):

$$LBANKR = 3{,}818 - \underset{(-3{,}098)^{***}}{0{,}2620\, LPOL1} + \underset{(2{,}170)^{**}}{0{,}1198\, LRINT2} + \underset{(18{,}615)^{***}}{1{,}7205\, LLEV1} - \underset{(-1{,}034)}{0{,}0654\, LTPIR2} \quad (2)$$

where adjusted $R^2 = 90{,}84$ percent, degrees of freedom = 41, d = 1,235, t-values are shown in parentheses, and *** and ** indicate significance at the 1 percent and 5 percent levels respectively.

The coefficients, except for LTPIR2, are statistically significant. LTPIR2 is retained in the model due to the coefficient's t-value being greater than one (Maddala, 1977: 121). Multicollinearity is not likely to be a problem due to there being no statistically significant pairwise correlations between the explanatory variables. The model in equation **(2)** was also estimated in standardised form. Standardised variables are expressed in terms of deviations from their means (change of origin) and divided by their sample standard deviation (change of scale); therefore the standardised variables have a zero mean value and a variance of one (Gujarati, 1995: 182). Thus, standardised variables are independent of the original units of measurement, and their coefficients show the relative importance of the variables, which is important for policy purposes. The standardised aggregate farm bankruptcy model is estimated as:

$$ZLBANKR = -0{,}147\ ZLPOL1 + 0{,}103\ ZLRINT2 + 0{,}877\ ZLLEV1 - 0{,}049\ ZLTPIR2 \quad \textbf{(3)}$$

The leverage ratio, ZLLEV1, is the most important explanatory variable in equation **(3)**, followed by lagged real government subsidies, ZLPOL1, lagged real interest rates, ZLRINT2, and lagged supply shocks, ZLTPIR2.

Attempts were made to fit an interaction term to the model to determine the effects of real interest rates on leverage and hence bankruptcy. Due to multicollinearity, induced by the interaction term on the model, principal component analysis was used (Kendall, 1957; Chatterjee and Price, 1977; Doran, 1989). Principal component analysis converts the original set of variables into a new set of uncorrelated variables called principal components, which are linear combinations of the original variables. The component loadings (principal component coefficients) are chosen so that the principal components satisfy two conditions; the principal components are orthogonal, and they are ordered; the first principal component accounts for the maximum possible proportion of the total variation of the original variables, the second principal component accounts for the maximum of the remaining variation in the original variables, and so on. By deleting subsets of principal components, more stable coefficient estimates of the explanatory variables can be obtained (Jolliffe, 1986: 132).

The aggregate model did not stabilise with the correct coefficient signs, probably due to the lack of variability of the bankruptcy variable between 1948 and 1970. The aggregate farm bankruptcy model was then analysed for the period 1970 to 1994 (to be consistent with the product sector models).

3.2 Aggregate farm bankruptcy model: 1970-1994

The preliminary aggregate farm bankruptcy model is given by equation **(4)**:

$$BANKR = \beta_0 + \beta_1 POL + \beta_2 RINT + \beta_3 LEV + \beta_4 TPIR + \beta_5 IL + e_t \qquad \textbf{(4)}$$

where BANKR, POL, RINT, LEV and TPIR are defined as before; IL = interaction term (product of RINT and LEV showing how higher real interest rates reduce asset values and hence increase leverage and potential bankruptcy); and e_t = disturbance term. Correlation coefficients were used to identify the appropriate length of lag for the explanatory variables.

3.2.1 Correlation coefficients

A correlation matrix of the model variables is shown in Table 3.2. All correlation coefficient signs agree with *a priori* expectations. Annual bankruptcy, BANKR, is negatively correlated with POL1 (government policy lagged on year) and TPIR1 (total production index residuals lagged one year), and positively correlated with LEV1 (leverage in previous year), RINT2 (real commercial bank interest rate two years prior) and IL21 (RINT2 x LEV1). Multicollinearity is likely to be a problem due to statistically significant pairwise correlations between the explanatory variables.

Table 3.2 Correlation coefficients between variables of the aggregate farm bankruptcy model, 1970-1994.

	BANKR	POL1	RINT2	LEV1	TPIR1	IL21
BANKR	1,0000					
POL1	-0,7785***	1.0000				
RINT2	0,5206**	-0,3109	1,0000			
LEV1	0,8083***	-0,4383**	0,4998**	1,0000		
TPIR1	-0,2604	0,2210	-0,4796**	-0,2255	1,0000	
IL21	0,6644***	-0,3423	0,9424***	0,7263***	-0,4218**	1,0000

Note: *** and ** indicate significance at the 1 percent and 5 percent levels respectively.

3.2.2 Regression model

The initial estimated OLS aggregate farm bankruptcy model (GENSTAT, 1993) was:

$$BANKR = 0{,}199 \underset{(-6{,}122)^{***}}{- 0{,}0003\, POL1} \underset{(-0{,}397)}{- 0{,}009\, RINT2} \underset{(0{,}287)}{+ 0{,}001\, TPIR1} \underset{(1{,}940)^{*}}{+ 2{,}182\, LEV1} \underset{(0{,}649)}{+ 0{,}202\, IL21} \quad (5)$$

where adjusted R^2 = 86,55 percent, d = 1,920, degrees of freedom = 17, t-values are in parentheses, and *** and * indicate significance at the 1 and 10 percent levels respectively.

Expected multicollinearity occurs in equation **(5)** as there is a high adjusted R^2, the coefficients of variables RINT2, TPIR1 and IL21 are not statistically significant, and the RINT2 and TPIR1 coefficients have the wrong sign. Principal components (PCs) extracted from the standardised explanatory variables (ZPOL1, etc.) to cope with this problem are shown in Table 3.3. The Durbin-Watson *d* statistic for detecting autocorrelation indicates there is no first-order autocorrelation, so the hypothesis of randomness is accepted (Gujarati, 1995: 423).

Table 3.3 Principal components extracted for the aggregate farm bankruptcy model, 1970-1994.

	Principal Component				
Variable	PC_1	PC_2	PC_3	PC_4	PC_5
ZPOL1	-0,32125	-0,87150	-0,17321	0,32606	0,03115
ZRINT2	0,51557	-0,34109	-0,06068	-0,49408	0,60832
ZLEV1	0,45319	0,19322	-0,41206	0,71856	0,26677
ZTPIR1	-0,35508	0,17842	-0,85447	-0,33134	0,04663
ZIL21	0,54729	-0,23447	-0,25768	-0,15315	-0,74541
Eigenvalue	2,964	0,824	0,755	0,449	0,012
% variation	59,28	16,43	15,09	8,98	0,23

The principal components (PCs) are used to restate equation **(5)** in terms of the original variables purged of multicollinearity (Chatterjee and Price, 1977; Doran, 1989). Standardised annual aggregate farm bankruptcy, ZBANKR, is first regressed on all the principal components. Successive principal components with small variances are dropped until the sign and magnitude of the estimated standardised coefficients stabilise. This resulted in ZBANKR being regressed on PC_1 and PC_2. These two PCs explain most (75,71 percent) of the variation in the explanatory variables (principal components PC_3, PC_4 and PC_5 were omitted as they showed the linear relationships between the explanatory variables which were the source of the multicollinearity, and resulted in instability in the model).

$$ZBANKR = 0{,}457\ PC_1 + 0{,}543\ PC_2 \qquad (6)$$
$$(9{,}451)^{***} \qquad (5{,}906)^{***}$$

where adjusted R^2 = 84,70 percent, d = 1,926, degrees of freedom = 20, t-values are in parentheses, and *** indicates significance at the 1 percent level.

