Optimal Capital Structure in Centralized Agricultural Cooperatives

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This research used a stochastic interest rate to determine the optimal solvency (equity to asset) for 14 Kansas centralized agricultural cooperatives. Solvency was sensitive to including a stochastic interest rate. Additionally, solvency was sensitive to the change in business and financial risk.

Key words: capital structure, cooperatives, solvency

Introduction

One of the most important and most difficult decisions a cooperative must make is the choice of capital structure. The theory of optimal leverage suggests the cost of debt is less than the cost of equity capital due to differences in risk and the tax deductibility of debt. Thus, the use of leverage can increase the rate of return to equity. However, debt increases financial risk, making insolvency a more likely possibility. Thus, the management of a cooperative must weigh the trade-offs between debt and equity. Through proper capital structure, management can influence the financial performance of the business (Forster).

An agricultural cooperative requires capital to purchase land, buildings, and equipment, and provide a means for acquiring working capital. Cooperatives acquire capital from equity or debt. Cooperatives acquire equity capital by selling equity interest and by retaining equity from revenues and net income generated through operations.[1] Individual members are generally expected to provide equity in proportion to their use of the cooperative (Cobia). Typically, the equity is held at par value (i.e., does not appreciate or depreciate) and pays no dividends. Some cooperative managers incorrectly perceive the cost of acquiring equity to be zero in this situation. Thus, cooperative management may follow the practice of maximizing the use of equity capital and minimizing the use of debt. The size of the equity pool may also depend on the equity management strategy.[2] Decisions

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[1] Retained equity may be per unit capital retained, retained patronage refunds, or retained earnings.

[2] Equity redemption methods used by cooperatives are age of patron, special redemptions (such as estate settlement), revolving fund, and percentage of base capital.

by the cooperative and members on equity investment should be made based on the members cost of equity capital. The cost of providing equity to a cooperative by the member is the opportunity cost of investing money in a member's own operation or other alternatives.

Cooperatives also acquire capital through debt financing. Acquiring an optimal level of debt is attractive to cooperative directors, because it allows for members to achieve a higher return on patronage when the cost of debt is less than the cost of equity. However, acquiring too much debt may subject cooperatives to financial risk due to varying interest rates and variability in net income may compound risk (Cobia).

The cooperative needs to operate at an optimal solvency level. Equity financing should be decreased as the cost of equity approaches the cost of debt. Cooperatives need to be able to determine an optimal level of debt and equity to operate efficiently and guard against unexpected shocks. This study examines the optimal solvency ratios for 14 cooperatives and derives how the solvency ratio id effected from changes in risk.

This analysis uses the theoretical model developed by Collins and incorporates a stochastic interest rate to better model exogenous risk.[3] Incorporating a stochastic interest rate into the Collins model has two effects on determining an optimal solvency ratio. First, the interest rate is allowed to vary over time (increased risk). Secondly, interaction between the interest rate and the rate of return on assets is incorporated into the model because of

[3]Moss et. al. incorporated taxes into the model derived by Collins and evaluated the effects of changes in taxes.

the interdependence of the two variables. If differences in optimal capital structure exist from the use of a stochastic interest rate, cooperative management must be made aware of this.

Empirical Model

An agricultural cooperative is sometimes perceived as an extension of the farm (Sexton).[4] Centralized agricultural cooperatives are owned by members (agricultural producers) and the board of directors is almost always made up of a set of these members. Federated and mixed cooperatives are indirectly, if not directly, owned and controlled by producer-members. Thus, we extend a theoretical model of farmer behavior to the cooperative. Collins derived an empirical model to estimate the optimal equity/asset ratio.

The Collins model can be used to indicate how decreasing the variability of returns on equity (e.g., management, including investment and equity redemption strategies) decreases a cooperative's solvency position. Following Collins, it is possible to derive a mean stochastic rate of return on equity ($\bar{R}_E$) as:

(1) $$\bar{R}_E=(\bar{R}_A - \bar{K}\,\delta) \cdot 1/(1 - \delta),$$

where $\bar{K}$ represents the mean stochastic interest rate, $\bar{R}_A$ is the mean rate of return on assets, and δ is the ratio of debt to assets. Under the assumption of a stochastic interest rate, the variance of the rate of return on equity (σ_E^2) is:

[4]For this analysis, agricultural cooperatives are assumed to not have a readily available equity market. This assumption makes the decision process parallel between farmers and agricultural cooperatives.

