Causes of Bankruptcy amongst Maize and Extensive Beef Farmers in South Africa: 1970-1994

D S Swanepoel, G F Ortmann and **M A G Darroch**

Department of Agricultural Economics, University of Natal, Pietermaritzburg

ABSTRACT

The number of maize farms and extensive beef farms annually declared bankrupt in South Africa rose sharply over the period 1970 to 1994. Principal components regression confirmed *a priori* expectations that maize farm and extensive beef farm bankruptcies were negatively related to annual rainfall (business risk factor), but positively related to the lagged aggregate farm debt/asset ratio and lagged real interest rates (financial risk factors). Maize farm bankruptcies also increased as lagged real maize and beef producer prices fell (business risk factors). Beef farm bankruptcies rose with lower lagged real beef producer prices and higher lagged real stockfeed subsidies and transport rebates (business risk factors). Part of the rise in maize and extensive beef farm failures between 1970 and 1994 can therefore be ascribed to changed agricultural price and macroeconomic policies

INTRODUCTION

The number of maize farms and extensive beef farms annually declared bankrupt in South Africa rose sharply over the period 1970 to 1994. Bankrupt maize farms increased from 16 to around 150 farms per year, 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, 1988a and 1988b; Directorate Agricultural Statistics, 1996, p.110). While the rate of bankruptcy for both farm types is relatively low, the marked rise in the number of bankrupt farms is of concern. Maize is the major field crop in

South Africa comprising some 40 per cent by value of all field crops, and about nine per cent of the gross value of all agricultural products in 1994/95. Beef constituted approximately 37 per cent of the gross value of animal products, and approximately 11 per cent 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. 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 (Human, 1989; Volkskas Bank, 1988), research on the causes of farm failure can help to identify appropriate future policy and management measures to avoid having to reorganise an insolvent business or liquidate the business and pay creditors (Barry *et al.*, 1995, p. 557).

Shepard and Collins (1982) studied aggregate United States (US) farm sector bankruptcy data over the period 1910 to 1978. 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 (variable real net farm income). Agricultural support payments since World War II did not induce, defer or reduce farm failures. Chan and Rotenberg (1988) identified financial leverage and energy-related expenses as key causes of farm loan arrears and ultimate bankruptcy in Canada during 1979 to 1986. 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.

In South Africa, Van Zyl *et al.* (1987) found that the initial farm solvency position, nominal interest rates and inflation together affected survival of 'typical' Western Transvaal and North-Western Transvaal Bushveld farms. Leslie and Darroch (1993) reported that successful farms (positive long-run real return on equity) in Natal, the Eastern Orange Free State and Western Transvaal in 1993 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. De Jager and Swanepoel (1994) identified insolvent farmers in the Northern Springbok Flats during 1990 as having higher directly allocatable costs, relatively more carry-over debt, liquidity problems, less land as collateral and lower gross farm incomes relative to long-term debt.

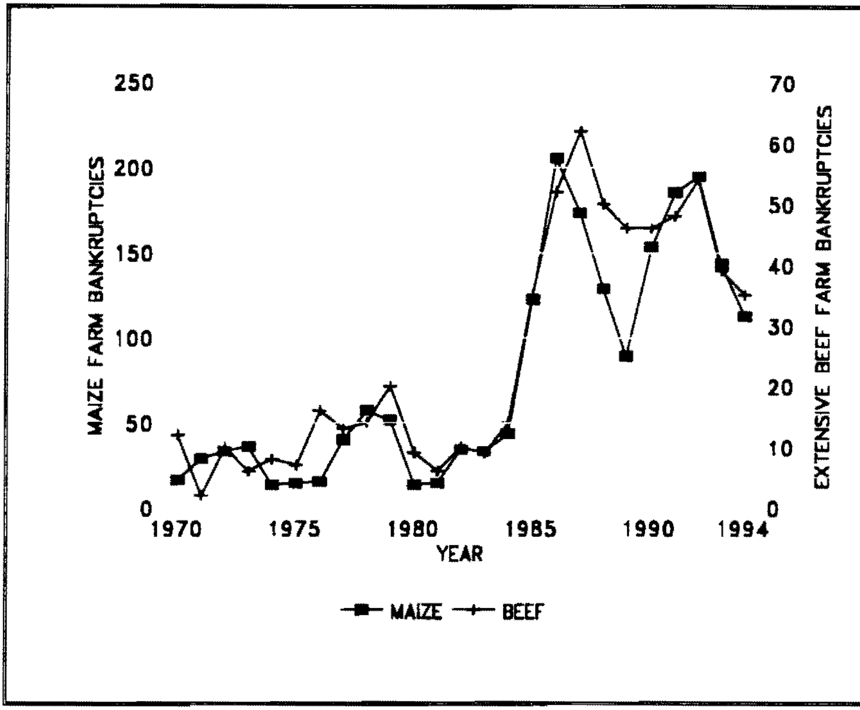
Given that no published study, to the authors' knowledge, has yet analysed causes of farm bankruptcy at a product sector level, this paper considers sources of business and financial risk which may have caused maize and extensive beef farm bankruptcies in South Africa to rise since 1970. Bankruptcy trends and possible causes are outlined in the next two sections, after which research methodology and results are reported. A concluding section considers the management and policy implications of the results.

