AN ANALYSIS OF OPTIMAL FARM CAPITAL STRUCTURE

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Use of debt in financing agricultural firms is an issue of perennial interest. Much of this interest reflects farmers' disastrous experience with debt during the Great Depression. The foreclosed mortgages and bankruptcies of that era reaffirmed an historical feeling that achieving a level of zero debt or financial leverage was a high priority goal. E. G. Johnson, who was Chief of the Economic and Credit Research Division of the Farm Credit Administration, articulated the position in the *1940 Yearbook of Agriculture* that this goal is even more important than increasing profits: "It may be well to emphasize again that while credit properly used may help farmers to increase their income and raise their standard of living, the fact must not be overlooked that more credit will not cure all the ills of agriculture. The greatest need is to assist the farmers in getting out of debt, not deeper into it," [6, p. 754]. As memories of the Great Depression faded, agricultural economists tended to emphasize the effect of debt on farm size and therefore net income. Heady emphasized increased income from obtaining more resources through use of debt [3, pp. 535-561], and Hopkin, Barry and Baker stressed that leverage could increase rate of growth of farm firms [5, pp. 143-163]. Increased use and acceptability of leverage in agriculture has stimulated some empirical research on factors affecting the level of farm debt. The earliest research attempts in this area used time series data [4, 7, 9]. Lins and Donaldson [8] provided a recent cross-sectional analysis of level of farm debt in 1970.

One limiting factor in empirical analysis of agricultural use of financial leverage has been the weak theoretical framework. Many earlier writings have been conceptualized in a marginal returns and marginal costs framework. Conceptual and empirical difficulties in including risk in this standard framework limit its usefulness in analyzing situations where risk is important. In corporate finance theory, the concept of cost of capital is utilized to analyze optimum level of financial leverage [1, 11]. While Hopkin, Barry and Baker present a theoretical discussion of this concept in their textbook [5, pp. 251-256], it has not been integrated into empirical analysis in agricultural finance. The purpose of this paper is to explore applicability of the concept of cost of capital in analyzing farmers' decisions to utilize financial leverage. Specific objectives include: (1) a brief discussion of the concept of cost of capital, (2) derivation of an empirical model from the cost of capital concept to analyze the decision to employ financial leverage and (3) presentation of a discriminant analysis which tests the model for a sample of Georgia farmers.

THE COST OF CAPITAL CONCEPT[1]

In general terms, cost of capital is the weighted sum of the component cost of each capital source weighted according to its long-run level of use in the firm's capital structure. If a farm firm is financed with two categories of debt and proprietor equity, the cost of capital is calculated as follows:

$$K_O = (\frac{D}{A})\,K_D + (1 - \frac{D}{A})\,K_E \qquad (1)$$

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[1] This section synthesizes the traditional theory of cost of capital. The seminal work in this area is Solomon [10]. This subject matter is also considered in corporate finance textbooks such as Weston and Brigham [11, pp. 594-622].

where

K_O = weighted average cost of capital

K_D = cost of debt capital

K_E = cost of equity capital and

$\frac{D}{A}$ = debt-asset ratio in the firm's capital structure.

The cost of debt, K_D, is the after-tax effective interest rate on debt and is calculated as follows:

$$K_D = E_D (1 - T) \quad (2)$$

where

E_D = current effective interest rate on debt and
T = marginal income tax rate.

K_E is the historical rate of return the owner has been receiving on his equity capital with his particular production and financial organization and is calculated as follows:

$$K_E = \frac{NP - OL + LV (1 - T_C)}{E} \quad (3)$$

where

NP = net farm profits after taxes
OL = value of unpaid family labor
LV = amount of increase in land value
T_C = capital gains tax rate and
E = owner equity.

The behavioral assumption of the theory of optimal capital structure is that the firm operates at that level of financial leverage, measured by D/A, which minimizes the weighted average cost of capital in equation (1). To explore the implications of this behavioral assumption, an understanding of likely magnitudes of K_E and K_D and their responses to increases in D/A is necessary. K_E and K_D in equations (2) and (3) measure the rate of return that owners and lenders, respectively, demand to supply funds to a given firm. Like any rate of return, K_E and K_D include the risk-free interest rate and a risk premium. This risk premium varies directly with risks associated with production and financial organization of the firm. Furthermore, the risk premium associated with equity capital is generally higher than that for debt because of the greater risks associated with ownership. This latter point results in K_E generally being greater than K_D for any given production and financial organization. Despite this generalization, firms typically cannot minimize K_O by using all debt. Increasing financial leverage increases risk for both owners and lenders so that both K_E and K_D are increasing functions of financial leverage. The standard formulation is that some level of debt, such as $0 < D/A < 1$, minimizes the cost of capital.