The Durbin-Watson d statistic for detecting autocorrelation still indicates there is no first-order autocorrelation, so the hypothesis of randomness is again accepted. Standardised annual aggregate farm bankruptcy could also be estimated by OLS regression of ZBANKR on the standardised explanatory variables as per equation **(7)**:

$$ZBANKR = \beta_1\ ZPOL1 + \beta_2\ ZRINT2 + \beta_3\ ZLEV1 + \beta_4\ ZTPIR1 + \beta_5\ ZIL21 \qquad (7)$$

Chatterjee and Price (1977: 176) show that the β coefficients of equation **(7)** can be estimated from equation **(6)** coefficients and the PC_1 and PC_2 loadings in Table 3.3 as:

$$\beta_i = \sum_{j=1}^{k} a_{ij} c_{ij} \qquad (8)$$

where a_{ij} = estimated loading for variable i in PC_j, c_{ij} = estimated coefficient for PC_j from equation **(6)**, and k = number of PCs retained. For example, β_1= (-0,32125 x 0,457) + (-0,87150 x 0,543) = -0,620.

Substituting these expressions into equation **(7)** gives the estimated standardised aggregate farm bankruptcy regression model as:

$$ZBANKR = -0{,}620\ ZPOL1 + 0{,}051\ ZRINT2 + 0{,}312\ ZLEV1 - 0{,}061\ ZTPIR1 + 0{,}123\ ZIL21 \qquad (9)$$

The government subsidy variable, ZPOL1, is the most important explanatory variable, followed by lagged leverage, ZLEV1, the interaction term, ZIL21, lagged total production index residuals, ZTPIR1, and lagged real interest rates, ZRINT2. Variances and hence standard errors and t-values of the β coefficients are estimated following Gujarati (1995: 70):

$$Var\ (\beta_i) = \sum_{j=1}^{k} (a_{ij}^{\ 2} * Var\ (c_{ij})) \tag{10}$$

where a_{ij} = estimated loading for variable i in PC_j, Var (c_{ij}) = variance of the estimated coefficient for PC_j from equation **(6)**, and k = number of PCs retained.

The t-values are equivalent to those in original scale since scaling does not affect the correlation of the variables. Finally, the regression coefficients in equation **(9)** are multiplied by S_{BANKR}/S_{Xi} (standard deviation of BANKR divided by standard deviation of the relevant explanatory variable) to express the amended OLS annual aggregate farm bankruptcy model in original scale (Chatterjee and Price, 1977: 178), as per equation **(11)**:

$$\underset{}{BANKR} = 0{,}315 \underset{(-7{,}596)^{***}}{- 0{,}0004\ POL1} \underset{(1{,}263)}{+ 0{,}003\ RINT2} \underset{(11{,}056)^{***}}{+ 1{,}631\ LEV1} \underset{(-2{,}758)^{***}}{- 0{,}002\ TPIR1} \underset{(3{,}602)^{***}}{+ 0{,}036\ IL21} \tag{11}$$

where adjusted R^2 = 84,70 percent, t-values are shown in parentheses, and *** indicates significance at the 1 percent level.

Comparing equations **(11)** and **(5)**, the adjusted R^2 falls slightly but the t-values increase markedly. All coefficients are now highly statistically significant, except for RINT2, which has a t-value greater than one and is therefore retained in the model (Maddala, 1977: 121). The RINT2 and TPIR1 coefficient signs are correct in the amended model.

3.3 Maize farm bankruptcy model: 1970-1994

The preliminary maize bankruptcy model is given by equation **(12)**:

$$BANKRM = \beta_0 + \beta_1 RMP + \beta_2 WEA + \beta_3 LEV + \beta_4 RINT + \beta_5 IL + \beta_6 RBP + e_t \quad (12)$$

where BANKRM = annual number of maize farm bankruptcies; RMP = lagged real maize producer price; WEA = lagged annual rainfall in summer grain areas (annual rainfall is used because of the importance of soil moisture levels in maize production) (CCWR, 1996); LEV = lagged farm sector leverage; RINT = lagged real commercial bank overdraft interest rate (again reflecting naive expectations); IL = interaction term (RINT x LEV, showing how higher real interest rates reduce asset values and hence increase leverage and potential bankruptcy); RBP = lagged real producer beef price, and e_t = disturbance term. LEV is a reasonable proxy for maize farm leverage as farm debt is concentrated in the summer rainfall and cattle grazing areas (Volkskas Bank, 1988; Human, 1989).

3.3.1 Correlation coefficients

A correlation matrix of the maize farm bankruptcy model variables is shown in Table 3.4. All correlation coefficient signs agree with *a priori* expectations. Annual bankruptcy, BANKRM, is negatively correlated with RMP1 (real maize producer price in previous year), RBP1 (real beef price in previous year) and WEA1 (annual rainfall in previous year), but positively correlated with LEV1 (leverage in previous year), RINT2 (real commercial bank interest rate two years prior) and IL21 (RINT2 x LEV1). Again, multicollinearity is likely to be a problem due to statistically significant pairwise correlations between the explanatory variables.

Table 3.4 Correlation coefficients between variables of the maize bankruptcy model, 1970-1994.

	BANKRM	RMP1	RINT2	LEV1	WEA1	IL21	RBP1
BANKRM	1,0000						
RMP1	-0,4531**	1,0000					
RINT2	0,6663***	-0,0906	1,0000				
LEV1	0,8418***	-0,3688*	0,4998**	1,0000			
WEA1	-0,4011*	0,0122	-0,4704**	-0,4393**	1,0000		
IL21	0,6959***	-0,0896	0,9790***	0,5474***	-0,4767**	1,0000	
RBP1	-0,4470**	0,4312**	-0,6606***	-0,2705	0,3730*	-0,5939**	1,0000

Note: ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels respectively.

3.3.2 Regression model

The initial estimated OLS maize farm bankruptcy model (GENSTAT, 1993) was:

$$BANKRM = 30{,}427 - 0{,}202\ RMP1 + 0{,}012\ WEA1 + 945{,}783\ LEV1 + 2{,}935\ RINT2 + 27{,}568\ IL21 + 0{,}023\ RBP1 \quad \textbf{(13)}$$

$$(-1{,}615) \quad (0{,}154) \quad (3{,}515)^{***} \quad (0{,}277) \quad (0{,}407) \quad (0{,}193)$$

where adjusted R^2 = 75,87 percent, d = 1,077, degrees of freedom = 16, t-values are in parentheses, and *** indicates significance at the 1 percent level.

Expected multicollinearity occurs in equation **(13)** as there is a high adjusted R^2, the coefficients of variables RMP1, WEA1, RINT2, IL21 and RBP1 are not statistically significant, and the WEA1 and RBP1 coefficients have the wrong sign. Principal components extracted from the standardised explanatory variables (ZRMP1, etc.) to cope with this problem are shown in Table 3.5. The Durbin-Watson *d* statistic for detecting autocorrelation falls in the inconclusive range, but the non-parametric Geary test passed at the 5 percent significance level, so the hypothesis of randomness is accepted (Gujarati, 1995: 419).