TRENDS IN BANKRUPTCIES OF MAIZE AND EXTENSIVE BEEF FARMERS IN SOUTH AFRICA: 1970-1994

Figure 1 shows trends in annual maize and extensive beef farm bankruptcies in South Africa during 1970-1994 for the areas defined by the Directorate Agricultural Statistics (1996, p.110) as summer rainfall and cattle grazing areas respectively.

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 12 farms in 1970 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 level of farm failures and bankruptcy rate are higher for maize farmers compared to extensive beef farmers. The fall in both maize and beef farm bankruptcies in 1993 and 1994 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 (Directorate Financial Assistance, 1996). The following section explains possible causes of the sharp rises in the level of farm bankruptcies.

Figure 1: Maize and Extensive Beef Farm Bankruptcy Trends in South Africa, 1970-1994



Source: Directorate Agricultural Economic Trends (1995); Central Statistical Service (1994 and 1995); Van Niekerk (1995).

POSSIBLE CAUSES OF BANKRUPTCY OF MAIZE AND EXTENSIVE BEEF FARMERS IN SOUTH AFRICA

Commercial maize and extensive beef farmers in South Africa experience 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 & Baker, 1980).

Business Risk Factors

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 & Robinson, 1991, p.179; Tweeten, 1985, p.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 & Collins, 1982). Reliable net farm income data for the maize and extensive beef sectors were not available, hence product prices were used as a 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 thus expected. In this analysis, producer prices are adjusted to real terms using the Consumer Price Index (CPI) (1990=100).

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 & 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 per cent 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 beef producer price and maize farm bankruptcy is thus expected.

Drought

Drought is expected to increase bankruptcies by reducing net cash flows and creating financial stress. Particularly severe drought conditions occurred in the summer rainfall and extensive beef areas in 1982, 1990, 1991 and 1992 (CCWR, 1996). Annual rainfall in the summer rainfall and cattle grazing areas of South Africa was used as a proxy for drought conditions.

Agricultural Policy

Government support, such as drought relief schemes, can improve farm liquidity by reducing current liabilities and hence improving 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, e.g., 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 severely (Drabenstott, 1983).

Stockfeed purchase subsidies paid to extensive beef farmers in South Africa since 1965 may have promoted more intensive production in higher risk production areas. Also, 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 subsidies and transport rebates. Annual subsidies were adjusted to real terms using the CPI (1990=100) (Directorate Agricultural Statistics, 1996). It is paradoxical that policies intended to make farming less risky, may lead to more risk for farmers in the long-term.

Financial Risk Factors

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). Murdock and Leistritz (1988, p.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 relatively high interest rates in local markets attract capital from abroad.

Higher than expected real interest rates transfer wealth from debtors to creditors, placing farmers who are net debtors at a disadvantage (Tweeten, 1985, p.100). 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. This would suggest a positive relationship between real interest rates and farm bankruptcy. 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. 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, p.100).

Interest rates affect agriculture directly through cost and stock effects (Devadoss, 1985; Rausser, 1988, p.150). A higher interest rate will increase the cost of production through higher financing costs which in turn will decrease farm supply (cost effect). An increase in the 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 (Hughes *et al.*, 1985; Rausser, 1985, p.220).