Derivation of hypotheses for empirical analysis in this paper requires consideration of situations when zero financial leverage results in the minimum weighted average cost of capital. In equation (1), zero financial leverage is reflected in $D/A = 0$ and $K_O = K_E$. One obvious situation when zero D/A would be optimal is when K_E is less than K_D at all levels of leverage. While this possibility is inconsistent with general corporate finance theory, Brigham and Smith argue that small business proprietors will accept lower than competitive returns on their equity capital because of the pecuniary and, more important, nonpecuniary advantages of self-employment and business ownership [2]. This finance proposition is familiar to agricultural economists; in fact, Hopkin, Barry and Baker hypothesized that farmers in the past have judged equity capital as costing less than debt capital [5, pp. 254-255].

The small firm situation of $K_E < K_D$ is not necessary for zero debt to minimize K_O. Situations can exist when $K_E > K_D$, and zero D/A is also optimal. Figure 1 illustrates these two possibilities.[2] The curves K_E, K_D and K_O, which are linear for graphic convenience, illustrate a case in which $K_E < K_D$ for all levels of leverage and the minimum K_O occurs when $D/A = 0$. However, the curves K_E', K_D and K_O' illustrate a case for which the minimum K_O occurs at $D/A = 0$ even though $K_E > K_D$ for all levels of D/A. Salient features of this second case are: (1) absolute difference between K_E and K_D is small and (2) rate of increase in K_D with respect to changes in leverage is equal to that for K_E. If the difference between K_E and K_D was larger and/or if the increase in K_E in response to increases in leverage was larger relative to that for K_D, $D/A = 0$ would no longer be optimal. The responsiveness of K_E and K_D to leverage depends on risk preferences and impact of leverage on riskiness of the owner's equity and the lender's debt. For any given attitude of lenders

[2]Figure 1 is an abstraction from general theory and the institutional environment in agricultural finance. In the general theory, the K_E, K_D and K_O curves are not linear. K_D for farmers would also not be continuous since lenders do not ration credit with interest rates but with amounts of loans. However, representing these points in Figure 1 would not alter the basic propositions and would complicate the graphic analysis. Weston and Brigham use similar theoretical abstractions in discussing the theory of the cost of capital [11, pp. 636-657].

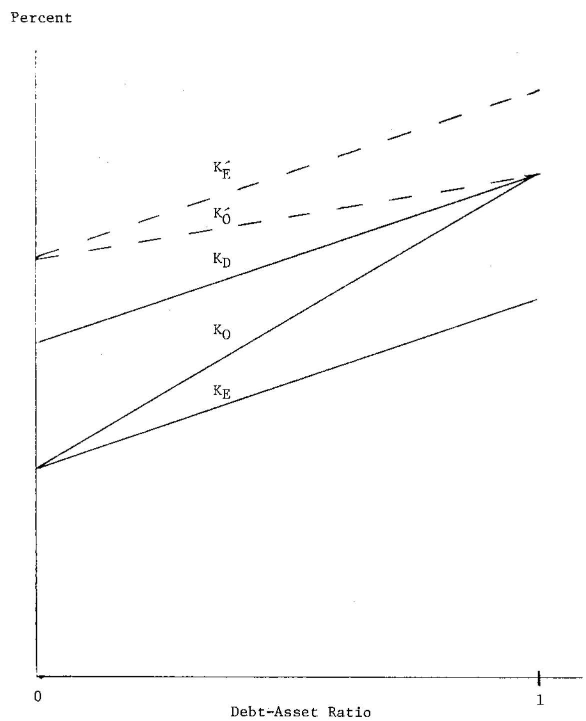

FIGURE 1. COST OF EQUITY (K_E), COST OF DEBT (K_D), AND COST OF CAPITAL (K_O) CURVES ILLUSTRATING ZERO LEVERAGE IN AN OPTIMAL CAPITAL STRUCTURE

towards the firm which is expressed in a given K_D function, K_E will increase faster with leverage the greater the degree of risk aversion of the farmer. For any given level of the K_E function, K_D will be more responsive to leverage, the more risky the lender perceives the debt or, in more conventional terms, the borrower's credit worthiness.

In summary, the cost of capital concept provides a convenient framework for identification of situations in which a farmer would be expected to have no debt in his financial structure. If cost of equity is less than that of debt, a clear case for no financial leverage exists. If cost of equity is not much larger than cost of debt, zero financial leverage can also be optimal if the owner's risk premium for debt increases faster than that for lenders. Thus, analysis of the use of debt among farm firms can concentrate on the relative level of K_E to K_D and of factors affecting the risk preferences of farmers and agricultural lenders.