(2) $$\sigma_E^2 = \sigma_A^2 \cdot (1/(1\text{-}\delta))^2 + \sigma_K^2 \cdot \; (\delta/(1\text{-}\delta))^2 - \; 2\delta/(1\text{-}\delta)^2 \cdot \gamma_{A,K},$$

where $\gamma_{A,K}$ represents the covariance between rate of return on assets and the interest rate, σ_K^2 is the variance of the interest rate, and σ_A^2 is the variance of the rate of return on assets. Note, by allowing the variance of the interest rate to be zero in equation 2, the computation of the optimal solvency ratio is identical to that derived by Collins.

It is assumed that farmers maximize expected utility and that their preferences can be represented by a negative exponential utility function (Freund, Selley). Under the conditions of normality, $\bar{R}_A \sim N(\bar{R}_A , \sigma_A^2)$ and $\bar{K} \sim N(\bar{K} , \sigma_K^2)$, and a constant risk-aversion coefficient, the expected utility-maximizing solution is obtained by maximizing:

(3) $$L(\delta) = (\bar{R}_E - \bar{K}\,\delta) \cdot (1/(1 - \delta))^2 - (\rho/2) \cdot (\sigma_A^2 \cdot (1/(1 - \delta))^2 + \sigma_K^2 \cdot (\delta/(1 - \delta))^2 - (2\delta/(1 - \delta)^2) \cdot \gamma_{A,K}),$$

where ρ refers to the Pratt-Arrow decreasing relative risk aversion coefficient. First order conditions for maximization indicate the derivative of expected utility of the rate of return on equity as a function of leverage is:

(4) $$\partial L(\delta)/\partial\delta = \bar{K} /(1 - \delta) + (\bar{R}_A - \bar{K}\,\delta) \cdot (1/(1 - \delta)^2) - \rho \cdot \sigma_A^2 \cdot (1/(1 - \delta)^3) - \rho \cdot \sigma_K^2 \cdot (\delta/(1 - \delta)^3) + \rho \cdot \gamma_{A,K} \cdot ((1+\delta)/(1 - \delta)^3) = 0.$$

Solving equation 4 for δ, the optimal leverage ratio (δ^*) is:

(5) $$\delta^* = (\bar{R}_A - \bar{K} - \rho\cdot\sigma_A^2 + \rho\cdot\gamma_{A,K})/(\bar{R}_A - \bar{K} + \rho\cdot\sigma_K^2 - \rho\cdot\gamma_{A,K}).$$

Equation 5 provides an optimal leverage ratio for alternative levels of a cooperative's risk aversion, rate of return on assets, cost of debt, variance of the return on assets, variance on the cost of debt, and the correlation between the rate of return on assets and cost of debt.

For the leverage or solvency condition to be met, the mean of the rate of return on assets must be greater than the mean of the interest rate for equation 5. If the mean return on assets is not greater than the mean interest rate, the agricultural cooperative is eroding it's equity position with the use of debt. In addition, the optimal solvency ratio (equity-asset ratio) may be written as one minus the leverage ratio ($1-\delta^*$). This yields an optimal solvency ratio (s^*) of:[5]

(6) $$s^* = (1 - \delta^*) = 1 - (\bar{R}_A - \bar{K} - \rho\cdot\sigma^2_A + \rho\cdot\gamma_{A,K})/(\bar{R}_A - \bar{K} + \rho\cdot\sigma^2_K - \rho\cdot\gamma_{A,K}).$$

Risk Effects

Because the optimal solvency ratio (s^*) is defined as one minus the leverage ratio ($1-\delta^*$), differentiating s^* allows for inferences to be made about business risk. To unequivocally sign the following results, it is assumed that the covariance between the interest rate and the rate of return on assets is negative or zero. To analyze the effects of σ^2_A on s^*, differentiate equation 6 with respect to σ^2_A to obtain:

(7) $$\partial s^*/\partial\sigma^2_A = \rho/(\bar{R}_A - \bar{K} + \rho\cdot\sigma^2_K - \rho\cdot\gamma_{A,K}).$$

Thus, the change in the solvency ratio from a change in the variance of return on assets has a positive relationship ($\partial s^*/\partial\sigma^2_A > 0$). That is, an increase in business risk (σ^2_A) would lead a cooperative to increase financing through equity. Similarly, the effect of a change in σ^2_K on s^* is:

[5] The optimal solvency ratio formula derived by Collins for a non-stochastic interest rate is of the form $s^* = (1 - \delta^*) = \rho\cdot\sigma^2_A /(\bar{R}_A - K)$.