Table 3.5 Principal components extracted for the maize farm bankruptcy model, 1970-1994.

			Principal Component			
Variable	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6
ZRMP1	0,18784	-0,84989	0,01351	0,04826	0,48923	0,02333
ZWEA1	0,35692	0,26765	0,57445	0,63961	0,24870	0,00519
ZLEV1	-0,39584	0,21561	-0,58040	0,45820	0,49893	-0,03269
ZRINT2	-0,50236	-0,23602	0,28239	0,21360	-0,21157	-0,72236
ZIL21	-0,50015	-0,24167	0,20173	0,30876	-0,29644	0,68377
ZRBP1	0,42205	-0,21319	-0,46100	0,48750	-0,56323	-0,09495
Eigenvalue	3,2916	1,1565	0,7894	0,5504	0,1968	0,0154
% variation	54,86	19,27	13,16	9,17	3,28	0,26

The principal components (PCs) are used to restate equation **(13)** in terms of the original variables purged of multicollinearity. Standardised annual maize farm bankruptcy, ZBANKRM, is first regressed on PC_1, PC_2 and PC_3. These three PCs explain most (87,29 percent) of the variation in the explanatory variables (principal components PC_4, PC_5 and PC_6 were omitted as they showed the linear relationships between the explanatory variables which were the source of the multicollinearity, and resulted in instability in the model).

$$ZBANKRM = -0{,}444\ PC_1 + 0{,}217\ PC_2 - 0{,}231\ PC_3 \quad (14)$$

$$(-6{,}940)^{***} \quad (2{,}010)^{*} \quad (-1{,}770)^{*}$$

where adjusted R^2 = 70,40 percent, d = 0,991, degrees of freedom = 19, t-values are in parentheses, and *** and * indicate significance at the 1 percent and 10 percent levels respectively.

The Durbin-Watson d statistic falls in the inconclusive range (1 percent significance level), and the hypothesis of randomness is still accepted as the Geary test passed at the 1 percent significance level.

Following the same procedure outlined in equation **(8)**, the standardised maize farm bankruptcy model was estimated as:

$$ZBANKRM = -0{,}271\ ZRMP1 - 0{,}233\ ZWEA1 + 0{,}356\ ZLEV1 + 0{,}107\ ZRINT2 + 0{,}123\ ZIL21 - 0{,}127\ ZRBP1 \quad (15)$$

The leverage ratio, ZLEV1, is the most important explanatory variable, followed by the lagged real maize producer price, ZRMP1, lagged annual rainfall, ZWEA1, lagged real beef price, ZRBP1, the interaction term, ZIL21, and lagged real interest rate, ZRINT2. The amended OLS annual maize farm bankruptcy model in original scale was then estimated as follows:

$$BANKRM = 244{,}800 - 0{,}235\ RMP1 - 0{,}140\ WEA1 + 612{,}818\ LEV1 + 1{,}840\ RINT2 + 14{,}265\ IL21 - 0{,}082\ RBP1 \quad (16)$$

$$(-2{,}921)^{***} \quad (-2{,}779)^{**} \quad (4{,}271)^{***} \quad (1{,}933)^{*} \quad (2{,}512)^{**} \quad (-1{,}816)^{*}$$

where adjusted R^2 = 70,40 percent, t-values are shown in parentheses, and ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels respectively.

Comparing equations **(16)** and **(13)**, the adjusted R^2 falls slightly but the t-values increase markedly. All coefficients are now statistically significant and the WEA1 and RBP1 coefficient signs are correct.

3.4 Extensive beef farm bankruptcy model: 1970-1994

The preliminary OLS model is given by equation **(17)**:

$$BANKRB = \beta_0 + \beta_1\, RBP + \beta_2\, RINT + \beta_3\, LEV + \beta_4\, WEA + \beta_5\, RBS + \beta_6\, IL + e_t \qquad \textbf{(17)}$$

where BANKRB = annual number of bankrupt extensive beef farmers; RBP = lagged real beef producer price; RINT = lagged real commercial bank overdraft interest rate (again showing naive expectations); LEV = lagged farm sector leverage ratio; WEA = lagged annual rainfall in cattle grazing area (CCWR, 1996); RBS = lagged real stockfeed subsidies and transport rebates; IL = lagged interaction term (product of lagged RINT and lagged LEV, showing that higher real interest rates reduce asset values and hence raise leverage and potential bankruptcy), and e_t = disturbance term. LEV is again a reasonable proxy for extensive beef farm leverage as farm debt is concentrated in the summer rainfall and cattle grazing areas (Volkskas Bank, 1988; Human, 1989). Correlation coefficients were used to identify the most appropriate length of lag for the factors affecting BANKRB.

3.4.1 Correlation coefficients

A correlation matrix of the extensive beef farm bankruptcy model variables is shown in Table 3.6. BANKRB is negatively related to RBP1 (real beef price lagged one year, at the 15 percent significance level) and WEA4 (annual rainfall four years prior), but positively related to RINT3 (real interest rates lagged three years), LEV3 (farm leverage lagged three years), RBS3 (real beef subsidies lagged three years) and IL43 (product of real interest rates lagged four years and leverage lagged three years). These coefficient signs agree with *a priori* expectations. Multicollinearity is again likely to be a problem due to statistically significant pairwise correlations between most of the explanatory variables.

Table 3.6 Correlation coefficients between variables of the extensive beef bankruptcy model, 1970-1994.

	BANKRB	RBP1	RINT3	LEV3	WEA4	RBS3	IL43
BANKRB	1,0000						
RBP1	-0,3085	1,0000					
RINT3	0,5278**	-0,3221	1,0000				
LEV3	0,9158***	-0,3626*	0,5182***	1,0000			
WEA4	-0,6337***	0,4038*	-0,5716***	-0,6083***	1,0000		
RBS3	0,6319***	0,1929	0,4173**	0,5885***	-0,4473**	1,0000	
IL43	0,4121*	-0,0090	0,5876***	0,5689***	-0,3649*	0,4600**	1,0000

Note: ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels respectively.

The three and four year lags in the explanatory variables are expected as beef herds take from three to four years to build up (Directorate Agricultural Statistics, 1996). A real interest rate increase, for example, would therefore probably take a number of years to impact on farmers' destocking decisions.

3.4.2 Regression model

The initial extensive beef farm bankruptcy model estimated by OLS (GENSTAT, 1993) was:

$$BANKRB = 13{,}463 - 0{,}042\,RBP1 + 0{,}513\,RINT3 + 318{,}178\,LEV3 - 0{,}006\,WEA4 + 0{,}095\,RBS3 - 2{,}472\,IL43 \quad (18)$$
$$(-1{,}855)^{*} \quad (0{,}931) \quad (4{,}497)^{***} \quad (-0{,}372) \quad (2{,}006)^{*} \quad (-0{,}678)$$

where adjusted R^2 = 86,40 percent, d = 1,544, degrees of freedom = 14, t-values are in parentheses, and *** and * indicate significance at the 1 percent and 10 percent levels respectively.