AN EMPIRICAL MODEL

In the previous section, two factors were deduced as being important in identifying situations in which zero financial leverage would be optimal in the cost of capital framework. In this section, an empirical model is developed which includes variables to test the influence of these two factors. In development of this model, empirical propositions from the literature on agricultural finance are integrated with the theoretical results of the previous section.

Identification of variables to analyze the relative levels of K_E and K_D requires particular attention to K_D. As indicated in equation (3), K_E depends largely on factors which are observable in operation of a farm business. Estimation of K_D is more difficult. As shown in equation (2), an estimate of K_D requires the effective interest rate, which is difficult to estimate for farmers with no debt. The approach taken in this study is to utilize estimates of K_E as a variable to reflect differences between K_E and K_D. Since interest rates are relatively uniform among farmers [3, pp. 558-559], the main variation in K_D among farm firms results from variation in the income tax rate. The depressing effect of the tax rate on K_D would also be positively related to K_E since a higher K_E reflects a higher net income with a given investment. Thus, the level of K_E measures both the relationship between K_E and a standard interest rate and the effect of taxes on K_D.

In the theoretical area of risk preferences of farmers and lenders, operator's age and enterprise portfolio effects were included to represent important differences. Inclusion of age is in recognition of the inverse relationship between debt and age which is often noted in literature [3, pp. 549-550; 5, pp. 138-141; 1, pp. 23-24]. This literature indicates that farmers begin to stress stability of income during the middle of the life cycle more than in their younger years. In the framework of the cost of capital model, farmers would be expected to require a higher level of K_E for positive levels of leverage as they get older. Thus, increasing age would be expected to be associated with lower likelihood of using debt in the capital structure.

Enterprise portfolio effects are a result of the well-known reduction in risk from diversification in farm organization. For farmers with a specialized farm organization, the risk of any particular level of financial leverage is higher. If farmers' risk patterns follow the typical pattern of decreasing rate of personal substitution of risk for returns, it could be expected that the rate of increase in K_E with respect to leverage would be greater on specialized than on diversified farms. Ideally, portfolio effects would be measured as a percentage of net income derived from the major enterprise. The problems of allocating costs to particular enterprises makes this a difficult procedure even if complete farm record data are available.

Thus, percentage of total gross income from the major enterprise is utilized as a portfolio effects variable.

For age and portfolio effects to have the hypothesized relationship on capital structure, their effect on the responsiveness of K_D function to leverage must be contrasted to that on K_E function. This proposition has largely been ignored in the literature. However, a case can logically be built that these variables do not have as large an effect on lenders as on farm owners. The effect of age on K_E arises from personal preferences not from productive characteristics of the farm. Therefore, age would not be expected to be perceived by lenders as increasing risk. For portfolio effects, farm production does not become more risky. However, lenders are concerned with security values as much as, or more than with income, and the risk associated with security values on specialized farms relative to diversified farms would be expected to increase as much as the relative risk of income. Thus, effects of age and specialization on K_D would not be expected to be as large as on K_E.

In summary, variables in the empirical analysis include cost of equity, age and percentage of gross income from major enterprise. The first variable measures differences between K_E and K_D functions and the second and third differences in farmers' risk preferences.

DATA AND METHODOLOGY

A sample of 121 Georgia farmers was used in this study. These farm operators were selected through a stratified random sample and thus represented a cross-sectional sample of the State's farmers. Information on sales, operating expenses, net taxable farm income, income tax payments, value of assets, debt, interest rate paid and family and operator labor use was obtained from interviews and farm tax records for 1972. Secondary data on wage rates and land values supplemented the primary data; the wage data was the Georgia average rate for hired farm labor for 1972 while the rate of land value appreciation varied by crop reporting districts. Since optimal capital structure is a long-run concept, time series data may be preferable to using data for a single year. Data from 1972 would, however, be more appropriate than some other years since that year was representative of the average recent farming situation.

Statistical analysis of the empirical model involved derivation of a classification function for debt and no-debt groups through discriminant analysis, with the three variables discussed previously serving as discriminating variables. Since farmers with only a small amount of debt were likely to include cases which were temporary debtors rather than having a long-run goal of including debt in their financial structure, farmers with $D/A \leq .05$ were classified in the no-debt group prior to the statistical analysis.

Besides statistical results of the discriminant analysis, a breakeven value for each independent variable was calculated using sample means. This value was calculated by equating the discriminant function to zero:

$$a + \sum_{i=1}^{2} b_i \overline{X}_i + b_k X_k = 0 \qquad (4)$$

where

a = constant in the discriminant function

b_i and b_k = coefficients in discriminant function

$\overline{X}_i$ = sample mean for the two variables and

X_k = variable ($i \neq k$) for which a break-even value is being calculated.