Financial sector reform in South Africa during the mid-1980s led to the banking sector's reserve requirements being changed, and subsidised interest rates to farmers from the Land Bank were discontinued (Vink, 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 on the economy as a whole. Commercial bank overdraft interest rates adjusted to real terms using the change in CPI (1990=100) are used in this study as a proxy for market interest rates. Annual real overdraft interest rates fell from two per cent to around -1,5 per cent from 1970 to 1975, rose to one per cent for the period 1976 to 1978 and fell to -4,5 per cent 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 per cent during 1983 to 1985, while positive real rates between 2,5 and 6,5 per cent have continued since 1988 (South African Reserve Bank, various years; Standard Bank, 1994). More market-related rates imply greater expected future interest rate volatility and higher financial risk.

Debt/Asset (Leverage) Ratio

The aggregate farm debt/asset (leverage) ratio (total farm debt as a per cent of total farm assets) shows the solvency and risk-bearing ability of farmers. Farmers with substantial net worth or equity have the potential to borrow additional funds to meet short-term needs (Murdock & Leistritz, 1988, p.78). Higher debt burdens imply higher fixed debt service charges and greater financial risk, as debts must be repaid in high and low income years. This increases the probability that highly leveraged farmers will face difficulties in servicing debt (Chan & 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, p.169). Leverage and bankruptcy of maize and extensive beef farmers are expected to be positively related. 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 to 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; Human 1989; Volkskas Bank, 1988). Favourable accelerated depreciation allowances on machinery investment, negative real interest rates in the early 1980s and drought in the early 1980s and 1990s probably 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 extensive 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, p.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 & Leistritz, 1988, p.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).

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 & Alston, 1987). Lagged proxy variables for business and financial risk in the maize and extensive beef farm bankruptcy models estimated below are used to indicate that the bankruptcy process is dynamic.

RESEARCH METHODOLOGY AND RESULTS

Factors affecting bankruptcy of maize and extensive beef farmers during 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, excluding farm companies and close corporations (Van Niekerk, 1995). The number of farm sequestrations was taken as a proxy for the number of farm bankruptcies.

Maize Farm Bankruptcy Model

The preliminary OLS model is given by equation (1):

$$BANKRM = a_0 + a_1 RMP + a_2 WEA + a_3 LEV + a_4 RINT + a_5 IL + a_6 RBP + e_t \quad (1)$$

where BANKRM = number of annual 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 for crop growth) (CCWR, 1996); LEV = lagged annual farm sector leverage ratio; RINT = lagged real annual commercial bank overdraft interest rate; 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 farm beef price, and e_t = disturbance term. Correlation coefficients reported below were used to identify the appropriate length of lag for the explanatory variables. The LEV variable is a reasonable proxy for maize farm leverage as farm debt is concentrated in the summer rainfall and cattle grazing areas (Human, 1989; Volkskas Bank, 1988).

Correlation Coefficients

A correlation matrix of the variables used in the analysis is presented in Table 1. All coefficient signs agree with *a priori* expectations, with BANKRM negatively related to RMP1 (real maize producer price in previous year), WEA1 (annual rainfall in summer grain areas in previous year) and RBP1 (real beef producer price in previous year). However, BANKRM is positively related to RINT2 (real annual commercial bank interest rate two years prior), LEV1 (farm sector leverage lagged one year) and IL21 (RINT2 x LEV1). Multicollinearity is likely to be a problem due to statistically significant pairwise correlations between the explanatory variables. For example, RINT2 and LEV1 were significantly correlated with IL21 and RBP1, and IL21 respectively, at the 1 per cent level.

Table 1: Correlation Coefficients Between Variables of the Maize Bankruptcy Model, 1970-1994

	BANK-RM	RMP1	RINT2	LEV1	WEA1	IL21	RBP1
BANK-RM	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 per cent, 5 per cent and 10 per cent levels respectively.