Expected multicollinearity occurs in equation **(18)** as the IL43 coefficient is not statistically significant and has the wrong sign. The model has a high adjusted R^2 but the coefficients of variables RINT3 and WEA4 are not statistically significant. The Durbin-Watson d statistic falls in the inconclusive range, but the hypothesis of randomness is accepted (the Geary test passed at the 5 percent significance level). Extracted principal components to remedy multicollinearity are shown in Table 3.7.

Table 3.7 Principal components extracted for the extensive beef bankruptcy model, 1970-1994.

	Principal Component					
Variable	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6
ZRBP1	0,20901	0,77605	0,08287	0,26251	0,16217	0,50198
ZRINT3	-0,44715	-0,07394	-0,47238	0,55335	-0,57255	0,23684
ZLEV3	-0,48970	-0,03604	0,26170	-0,57255	-0,18101	0,57431
ZWEA4	0,44198	0,24607	-0,37438	-0,43112	-0,64285	-0,06950
ZRBS3	-0,40651	0,47060	0,43355	0,06505	-0,33541	-0,55551
ZIL43	-0,39492	0,33010	-0,61105	-0,32709	0,45390	-0,22062
Eigenvalue	2,968	1,292	0,694	0,528	0,353	0,165
% variation	49,46	21,54	11,57	8,80	5,88	2,76

Standardised annual beef farm bankruptcy, ZBANKRB, is regressed on PC_1 and PC_2. These two PCs explain 71 percent of the variation in the explanatory variables (the other components, as sources of the multicollinearity, were omitted), as per equation **(19)**:

$$ZBANKRB = -0{,}504\,PC_1 - 0{,}115\,PC_2 \qquad \textbf{(19)}$$

$$\qquad (-7{,}665)^{***} \quad (-1{,}152)$$

where adjusted R^2 = 74,40 percent, d = 1,082, degrees of freedom = 18, t-values are in parentheses, and *** indicates significance at the 1 percent level.

The Durbin-Watson d statistic falls in the inconclusive range (5 percent significance level), and the hypothesis of randomness is still accepted as the Geary test again passed at the 5 percent level.

Following the same procedure outlined in equation **(8)**, the standardised beef farm bankruptcy model was estimated as:

$$ZBANKRB = -0{,}195\ ZRBP1 + 0{,}234\ ZRINT3 + 0{,}251\ ZLEV3 - 0{,}251\ ZWEA4 + 0{,}151\ ZRBS3 + 0{,}161\ ZIL43 \quad (20)$$

Lagged leverage, ZLEV3, and lagged annual rainfall, ZWEA4, are the most important explanatory variables, followed by the lagged real interest rate, ZRINT3, lagged real beef producer price, ZRBP1, the interaction term, ZIL43, and lagged real subsidies ZRBS3. The amended OLS beef farm bankruptcy model in original scale was then estimated as:

$$\underset{}{BANKRB} = 42{,}269 - \underset{(-2{,}476)^{**}}{0{,}036\ RBP1} + \underset{(7{,}717)^{***}}{1{,}130\ RINT3} + \underset{(7{,}744)^{***}}{126{,}473\ LEV3} - \underset{(-6{,}603)^{***}}{0{,}035\ WEA4} + \underset{(2{,}798)^{***}}{0{,}053\ RBS3} + \underset{(3{,}848)^{***}}{5{,}367\ IL43} \quad (21)$$

where adjusted $R^2 = 74{,}40$ percent, t-values are shown in parentheses, and *** and ** indicate significance at the 1 percent and 5 percent levels respectively.

When equations **(18)** and **(21)** are compared, the adjusted R^2 falls but remains relatively high, the t-values increase markedly and all estimated coefficients are highly statistically significant.

The regression coefficient estimates in equations **(11)**, **(16)** and **(21)** are biased as some information was lost by dropping respective principal components, but the new estimates are more precise (smaller mean square errors) than the OLS estimates in equations **(5)**, **(13)** and **(18)** respectively (McCallum, 1970; Chatterjee and Price, 1977: 175; Doran, 1989: 106). Therefore, in this study, principal component regression offers an option for improving upon conventional estimation techniques in overcoming multicollinearity.

IMPLICATIONS AND CONCLUSIONS

The aggregate farm bankruptcy rate in South Africa for the period 1948 to 1994 was positively related to the lagged aggregate farm debt/asset (leverage) ratio, lagged real interest rates (financial risk factors), and drought conditions, and negatively related to real agricultural subsidies (business risk factors). An aggregate model for the period 1970 to 1994 showed similar results; however, farm bankruptcy was also positively related to an interaction term between real interest rates and the aggregate farm leverage ratio, which captured how rising real interest rates increase leverage (reduce asset values) and hence the likelihood of bankruptcy.

Higher lagged aggregate farm debt/asset ratios and lagged real interest rates (financial risk), and lower annual rainfall (business risk) increased bankruptcies of South African maize and extensive beef farmers over the period 1970 to 1994. Farm bankruptcies in both sectors were also negatively related to the lagged real producer prices (business risk). Bankruptcy of extensive beef farmers was positively related to lagged real stockfeed purchase subsidies and transport rebates (business risk). Bankruptcies of both farm types were positively related to an interaction term between real interest rates and the aggregate leverage ratio. Bankruptcy is therefore a dynamic process, with a time lag between the incidence of these factors and ultimate farm failure. Lags for the extensive beef farmers are longer than for maize farmers, probably due to the longer production cycle for beef and beef farmers being able to increase liquidity via stock sales.

When estimated standardised coefficients for the four models are compared, the aggregate farm debt/asset ratio is the most important determinant of farm bankruptcies (except for the aggregate model, 1970 to 1994, where the aggregate farm debt/asset ratio was the second most important explanatory variable). Shepard and Collins (1982) and Chan and Rotenberg (1988) both showed leverage was an important determinant of farm bankruptcy in the US and Canada respectively. Higher leverage probably reflects a combination of (1) poor borrowing decisions by eventual bankrupts, (2) past tax policy measures (for example, accelerated depreciation allowances on machinery investments) which may have contributed to increased debt use and farm bankruptcies, and (3) past monetary policy (negative real interest rates) which made borrowing attractive.

The next most important factor affecting aggregate bankruptcy was real government support (subsidies). There was a negative relationship between aggregate farm bankruptcy and government support (lagged one year). Therefore, government supports in one year may forestall farm bankruptcies in the short-term, delaying bankruptcies to later years.

The adjusted R^2 for all four models is relatively high (ranging from 70,40 percent to 90,84 percent), indicating a good fit by the chosen explanatory variables. Variation not accounted for by the explanatory variables may be partly due to characteristics of individual farmers (for example, poor financial management skills) which could not be quantified.

Changes in Maize Board maize producer price policy from 1987/88 created another source of risk for maize farmers to manage as lower real maize prices led to more bankruptcies. Recent further deregulation of domestic maize pricing means that maize farmers must give more attention to managing price risk, possibly by forward contracting, electronic marketing, hedging a portion of their maize crop via futures contracts on the new South African Futures Exchange (SAFEX) or enterprise diversification. Producer price and rainfall effects on extensive beef farmers emphasise the need to build up fodder banks to counter drought, and possibly use forward contracting and hedging a portion of their intended beef sales via the recently introduced beef futures contracts to manage price risk.

A positive relationship between bankruptcy rates and government support (stockfeed purchase subsidies and transport rebates) intended to help extensive beef farmers led to more risk and potential bankruptcy for some of these farmers in the long-term. Input subsidies are perceived by policy makers as helping farmers to reduce production costs. However, this could have led to beef production in less suitable areas with less comparative advantage, and hence more farm bankruptcies.