Solving equation (4) for each variable in turn identifies a break-even value of the independent variable in reference to classification into debt and no-debt groups. The break-even value for each independent variable is the value for which the average farm operator would have equal probability of being classified in the debt and no-debt groups. For higher values than the break-even value for each respective value, the farmer would be more likely to be classified in one of the groups, and for lower values he would be more likely to be classified in the other group.

EMPIRICAL RESULTS

Results of the empirical analysis are presented in Tables 1 and 2. In Table 1, the discriminant equation for classification from debt into the no-debt group is presented along with F values for the coefficients. In Table 2, means of the classification variables in the sample and in both debt and no-debt subsamples are presented along with break-even values calculated with the discriminant function of Table 1 and equation (4).

Results of the discriminant analysis were very satisfactory. All variables were significant, with K_E and age being significant at the one percent level. Furthermore, 96 out of the 121 sample cases were classified in the correct group. More importantly, all coefficient values had the expected influence in the discriminant analysis. Since the coefficient for K_E is positive, an increase in K_E would increase the

TABLE 1. DISCRIMINANT FUNCTIONS WHICH CLASSIFY FARM OPERATORS INTO DEBT AND NO-DEBT GROUPS

Variables	Coefficients	F-Value
Constant	4.2527	
Cost of equity (K_E)	0.0977	16.2**
Age of farm operator	-0.0702	11.7**
Major source of income as a percentage of total income	-0.0132	3.1*

*.10 level of significance.
**.01 level of significance.

TABLE 2. VARIABLES USED IN DISCRIMINANT ANALYSIS WITH MEANS AND BREAK-EVEN VALUES

Variables	Mean Values			Break-even Values
	Debt Group	No Debt Group	Total Sample	
Cost of equity (K_E)	6.98	0.22	3.07	4.05
Age of farm operator	51.92	58.64	55.81	54.44
Major source of income as a percentage of total income	48.17	60.59	55.36	48.09
Number of observations	51	70	121	

likelihood that a farmer would be classified as having debt. Similarly, the negative coefficients for age and the specialization variable indicates that increases in these variables increase the likelihood that farmers will have no debt.

The break-even values in Table 2 were calculated with discriminant coefficients and sample means. These break-even values indicate the specific magnitude of variables for which the discriminant function is equated to zero if other variables are held at their mean values. If a particular farmer had a mean value for two variables and a value of the other variable above this break-even value, he would be expected to be in the group favored by the coefficient of the third variable. For example, a farmer with 55.36 percent of his income from one commodity source and an age of 55.81 years would have debt if his K_E were greater than 4.05 percent.

Estimated break-even values for age and specialization are consistent with prior expectations. The 54.44 value for age is in the middle age range in which farmers are generally considered to be increasingly interested in stability of income and therefore lower financial leverage. Farmers with income from one source being greater than 48.09 percent of total farm income would be specialists more concerned with risk of financial leverage than diversified farmers.

The break-even value for K_E of 4.05 percent is of more concern. With interest rates in the range of seven percent in 1972, a farmer would have to have a marginal income tax rate of 45 percent for K_D to be less than 4.05 percent. As this marginal tax rate was for the taxable income bracket of $26,000-$32,000, this estimate of the break-even value for K_E appears to understate the minimum K_E for the average farmer to introduce debt into his capital structure. For a farmer to take out a new loan in 1972, his interest charge might be seven to eight percent, so he would have to have K_E almost that high unless his taxable income were high. A possible explanation for this result is that many of the sample farmers with debt in their capital structure took out loans when interest rates were much lower, say four to six percent. A K_D based on a lower interest rate of the 1960s could be lower than 4.05 percent for relatively low tax rates: a marginal tax rate of 20 percent and an interest rate of five percent would result in a $K_D = 4$ percent. Interest rates increased rapidly in the early 1970s, but it would take many years for a cross-sectional sample of farmers to completely adjust their capital structures to higher rates.

CONCLUSIONS AND IMPLICATIONS

This paper reports on research which adapted the concept of weighted average cost of capital to conceptualize the use of zero financial leverage among many farmers. The concept was demonstrated to be consistent with previous research on this issue. An empirical model was developed which included cost of equity, age and a specialization variable to test applicability of the model for a sample of Georgia farmers. A discriminant analysis of the sample correctly classified 96 of the 121 farms in the sample with all coefficients having expected magnitudes and being significant. Thus, the cost of capital concept provides a useful theory to derive empirical models for analysis of issues associated with capital structure of agriculture.

Several shortcomings of the analysis need to be stressed. Since optimal capital structure is a long-run concept, the particular empirical results are sensitive to short-run phenomena. A cross-section sample with several years of time series data would be more appropriate than the one-year cross-sectional data utilized in this study. Using only one year of data would be appropriate during a period of stable internal and external financial conditions for agriculture. As such a situation is rare, perhaps the model could be developed into an adaptive expectations framework.

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