Regression model

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

$$\begin{array}{l} BANKRM = 30{,}427 - 0{,}202\ RMP1 + 0{,}012\ WEA1 + 945{,}783 LEV1 + 2{,}935\ RINT2 + \\ \qquad\qquad\qquad (-1{,}615) \qquad (0{,}154) \qquad (3{,}515)^{***} \qquad (0{,}277) \\ 27{,}568\ IL21 + 0{,}023\ RBP1 \\ (0{,}407) \qquad (0{,}193) \end{array} \tag{2}$$

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

The Durbin-Watson d statistic for detecting autocorrelation falls in the inconclusive range, but the Geary test passed at the 5 per cent significance level, so the hypothesis of randomness is accepted (Gujarati, 1995, p.419). However, the high adjusted R^2, non-significant coefficients for RMP1, WEA1, RINT2, IL21 and RBP1 and wrong signs for the WEA1 and RBP1 coefficients indicate expected multicollinearity. Principal components extracted from the standardised explanatory variables (ZRMP1, etc.) to cope with this problem are shown in Table 2.

Table 2: 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
Eigen value	3,292	1,156	0,789	0,550	0,197	0,015
% variation	54,86	19,27	13,16	9,17	3,28	0,26

The principal components (PCs) are used to restate equation (2) in terms of the original variables purged of multicollinearity (Chatterjee & Price, 1977). Standardised annual maize farm bankruptcy, ZBANKRM, is first regressed on PC_1, PC_2 and PC_3. These three PCs explain 87,29 per cent of the variation in the explanatory variables (PC_4, PC_5 and PC_6 were omitted as they showed the linear relationships between the explanatory variables which led to multicollinearity and instability in the model):

$$\text{ZBANKRM} = -0{,}444\ PC_1 + 0{,}217 PC_2 - 0{,}231 PC_3 \qquad (3)$$
$$(-6{,}940)^{***} \quad (2{,}010)^{*} \quad (-1{,}770)^{*}$$

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

The Durbin-Watson d statistic falls in the inconclusive range (1 per cent significance level), and the hypothesis of randomness is still accepted as the Geary test passed at the 1 per cent significance level. Standardised annual maize farm bankruptcy could also be estimated by OLS regression of ZBANKRM on the standardised explanatory variables as per equation (4):

$$\text{ZBANKRM} = b_1\ \text{ZRMP1} + b_2\ \text{WEA1} + b_3\ \text{LEV1} + b_4\ \text{RINT2} + b_5\ \text{IL21} + b_6\ \text{RBP1} \qquad (4)$$

The b coefficients of equation (4) can be estimated from equation (3) coefficients and the PC_1, PC_2 and PC_3 loadings in Table 2 as:

$$b_i = \sum_{j=1}^{k} m_{ij} n_{ij} \qquad (5)$$

where m_{ij} = estimated loading for variable i in PC_j, n_{ij} = estimated coefficient for PC_j from equation (3), and k = number of PCs retained. For example, b_1 = (0,18784 x -0,444) + (-0,84989 x 0,217) + (0,01351 x -0,231) = -0,271. Substituting these expressions into equation (4) gives the estimated standardised maize farm bankruptcy regression model as:

$$\text{ZBANKRM} = -0{,}271\ \text{ZRMP1} - 0{,}233\ \text{ZWEA1} + 0{,}356\ \text{ZLEV1} + 0{,}107\ \text{ZRINT2} + 0{,}123\ \text{ZIL21} - 0{,}127\ \text{ZRBP1} \qquad (6)$$

The standardised variables are independent of the original units of measurement, and their coefficients show the relative importance of the variables. Lagged leverage, 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. Standard errors and t-values of the b coefficients were estimated following Gujarati (1995, p.70). 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 (6) were multiplied by S_{BANKRM}/S_{Xi} (standard deviation of BANKRM divided by standard deviation of the relevant explanatory variable) to express the amended OLS annual maize farm bankruptcy model in original scale (Chatterjee & Price, 1977, p.178) as per equation (7):

$$\begin{aligned} \text{BANKRM} = 244{,}800 - &\underset{(-2{,}921)^{***}}{0{,}235\ \text{RMP1}} - \underset{(-2{,}779)^{**}}{0{,}140\ \text{WEA1}} + \underset{(4{,}271)^{***}}{612{,}818\ \text{LEV1}} + \\ &\underset{(1{,}933)^{*}}{1{,}840\ \text{RINT2}} + \underset{(2{,}512)^{**}}{14{,}265\ \text{IL21}} - \underset{(-1{,}816)^{*}}{0{,}082\ \text{RBP1}} \end{aligned} \tag{7}$$

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

Compared to equation (2), 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. Estimation of factors affecting bankruptcy of extensive beef farms is described in the next section.