Macroeconomic policy changes towards more market-related real interest rates directly affected commercial farmers by raising financing costs and indirectly raising leverage and potential bankruptcy. Stable monetary policy *over time* can thus contribute to stability in the agricultural sector, particularly for indebted maize and beef farmers. Highly leveraged farmers are particularly vulnerable to higher interest rates associated with deflationary monetary policy. Farmers must closely monitor changes in agricultural price, trade and macroeconomic policies in order to form accurate expectations of potential bankruptcy causes and improve management of debt and business and financial risk at farm level. Extension personnel, consultants and lenders need to advise clients on the relationship between net farm income, interest costs and leverage levels for successful debt management. Farmers could use improved information now available from local researchers on forecasting short-term regional weather patterns to better manage recurring droughts (for example, reduce fertilizer input at planting if below average rainfall is expected).

Available data limited the study to analysis of farm bankruptcies at aggregate, maize and extensive beef sector level, but more research is needed on why bankruptcies occurred in other enterprise types in South Africa (for example, wool and dairy). More research is also needed on the *individual* characteristics of bankrupt farmers. For example, are farmers operating relatively larger farms going bankrupt? and are younger, more leveraged farmers, or those less able to manage business and financial risk, failing? These important unanswered questions stress the need for improved cross-section and time series data bases on individual farmer attributes.

If highly leveraged farmers have borrowed more debt than they can realistically service in a changing agricultural and macroeconomic policy environment, major financial restructuring must occur. Therefore, the rise in farm bankruptcies in South Africa during 1948 to 1994 may have been a necessary financial adjustment for South African agriculture.

SUMMARY

Commercial farm bankruptcies in South Africa have increased sharply over the period 1948 to 1994 against a background of rising debt levels, fluctuating real interest rates, drought and declining real government support. Aggregate farm bankruptcies rose from 0,016 percent of all farms in 1948 (18 farms) to 0,632 percent of all farms in 1994 (389 farms). The increase has been particularly marked since the 1980s. The annual number of maize farms and extensive beef farms declared bankrupt in South Africa rose sharply from 1970 to 1994. Bankrupt maize farms increased from 16 to around 150 farms per year over this period, while bankrupt extensive beef farms increased from 12 to about 50 per year over the same period. While the rate of bankruptcies is relatively low, the substantial rise in the number of bankrupt farms is of concern.

Farm bankruptcy is costly and gives rise to demands for government assistance to alleviate financial stress for farmers and to provide relief for creditors, so it is appropriate to ask why these farmers failed. Research into farm bankruptcy can thus help to identify appropriate future policy and management measures. Past farm bankruptcy studies in developed countries and farm bankruptcy and farm financial stress studies in South Africa show similar trends in, and causes of, farm bankruptcies.

The object of this study was to identify factors affecting aggregate, maize and extensive beef farm bankruptcy in South Africa. These factors were separated into business risk and financial risk components. Business risk refers to risk inherent in a business independent of the way the business is financed and is reflected in the variability of net operating income.

Financial risk reflects added variability of net cash flows arising from fixed financial obligations associated with debt financing.

Due to data availability and enterprise importance, aggregate farm bankruptcies were modelled for the period 1948 to 1994, maize and extensive beef farm bankruptcies were analysed for 1970 to 1994, and for comparison with the product sector models, aggregate farm bankruptcies were also modelled between 1970 and 1994.

Farm bankruptcy amongst aggregate, maize and extensive beef farms was positively related to higher lagged aggregate farm debt/asset ratios and lagged real interest rates (financial risk factors). Lower lagged annual rainfall due to recurring drought (business risk factor) increased the likelihood of farm bankruptcy. In the aggregate model, increased government support (business risk factor) reduced farm bankruptcy in the short-term. Stockfeed purchase subsidies and transport rebates (business risk factor) increased extensive beef farm bankruptcies in the long-term. A decrease in real maize and beef producer prices (business risk factors) led to an increase in maize farm bankruptcies, while lower real producer prices increased the likelihood of extensive beef farm bankruptcies. Therefore, changes in Maize Board maize producer price policy from 1987/88 created another source of risk for maize farmers to manage. Beef and maize farmers should therefore give more attention to managing price risk via methods such as forward contracting or futures contracts. An interaction term capturing the effects of changes in real interest rates on asset values, leverage and potential bankruptcy, significantly increased bankruptcies in the product sector and aggregate models from 1970 to 1994.

Farmers will need to closely monitor agricultural policy and macroeconomic trends to form accurate expectations of potential bankruptcy causes. This, in turn, can lead to improved management of debt and business and financial risk at farm level. The sharp rise in farm bankruptcies in South Africa in the past may have been an unavoidable financial adjustment in response to high aggregate farm leverage levels which could not be sustained.

REFERENCES

BARRY, PJ, ELLINGER, PN, HOPKIN, JA and BAKER, CB. (1995). Financial Management in Agriculture. Fifth edition. Interstate Publishers, Danville, Illinois.

BOESSON, CR, FEATHERSTONE, AM, LANGMEIER, LN and BURTON, RO. (1990). Financial Performance of Successful and Unsuccessful Farms. *Journal of the American Society of Farm Management and Rural Appraisers*, Vol. 54(1): 6-15.

BRAKE, JR. (1983). Financial Crisis in Agriculture: Discussion. *American Journal of Agricultural Economics*, Vol. 65(5): 953-954.

CCWR. (1996). Computing Centre for Water Research, University of Natal, Pietermaritzburg. Personal communication.

CENTRAL STATISTICAL SERVICE. (1964). *Statistical Year Book*, Central Statistical Service, Pretoria.

CENTRAL STATISTICAL SERVICE. (1972 and 1994). *South African Statistics*, Central Statistical Service, Pretoria.

CENTRAL STATISTICAL SERVICE. (1988*a*). *Statistics on a Regional Basis, Development Regions, C (Orange Free State), Census of Agriculture 1988*. Central Statistical Service, Pretoria.

CENTRAL STATISTICAL SERVICE. (1988*b*). *Statistics on a Regional Basis, Development Regions, F,G, H and J (Transvaal), Census of Agriculture 1988.* Central Statistical Service, Pretoria.

CENTRAL STATISTICAL SERVICE. (1992). *Agriculture Survey, 1992.* Central Statistical Service, Pretoria.

CENTRAL STATISTICAL SERVICE. (1995). *CSS Bulletin of Statistics*, Vol. 29(30). Central Statistical Service, Pretoria.

CHAN, MWL and ROTENBERG, WD. (1988). Financial Distress in the Canadian Agricultural Sector: A Macro Analysis. *Canadian Journal of Agricultural Economics*, Vol. 36: 531-538.

CHATTERJEE, S. and PRICE, B. (1977). *Regression Analysis by Example*. John Wiley and Sons, New York.

COLLINS, RA. (1985). Expected Utility, Debt-Equity Structure and Risk Balancing. *American Journal of Agricultural Economics*, Vol. 67(3): 627-629.

CURZON, LB. (1979). *A Dictionary of Law*. Macdonald and Evans, Plymouth, Devon.

DAVIES, AS. (1996). Insolvency in Agriculture: Bad Managers or the Common Agricultural Policy? *Applied Economics*, Vol. 28: 185-193.