(8) $$\partial s^*/\partial\sigma_K^2 = \rho(\bar{R}_A - \bar{K} - \rho\cdot\sigma_A^2 + \rho\cdot\gamma_{A,K})/(\bar{R}_A - \bar{K} + \rho\cdot\sigma_K^2 - \rho\cdot\gamma_{A,K})^2.$$

Thus, the change in the solvency ratio from a change in the variance of interest rates has a positive relationship ($\partial s^*/\partial\sigma_K^2>0$). That is, as interest rates become more variable the amount of equity financing should increase.

Differentiating equation 6 with respect to $\bar{K}$ and $\bar{R}_A$, shows the effect of changes in the interest rate and the rate of return on assets on the solvency ratio:

(9) $$\partial s^*/\partial\bar{R}_A=-(\rho\cdot\sigma_K^2 - 2\rho\cdot\gamma_{A,K} + \rho\cdot\sigma_A^2)/(\bar{R}_A - \bar{K} + \rho\cdot\sigma_K^2 - \rho\cdot\gamma_{A,K})^2, \text{ and}$$

(10) $$\partial s^*/\partial\bar{K} =-(2\rho\cdot\gamma_{A,K} - \rho\cdot\sigma_K^2 - \rho\cdot\sigma_A^2)/(\bar{R}_A - \bar{K} + \rho\cdot\sigma_K^2 - \rho\cdot\gamma_{A,K})^2.$$

Equations 9 and 10 indicate that the relationship between the solvency ratio and mean interest rate and mean rate of return on assets is determined by the sign of the numerator. An increase in the rate of return on assets has a negative impact on the solvency ratio ($\partial s^*/\bar{R}_A<0$) and an increase in interest rates has a positive impact on the solvency ratio ($\partial s^*/\partial\bar{K}>0$). As the rate of return on assets increases, more debt financing should be used, and equity financing should be decreased. Alternatively, as interest rates increase the amount of debt financing should decrease and more equity financing used.

The empirical model derived above allows for the calculation of an optimal solvency ratio for a cooperative. Additionally, the effects of changes in business risk can be evaluated (i.e., changes in the variance of the rate of return of assets and the variance of the interest rate). The next section describes the data used to estimate the solvency ratios for this study.

Data

Data for this analysis were collected, on an annual basis, for Kansas local cooperatives from 1984 to 1992. This data were available from the Cooperative Finance Association (CFA), a business affiliated with and owned by Farmland Industries and the members of Farmland Industries. Cooperatives represented in this study are supply and grain marketing cooperatives. Grain marketing typically represents about 65% of sales. Local cooperatives are common to Kansas and those evaluated in this study have yielded a relatively high rate of return on assets. Only those cooperatives having data available over the entire period of study and having a mean rate of return on assets greater than the interest rate were evaluated. This produced 14 cooperatives for the 1984 to 1992 time period.

Tables 1 and 2 provide summary statistics on an annual basis for the cooperatives evaluated in this analysis and by cooperative over the period of study, respectively. Included in these tables are the number of cooperatives evaluated, mean rate of return on local assets (ROLA), the standard deviation of the return on local assets, average solvency ratio, and the Bank for Cooperatives (CoBank) interest rate. The rate of return on local assets was calculated as local net savings plus interest paid divided by total assets minus total investment. For table 2, the average interest rate realized by each cooperative, over the period of this study, was 9.4%.

Column three of table 1 indicates that the rate of return on assets varied considerably over the period of study. The rate of return on assets ranged from 8.0% to

15.7%. The solvency ratio increased over time. This trend may have been due to the relatively high financial stress realized by agricultural cooperatives during the early to mid 1980s. To guard against future shocks, cooperatives reduced leverage and relied more on equity. The correlation between the rate of return on assets and the interest rate was low, at 12.4%.

From table 2, it can be observed that the solvency ratio varies substantially among cooperatives. This is an indication of the varying management practices of cooperatives and the type of cooperative. The mean rate of return on local assets was relatively stable across cooperatives, but substantial variability was observed in the standard deviation of the rate of return on local assets across time. This represents varying degrees of business risk (variance of the rate of return on local assets) among cooperatives. The next section describes the results obtained from using the described data for determining optimal capital structure.