Extensive Beef Farm Bankruptcy Model

The preliminary OLS model is given by equation (8):

$$\text{BANKRB} = c_0 + c_1\,\text{RBP} + c_2\,\text{RINT} + c_3\,\text{LEV} + c_4\,\text{WEA} + c_5\,\text{RBS} + c_6\,\text{IL} + e_t \tag{8}$$

where BANKRB = annual number of bankrupt extensive beef farms; RBP = lagged real beef producer price; RINT = lagged real annual commercial bank overdraft interest rate; 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. The LEV variable is again a reasonable proxy for extensive beef farm leverage as farm debt is concentrated in the summer rainfall and cattle grazing areas (Human, 1989; Volkskas Bank, 1988). Correlation coefficients were used to identify the most appropriate length of lag for the factors affecting BANKRB.

Correlation coefficients

A correlation matrix of the model variables is shown in Table 3, where BANKRB is negatively related to RBP1 (at the 15 per cent significance level) and WEA4, but positively related to RINT3, LEV3, RBS3 and IL43 (the number(s) in each variable again show(s) the lag period). 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: Correlation Coefficients between Variables of the Extensive Beef Bankruptcy Model, 1970-1994

	BANKRB	RBP1	RINT3	LEV3	WEA4	RBS3	IL43
BAN-KRB	1,0000						
RBP1	-0,3085						
RINT 3		-0,3221	1,0000				
LEV3	0,9158***	-0,3626*	0,5182***	1,0000			
WEA 4	-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 per cent, 5 per cent and 10 per cent 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 instance, would probably take a number of years to impact on farm bankruptcy due to the liquidity effect of farmers' destocking decisions.

Regression model

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

$$\text{BANKRB} = 13{,}463 - \underset{(-1{,}855)^{*}}{0{,}042\ \text{RBP1}} + \underset{(0{,}931)}{0{,}513\ \text{RINT3}} + \underset{(4{,}497)^{***}}{318{,}178\ \text{LEV3}} - \underset{(-0{,}372)}{0{,}006\ \text{WEA4}}$$

$$+ \underset{(2{,}006)^{*}}{0{,}095\ \text{RBS3}} - \underset{(-0{,}678)}{2{,}472\ \text{IL43}} \tag{9}$$

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

Expected multicollinearity occurs in equation (9) 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 per cent level of significance). Extracted principal components to remedy multicollinearity are shown in Table 4.

Table 4: 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 per cent of the variation in the explanatory variables (the other components, as sources of the multicollinearity and model instability, were omitted), as per equation (10):

$$ZBANKRB = -0{,}504\ PC_1 - 0{,}115\ PC_2 \qquad (10)$$
$$(-7{,}665)^{***} \qquad (-1{,}152)$$

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

The Durbin-Watson d statistic falls in the inconclusive range at the 5 per cent significance level, and the hypothesis of randomness is still accepted as the Geary test again passed at the 5 per cent significance level. Following the same procedure outlined in equation (5), the standardised beef farm bankruptcy model was estimated as:

$$ZBANKRB = -0{,}195\ ZRBP1 + 0{,}234\ ZRINT3 + 0{,}251\ ZLEV3 - 0{,}251\ ZWEA4 + 0{,}151\ ZRBS3 + 0{,}161\ ZIL43 \qquad (11)$$

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:

$$BANKRB = 42{,}269 - \underset{(-2{,}476)^{**}}{0{,}036\ RBP1} + \underset{(7{,}717)^{**}}{1{,}130\ RINT3} + \underset{(7{,}744)^{***}}{126{,}473\ LEV3} -$$
$$\underset{(-6{,}603)^{***}}{0{,}035\ WEA4} + \underset{(2{,}798)^{***}}{0{,}05\ RBS3} + \underset{(3{,}848)^{***}}{5{,}367\ IL43} \qquad (12)$$

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

Compared to equation (9), 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 (7) and (12) are biased as some information was lost by dropping respective PCs, but the new estimates have more precision than the OLS estimators in equations (2) and (9) (Chatterjee & Price, 1977, p.175; Doran, 1989, p.106).