DE JAGER, F and SWANEPOEL, V. (1994). Factors Associated with Farm Financial Failure in the Northern Springbok Flats. *Agrekon*, Vol. 33(4): 242-247.

DE KOCK COMMISSION. (1985). *The Monetary System and Monetary Policy in South Africa: Final Report of the Commission of Inquiry*. Government Printer, Pretoria.

DENT, MC, SCHULTZ, RE, WILLS, HMM and LYNCH, SD. (1987). Spatial and Temporal Analysis of the Recent Drought in the Summer Rainfall Region of Southern Africa. *Water SA*, Vol. 13(1): 37-42.

DEVADOSS, S. (1985). *The Impacts of Monetary Policies on U.S. Agriculture*. Unpublished PhD Thesis, Iowa State University, Ames, Iowa.

DIRECTORATE AGRICULTURAL ECONOMICS. (1994). *COMBUD Enterprise Budgets: Transvaal Region, Part 2*, Government Printer, Pretoria.

DIRECTORATE AGRICULTURAL ECONOMIC TRENDS. (1971 and 1995). *Abstract of Agricultural Statistics*, Government Printer, Pretoria.

DIRECTORATE AGRICULTURAL STATISTICS. (1996). *Abstract of Agricultural Statistics*, Government Printer, Pretoria.

DIRECTORATE FINANCIAL ASSISTANCE. (1996). *Financial Assistance Schemes of the Department of Agriculture*, Directorate Financial Assistance, Pretoria.

DODSON, CB and COVEY, T. (1993). The Impacts of Interest Rates on Farm Businesses. *Agricultural Income and Finance*, Vol. 49: 27-30.

DORAN, HE. (1989). *Applied Regression Analysis in Econometrics*. Marcel Dekker, Inc., New York.

DRABENSTOTT, M. (1983). Financial Crisis in Agriculture: Discussion. *American Journal of Agricultural Economics*, Vol. 65(5): 955-957.

DUSHMANITCH, VY and DARROCH, MAG. (1990). An Economic Analysis of the Impacts of Monetary Policy on South African Agriculture. *Agrekon*, Vol. 29(4): 269-283.

DU TOIT, K. (1996). South African Agricultural Union, Pretoria. Personal communication.

FAMINOW, MD and LAUBSCHER, JM. (1991). Empirical Testing of Alternative Price Spread Models in the South African Maize Market. *Agricultural Economics*, Vol. 6: 49-66.

FEATHERSTONE, AM, MOSS, CB, BAKER, TG and PRECKEL, PV. (1988). The Theoretical Effects of Farm Policies on Optimal Leverage and the Probability of Equity Losses. *American Journal of Agricultural Economics*, Vol. 70(3): 572-579.

GABRIEL, SC and BAKER, CB. (1980). Concepts of Business and Financial Risk. *American Journal of Agricultural Economics*, Vol. 62(3): 560-564.

GENSTAT. (1993). *Genstat 5. Release 3.1.* Lawes Agricultural Trust, Rothamsted Experimental Station, United Kingdom.

GUJARATI, DN. (1995). *Basic Econometrics*. Third edition. McGraw-Hill, New York.

HARRISON, A and TRANTER, R. (1994). Farming through the Recession. *Farm Management*, Vol. 8(12): 550-562.

HATCH, GP. (1994). *The Bioeconomic Implications of Various Stocking Strategies in the Semi-Arid Savanna of Natal.* Unpublished PhD Thesis, University of Natal, Pietermaritzburg.

HUGHES, DW, RICHARDSON, JW and RISTER, ME. (1985). Effects of Sustained Financial Stress on the Financial Structure and Performance of the Farm Sector. *American Journal of Agricultural Economics*, Vol. 67(5): 1116-1122.

HUMAN, CJF. (1989). The Implications of Fiscal and Monetary Policy on Management in South Africa. *Agrekon*, Vol. 28(1): 9-13.

INTERNATIONAL MONETARY FUND. (1995). *International Financial Statistics Yearbook*. International Monetary Fund, Washington, DC.

ISLAM, N and SUBRAMANIAN, A. (1989). Agricultural Exports of Developing Countries: Estimates of Income and Price Elasticities of Demand And Supply. *Journal of*

Agricultural Economics, Vol. 49: 221-231.

JACOBS, AS. (1984). Possible Developments in South African Agriculture. *Agrekon*, Vol. 23(2): 5-8.

JACOBS, AS. (1985). Strategic Planning and Adaptations: Financing. *Agrekon*, Vol. 24(1): 14-17.

JOHNSON, AT. (1989). Agricultural Financing and Monetary Policy. *Business Alert*, No. 110, Wits Business School, Johannesburg.

JOHNSTON, WE and FRENGLEY, GAG. (1990). Financial Stress on New Zealand Sheep and Beef Farms: Analysis of Change in Financial Performance under Deregulation. *Agricultural Finance Review*, Vol. 50: 100-111.

JOLLIFFE, IT. (1986). *Principal Component Analysis*. Springer-Verlag, New York.

JOLLY, RW, PAULSEN, A, JOHNSON, JD, BAUM, KH and PRESCOTT, R. (1985). Incidence, Intensity, and Duration of Financial Stress among Farm Firms. *American Journal of Agricultural Economics*, Vol. 67(5): 1108-1115.

KENDALL, MG. (1957). *A Course in Multivariate Analysis*. Griffin, London.

LAND BANK. (various years). *Annual Report of the Board of the Land and Agricultural*

Bank of South Africa, Pretoria.

LEATHERS, HD and CHAVAS, JP. (1986). Farm Debt, Default and Foreclosure: An Economic Rationale for Policy Action. *American Journal of Agricultural Economics*, Vol. 68(4): 828-837.

LESLIE, JR and DARROCH, MAG. (1993). Components of Financial Stress on Selected Eastern Orange Free State and Natal Farms. *South African Journal of Economic and Management Sciences*, Vol. 11: 1-12.

LINS, DA and DUNCAN, M. (1980). Inflation Effects on Financial Performance and Structure of the Farm Sector. *American Journal of Agricultural Economics*, Vol. 62(5): 1049-1053.

LOUW, A. (1995). *Expanding the Role of Private Financial Institutions in the Creation of a More Financially Viable Agricultural Sector*. Paper presented at AGRI-TECH Conference, August 1995. CSIR Conference Centre, Pretoria.

MACVICAR, CN. (1996). Secretary, KwaZulu-Natal Department of Agriculture. Personal communication.

MADDALA, GS. (1977). *Econometrics*. McGraw-Hill, New York.

MCCALLUM, BT. (1970). Artificial Orthogonalization in Regression Analysis. *Review* *of Economics and Statistics*, Vol. 52: 110-113.

MILTON, JRL. (1995). Director and Professor, School of Law, University of Natal, Pietermaritzburg. Personal communication.

MISHKIN, FS. (1988). Understanding Real Interest Rates. *American Journal of Agricultural Economics*, Vol. 70(2): 1064-1072.

MURDOCK, SH and LEISTRITZ, FL. (1988). *The Farm Financial Crisis: Socioeconomic Dimensions and Implications for Producers and Rural Areas*. Westview Special Studies in Agricultural Science and Policy, Boulder, Colorado.