CONCLUSIONS

Higher lagged aggregate farm leverage and lagged real interest rates (financial risk factors), and lower annual rainfall (business risk factors) increased bankruptcies of South African maize and extensive beef farmers over the period 1970 to 1994. Farm bankruptcy in both sectors was also negatively related to lagged real producer prices (business risk factors). Bankruptcy of extensive beef farmers was positively related to lagged real stockfeed purchase subsidies and transport rebates (business risk factors). 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 causal factors and ultimate farm failure. Lags for the beef bankruptcy model are longer than for the maize bankruptcy model, 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 both models are compared, the aggregate farm debt/asset ratio is the most important determinant of farm bankruptcies. Higher leverage probably reflects a combination of poor borrowing decisions by eventual bankrupts, past tax policy measures (e.g., accelerated depreciation allowances on machinery investments) which may have contributed to increased debt use and farm bankruptcies, and past monetary policy (negative real interest rates) which made borrowing attractive.

Changes in Maize Board maize producer price policy from 1987/88 created another source of risk for maize farmers to manage. 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 or hedging a portion of their maize crop via recently introduced futures contracts on the 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 new SAFEX beef futures contracts to manage price risk. Stockfeed purchase subsidies and transport rebates intended to help beef farmers led to more risk and potential bankruptcy for some of these farmers in the long-term as they probably encouraged beef production in unsuitable areas.

Macroeconomic policy changes towards more market-related real interest rates directly affected maize and extensive beef farmers by raising financing costs and indirectly raised leverage and potential bankruptcy. Stable monetary policy *over time* can thus contribute to stability in the maize and extensive beef sectors. Highly leveraged farmers are particularly vulnerable to higher interest rates associated with deflationary policy. Farmers must closely monitor changes in agricultural price, trade and macroeconomic policies to form accurate expectations of potential bankruptcy causes and improve management of debt and business and financial risk at farm level. Specialist 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 (e.g., reduce fertilizer input at planting if below average rainfall is expected).

Available data limited the study to analysis of farm bankruptcies at maize and extensive beef regional level, but more research is 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? Highly leveraged maize and extensive beef farmers may have incurred more debt than they can realistically service in a changing agricultural and macroeconomic policy environment. Therefore, the rise in maize and extensive beef farm bankruptcies in South Africa during 1970 to 1994 could have been a necessary financial adjustment.

NOTE

This research was conducted in the Agricultural Policy Research Unit, University of Natal, South Africa, which is financed by the Centre for Science Development (CSD). Financial support from the CSD is gratefully acknowledged. Opinions expressed are, however, those of the authors. The authors thank colleagues at the University of Natal for constructive criticism on earlier drafts of the paper.

REFERENCES

1. BARRY, P.J., ELLINGER, P.N., HOPKIN, J.A. & BAKER, C.B. (1995). *Financial Management in Agriculture*. 5th ed., Danville, Illinois, Interstate Publishers.
2. CCWR (1996). Computing Centre for Water Research, University of Natal, Pietermaritzburg. *Personal communication*.
3. CENTRAL STATISTICAL SERVICE (1995). *CSS Bulletin of Statistics*, 29(30). Central Statistical Service, Pretoria.
4. CENTRAL STATISTICAL SERVICE (1992). *Agriculture Survey*, Central Statistical Service, Pretoria.
5. CENTRAL STATISTICAL SERVICE (1972; 1994). *South African Statistics*, Central Statistical Service, Pretoria.
6. CENTRAL STATISTICAL SERVICE (1988a). *Statistics on a Regional Basis, Development Regions, C (Orange Free State), Census of Agriculture 1988*, Central Statistical Service, Pretoria.
7. CENTRAL STATISTICAL SERVICE (1988b). *Statistics on a Regional Basis, Development Regions, F,G, H and J (Transvaal), Census of Agriculture 1988*, Central Statistical Service, Pretoria.
8. CHAN, M.W.L. & ROTENBERG, W.D. (1988). Financial Distress in the Canadian Agricultural Sector: A Macro Analysis, *Canadian Journal of Agricultural Economics*, 36,531-538.
9. CHATTERJEE, S. & PRICE, B. (1977). *Regression Analysis by Example*. New York, John Wiley and Sons.
10. DAVIES, A.S. (1996). Insolvency in Agriculture: Bad Managers or the Common Agricultural Policy? *Applied Economics*, 28,185-193.
11. DE JAGER, F. & SWANEPOEL, V. (1994). Factors Associated with Farm Financial Failure in the Northern Springbok Flats, *Agrekon*, 33(4),242-247.
12. DEVADOSS, S. (1985). *The Impacts of Monetary Policies on US Agriculture*. Unpublished PhD thesis, Ames, Iowa, Iowa State University.
13. DIRECTORATE AGRICULTURAL ECONOMIC TRENDS (1995). *Abstract of Agricultural Statistics*. Government Printer, Pretoria.
14. DIRECTORATE AGRICULTURAL STATISTICS (1996). *Abstract of Agricultural Statistics*. Government Printer, Pretoria.