NIEUWOUDT, WL. (1985). *Agricultural Policy, The Economic Perspective*. Inaugural lecture delivered at the University of Natal, Pietermaritzburg.

PASOUR, EC, Jr. (1990). *Agriculture and the State: Market Processes and Bureaucracy*. First edition. Holmes and Meier, New York.

PENSON, JB. (1987). Evaluating Financial Trends in Agriculture. *Agricultural Finance Review*, Vol. 47: 14-20.

RAUSSER, GC. (1985). Macroeconomics and U.S. Agricultural Policy. In Gardner, BL, (Ed.), *US Agricultural Policy: The 1985 Farm Legislation*: 207-252. American Enterprise Institute for Public Policy Research, Washington, DC.

RAUSSER, GC. (1988). Stability Issues and Policy Analysis. In Sumner, DA, (Ed.), *Agriculture Stability and Farm Program: Concepts, Evidence and Implications*: 143-170. Westview Special Studies in Agricultural Science and Policy, Boulder, Colorado.

RUCKER, RR and ALSTON, LJ. (1987). Farm Failures and Government Intervention: A Case Study of the 1930s. *American Economic Review*, Vol. 77(4): 724-730.

SHEPARD, LE. (1986). The Farm Debt Crisis: Temporary or Chronic? *Contemporary Policy Issues*, Vol. 4(1): 62-71.

SHEPARD, LE and COLLINS, RA. (1982). Why Do Farmers Fail? Farm Bankruptcies 1910-1978. *American Journal of Agricultural Economics*, Vol. 64(4): 609-615.

SHONKWILER, JS and MOSS, CB. (1993). A Multidimensional Index of Financial Stress in the Farm Sector. *Social Indicators Research*, Vol. 29: 307-316.

SOUTH AFRICAN RESERVE BANK. (various years). *South African Reserve Bank Quarterly Bulletin of Statistics*, Pretoria.

SPSS. (1995). *Statistical package for Social Sciences, Release 4.0, for Sun 4 (Unix)*. SPSS Incorporated.

STANDARD BANK. (January 1994). *AgriReview*. Agricultural Department, Commercial Services Division, Standard Bank of South Africa.

STARLEAF, DR, MEYERS, WH and WOMACK, AW. (1985). The Impact of Inflation on the Real Income of US Farmers. *American Journal of Agricultural Economics*, Vol. 67(2): 384-389.

STEENKAMP, E. Directorate Marketing, Department of Agriculture, Pretoria. Personal communication.

TOMEK, WG and ROBINSON, KL. (1991). *Agricultural Product Prices*. Third edition. Cornell University Press, Ithaca.

TWEETEN, LG. (1985). Farm Financial Stress, Structure of Agriculture and Public Policy. In Gardner, BL, (Ed.), *US Agricultural Policy: The 1985 Farm Legislation*: 83-112. American Enterprise Institute for Public Policy Research, Washington, DC.

VAN NIEKERK, T. (1995). NAMPO, Bothaville. Personal communication.

VAN ZYL, J, VAN DER VYVER, A and GROENEWALD, JA. (1987*b*). The Influence of Drought and General Economic Effects on Agriculture: A Macro Analysis. *Agrekon*, Vol. 26(1): 8-12.

VAN ZYL, J, VAN DER VYVER, A and MOSTERT, CW. (1987*a*). The Effect of Debt burden, Interest Rates and Inflation on the Survival of Farming Enterprises: A Case Study in the Western Transvaal and the North-Western Bushveld. *Agrekon*, Vol. 26(1): 1-7.

VOLKSKAS BANK. (March 1988). *Economic Spotlight*. Volkskas Registered Bank.

WALKER, DM. (1980). *The Oxford Companion to Law*. Oxford University Press, New York.

ZUCCHINI, W and ADAMSON, PT. (1984). *The Occurrence and Severity of Droughts in South Africa*. Report to the Water Research Commission, Department of Civil Engineering, University of Stellenbosch, Stellenbosch.

APPENDIX

Table A.1 Data used for the farm bankruptcy models, 1948-1994 and 1970-1994.

Year	Aggregate farm bankruptcy number	Total farm number	Farm bankruptcy ratio (%)	Farm debt (R million)	Farm asssets (R million)	Farm debt/ asset ratio	CPI (1990=100)
1948	18	115723	0,016	70,366	2239,6	0,031	4,6
1949	28	117242	0,024	85,187	2508,2	0,034	4,8
1950	25	116848	0,021	80,068	2690,1	0,030	5,0
1951	19	118186	0,016	92,882	3066,5	0,030	5,3
1952	17	119556	0,014	116,694	3381,5	0,035	5,8
1953	17	119198	0,014	107,848	3680,0	0,029	6,0
1954	13	115416	0,011	131,082	3731,0	0,035	6,1
1955	33	111586	0,030	169,524	3987,2	0,043	6,3
1956	37	108883	0,034	190,813	4100,5	0,047	6,4
1957	50	103059	0,046	208,690	4299,8	0,049	6,6
1958	66	104093	0,063	222,386	4379,1	0,051	6,8
1959	77	106220	0,072	222,655	4697,9	0,047	6,9
1960	85	105859	0,080	289,414	4790,2	0,060	7,0
1961	80	105152	0,076	312,005	4845,8	0,064	7,1
1962	118	106011	0,111	328,627	5109,1	0,064	7,3
1963	82	104681	0,078	341,340	5386,4	0,063	7,4
1964	71	101387	0,070	350,024	6376,5	0,055	7,5
1965	69	95438	0,072	343,930	6772,0	0,051	7,8
1966	86	94146	0,091	359,834	6869,2	0,052	8,1
1967	75	92853	0,081	417,252	8175,8	0,051	8,3
1968	68	92908	0,073	582,891	8813,8	0,066	8,5
1969	75	91855	0,082	549,212	9057,2	0,061	8,7
1970	53	91139	0,058	634,941	9201,9	0,069	9,2
1971	86	90422	0,095	691,561	10199,0	0,068	9,8
1972	91	86092	0,106	821,261	11100,6	0,074	10,4
1973	79	81935	0,096	904,247	12633,8	0,072	11,4
1974	55	79855	0,069	884,378	14968,2	0,059	12,7
1975	63	77591	0,082	1185,502	16974,3	0,070	14,4
1976	61	75562	0,081	1397,851	18981,5	0,074	16,0
1977	92	73592	0,125	1621,224	21569,9	0,075	17,8
1978	116	71621	0,162	1858,982	22741,7	0,082	19,8
1979	84	69360	0,121	2104,242	25225,0	0,083	22,4
1980	65	69372	0,094	2396,468	27578,9	0,087	25,5
1981	40	64430	0,062	3023,872	29573,5	0,102	29,4
1982	107	62195	0,172	4321,625	33053,1	0,138	33,7
1983	87	59960	0,145	4949,909	36259,2	0,137	37,8
1984	76	62920	0,121	5726,591	38709,0	0,148	42,2
1985	141	65880	0,214	6044,533	39822,9	0,174	49,1
1986	243	64810	0,375	7567,217	47574,0	0,159	58,2
1987	317	65170	0,486	8255,396	54300,9	0,152	67,6
1988	261	62428	0,418	8611,910	60216,5	0,143	76,2
1989	202	62256	0,324	9309,198	64942,6	0,143	87,4
1990	267	62084	0,430	9950,802	67005,1	0,149	100,0
1991	387	61900	0,625	9475,303	67438,3	0,141	115,3
1992	386	61564	0,627	9984,229	65791,6	0,152	131,3
1993	316	61564	0,513	10970,660	67495,7	0,163	144,1
1994	389	61564	0,632	10589,720	69966,8	0,151	157,0

Sources: Central Statistical Service (1964, 1972, 1994 and 1995); Directorate Agricultural Economic Trends (1971 and 1995); Directorate Agricultural Statistics (1996).