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

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

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

18. FAMINOW, M.D. & LAUBSCHER, J.M. (1991). Empirical Testing of Alternative Price Spread Models in the South African Maize Market, *Agricultural Economics*, 6,49-66.

19. GABRIEL, S.C. & BAKER, C.B. (1980). Concepts of Business and Financial Risk, *American Journal of Agricultural Economics*, 62(3),560-564.

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

21. GUJARATI, D.N. (1995). *Basic Econometrics*, 3rd ed. New York, McGraw-Hill.

22. HUGHES, D.W., RICHARDSON, J.W. & RISTER, M.E. (1985). Effects of Sustained Financial Stress on the Financial Structure and Performance of the Farm Sector, *American Journal of Agricultural Economics*, 67(5),1116-1122.

23. HUMAN, C.J.F. (1989). The Implications of Fiscal and Monetary Policy on Management in South Africa, *Agrekon*, 28(1),9-13.

24. LESLIE, J.R. & DARROCH, M.A.G. (1993). Financial Characteristics of Successful and Unsuccessful Farms in Selected Areas of South Africa: Management Implications, *South African Journal of Agricultural Extension*, 22,6-12.

25. 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.

26. MISHKIN, F.S. (1988). Understanding Real Interest Rates, *American Journal of Agricultural Economics*, 70(2),1064-1072.

27. MURDOCK, S.H & LEISTRITZ, F.L. (1988). *The Farm Financial Crisis: Socioeconomic Dimensions and Implications for Producers and Rural Areas.* Boulder, Colorado, Westview Special Studies in Agricultural Science and Policy.

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

29. RAUSSER, G.C. (1985). Macroeconomics and US Agricultural Policy, in: Gardner B.L. (ed), *US Agricultural Policy: The 1985 Farm Legislation.* Washington, DC, American Enterprise Institute for Public Policy Research, 207-252.

30. RAUSSER, G.C. (1988). Stability Issues and Policy Analysis, in: Sumner D.A. (ed), *Agricultural Stability and Farm Programs: Concepts, Evidence and Implications.* Boulder, Colorado, Westview Special Studies in Agricultural Science and Policy, 143-170.

31. RUCKER, R.R. & ALSTON, L.J. (1987). Farm Failures and Government Intervention: A Case Study of the 1930s, *American Economic Review*, 77(4),724-730.

32. SHEPARD, L.E. & COLLINS, R.A. (1982). Why Do Farmers Fail? Farm Bankruptcies 1910-1978, *American Journal of Agricultural Economics*, 64(4),609-615.

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

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

35. TOMEK, W.G. & ROBINSON, K.L. (1991). *Agricultural Product Prices.* 3rd ed, Ithaca, Cornell University Press.

36. TWEETEN, L.G. (1985). Farm Financial Stress, Structure of Agriculture and Public Policy, in: Gardner B.L. (ed), *U.S. Agricultural Policy: The 1985 Farm Legislation.* Washington, DC, American Enterprise Institute for Public Policy Research, 83-112.

37. VAN NIEKERK, T. (1995). NAMPO, Bothaville, South Africa. *Personal communication.*

38. VAN ZYL, J., VAN DER VYVER, A. & MOSTERT, C.W. (1987). 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*, 26(1),1-7.

39. VINK N. (1993). Entrepreneurs and the Political Economy of Reform in South African Agriculture, *Agrekon*, 32(4),153-166.

40. VOLKSKAS BANK (1988). *Economic Spotlight*, March 1988.