Table A.2 Data used for the farm bankruptcy models, 1948-1994 and 1970-1994.

Year	Interest rate (%)	Real interest rate (%)	Farm subsidies (R million)	Real farm subsidies (R million) (1990=100)	Total production index (1990=100)	Total production index residuals
1948	4,500	-0,045	11,8	256,522	29	0,946
1949	4,600	0,252	16,2	337,500	31	1,679
1950	5,000	0,833	19,4	388,000	34	2,411
1951	5,000	-1,000	24,7	466,038	32	-1,421
1952	5,380	-4,054	28,0	482,759	36	1,138
1953	5,500	2,052	33,0	550,000	38	1,566
1954	5,500	3,833	31,4	514,754	39	0,777
1955	5,625	2,346	34,2	542,857	41	1,510
1956	6,000	4,413	30,9	482,813	44	1,939
1957	6,000	2,875	30,9	468,182	42	-1,285
1958	6,290	3,260	30,5	448,529	46	1,013
1959	6,000	4,529	31,9	462,319	48	1,311
1960	6,188	4,739	30,5	435,714	42	-6,391
1961	7,513	6,084	30,8	433,803	46	-4,093
1962	6,208	3,391	32,8	449,315	48	-3,795
1963	5,500	4,130	39,1	528,378	50	-3,497
1964	5,729	4,378	40,0	533,333	49	-6,199
1965	6,917	2,917	41,7	534,615	48	-8,901
1966	7,458	3,612	50,7	625,926	52	-6,603
1967	8,000	5,531	67,6	814,458	66	5,695
1968	7,854	5,444	72,9	857,647	57	-5,006
1969	7,750	5,397	73,1	840,230	60	-3,709
1970	7,823	2,076	65,8	715,217	60	-5,411
1971	8,503	1,981	92,5	943,877	69	1,887
1972	8,563	2,441	88,2	848,077	72	3,185
1973	7,844	-1,771	90,8	796,491	59	-11,517
1974	1,167	-1,237	75,6	595,276	77	4,781
1975	11,833	-1,553	106,8	741,667	76	2,079
1976	12,208	1,097	146,3	914,375	77	1,377
1977	12,000	0,750	158,7	891,573	83	5,675
1978	12,192	0,956	143,3	723,737	87	7,973
1979	10,125	-3,006	121,2	541,071	86	5,271
1980	9,500	-4,339	174,6	684,706	91	8,569
1981	13,583	-1,711	255,9	870,408	100	15,867
1982	18,500	3,874	297,4	882,493	93	7,165
1983	16,561	4,395	302,9	801,323	81	-6,537
1984	22,250	10,610	478,1	1132,938	88	-1,238
1985	21,779	5,428	502,5	1023,422	93	2,060
1986	14,599	-3,934	507,3	871,650	92	-0,643
1987	12,458	-3,693	345,1	510,503	95	0,656
1988	15,209	2,487	583,4	765,617	99	2,954
1989	19,709	5,011	288,1	329,633	106	8,252
1990	21,000	6,584	197,8	197,800	100	0,550
1991	20,313	5,013	170,0	147,442	104	2,848
1992	18,917	5,040	165,1	125,743	87	-15,854
1993	16,257	6,508	119,4	82,859	97	-7,556
1994	15,500	6,548	197,4	125,733	100	-6,258

Sources: Directorate Agricultural Economic Trends (1971 and 1995); Directorate Agricultural Statistics (1996); South African Reserve Bank (various years).

Table A.3 Additional data used for the maize farm bankruptcy model, 1970-1994.

Year	Maize farm bankruptcy number	Maize price (R/t)	Real maize price (R/t) (1990=100)	Annual rainfall (mm)
1970	16	37,37	406,20	588,700
1971	29	40,10	409,18	746,000
1972	33	45,50	437,50	531,200
1973	36	57,00	500,00	728,525
1974	13	62,00	488,19	709,625
1975	14	65,00	451,39	828,525
1976	15	73,60	460,00	783,675
1977	40	79,95	449,16	690,500
1978	57	100,15	505,81	586,125
1979	51	118,25	527,90	648,300
1980	13	118,25	463,73	698,575
1981	14	134,05	455,95	604,725
1982	34	167,55	497,18	452,450
1983	33	218,55	578,17	633,875
1984	43	218,60	518,00	530,325
1985	122	240,35	489,51	504,675
1986	205	258,00	443,30	626,925
1987	173	260,00	384,62	805,825
1988	129	264,00	346,46	617,875
1989	89	302,67	346,30	716,050
1990	153	357,62	357,62	499,950
1991	185	452,81	392,72	535,425
1992	194	417,00	317,59	452,775
1993	143	370,00	256,76	674,800
1994	112	700,00	286,62	408,550

Sources: CCWR (1996); Directorate Agricultural Statistics (1996); Van Niekerk (1995).

Table A.4 Additional data used for the extensive beef farm bankruptcy model, 1970-1994.

Year	Beef farm bankruptcy number	Beef price (c/kg)	Real beef price (c/kg) (1990=100)	Annual rainfall (mm)	Beef subsidies (R million)	Real beef subsidies (R million) (1990=100)
1970	12	44,90	488,04	220,240	3,5	38,043
1971	2	44,40	453,06	463,750	12,6	128,571
1972	10	58,60	563,46	506,440	3,8	36,538
1973	6	80,70	707,89	435,220	2,4	21,053
1974	8	89,30	703,15	453,600	2,2	17,323
1975	7	87,20	605,56	466,620	2,1	14,583
1976	16	93,60	585,00	446,060	2,3	14,375
1977	13	93,50	525,28	469,300	3,0	16,854
1978	14	96,90	489,39	641,640	4,0	20,202
1979	20	119,00	531,25	277,340	1,6	7,143
1980	9	202,40	793,73	668,320	6,3	24,706
1981	6	212,20	721,77	367,240	19,7	67,007
1982	10	211,40	627,30	222,120	17,2	51,039
1983	9	222,90	589,68	240,480	28,0	74,074
1984	14	228,40	541,23	312,450	73,5	174,170
1985	35	257,30	524,03	403,000	89,7	182,688
1986	52	353,40	607,22	240,800	74,3	127,663
1987	62	451,60	668,05	254,250	45,1	66,716
1988	50	482,60	633,33	233,900	76,0	99,738
1989	46	473,70	541,99	266,950	76,1	87,071
1990	46	474,90	474,90	238,350	15,9	15,900
1991	48	522,90	453,51	306,000	10,0	8,673
1992	54	521,60	397,26	204,100	65,1	49,581
1993	39	594,40	412,49	235,500	119,4	82,859
1994	35	827,00	526,75	266,500	160,8	102,420

Sources: CCWR (1996); Directorate Agricultural Statistics (1996); Van Niekerk (1995).