Results

Using equation 6, optimal solvency ratios were estimated for cooperatives using the rate of return on local assets and both a stochastic interest rate (table 3) and non-stochastic interest rate (table 4). The rate of return on local assets, as compared to the rate of return on total assets, was assumed to provide a better measure of the management practices of the individual cooperative since it excluded regional cooperative investment and patronage refund income. Alternative levels of risk aversion were required to estimate solvency ratios for various risk attitudes.

Risk aversion coefficients are a measure of the tradeoff between expected profit and risk. Relative risk aversion coefficients chosen for this analysis ranged from 5 to 25. Numerous studies have indicated the risk averse producer would be in the range of 20 to 30 and the almost risk neutral producer would be in the range of 0 to 2 (Cochran et al., King and Robison, and Tauer). If the agricultural cooperative is viewed as an extension of the producer's business, estimated risk aversion coefficients for producers are an adequate measure of risk aversion for the agricultural cooperative.

Tables 3 and 4 provide empirically estimated solvency ratios (column 3) using a stochastic and non-stochastic interest rate. The mean interest rate (9.4%) was used for computation of values for the non-stochastic interest rate (table 4). As the level of risk aversion increased, the solvency ratio increased. This indicates that a cooperative that is more risk averse prefers to accept a low return on equity to guard against financial risk. Column 2 of tables 3 and 4 show that the rate of return on equity decreases as solvency increases. Cooperatives could increase profitability by decreasing equity use.

Columns four through seven of tables 3 and 4 provide sensitivity analysis of the effects of a 10% change in the interest rate, the rate of return on local assets, variance of the interest rate, and variance of the rate of return on local assets, respectively.[6] The sensitivity of solvency to business risk can be seen in tables 3 and 4. Increasing the variability in business risk by 10% can cause an increase in the solvency ratio by 6% to 8% at some risk aversion levels.

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[6]Column seven of Table 4 is not applicable if interest rates are non-stochastic.

The macroeconomic climate effects interest rates and interest rate variability and hence the optimal level of solvency. Tables 3 and 4 show significant differences in estimated values. For the relative risk aversion level of 15, the solvency ratio using a stochastic interest rate, was 65.7%. The solvency ratio using a non-stochastic interest rate was 63.8%. The stochastic nature of interest rates increases the optimal solvency ratio at lower levels of risk aversion and decreases at higher levels. In addition, an increase in the interest rate from 9.4% to 10.3% increases the leverage ratio by roughly 50% at low levels of risk aversion. Similar differences are observed for a 10% change in the interest rate, rate of return on local assets, and variance of the rate of return on local assets. Moller, et. al. found that high interest rates accounted for 24% of the financial stress in agricultural cooperatives. They also found that larger cooperatives are more subject to interest rate problems. Clearly, the level and the variability of interest rates are important factors in determining optimal solvency.

Conclusions

The financial structure of an agricultural cooperative requires the balancing of debt and equity to assure member patrons the lowest possible margins on goods and services which they patronize. Equity provides security to the cooperative in times of financial stress. Many agricultural cooperatives experienced substantial financial stress during the 1980s and have sought to determine an optimal level of equity/debt financing. Sometimes, cooperative management views the cost of equity as relatively free, allowing for a strong balance sheet, and the patron views the cost of equity as the opportunity cost of investing in the patrons own operation. Determination of an optimal equity/debt ratio is required to meet the requirements of both cooperative management and members.

Macroeconomic policy affects the optimal solvency level of an agricultural cooperative. Variance in the interest rate and the level of interest rate affects capital structure and must be accounted for. An increase in the interest rate from 9.4% to 10.3% caused the optimal solvency ratio to double while a similar percentage change in the variance of interest rates was much less dramatic effect.

As agricultural cooperatives prepare to move into the twenty-first century, they must better project their financial structure if to compete in the market place. Determining the optimal capital structure of a cooperative is the first step in building a financially sound cooperative.

Table 1. Summary statistics by year (averages by year for 1984-1992)

Year	Number of observations	Return on local assets	Standard deviation	E/A ratio[a]	Interest rate
1984	14	0.099	0.076	0.609	0.114
1985	14	0.098	0.106	0.662	0.105
1986	14	0.115	0.060	0.673	0.093
1987	14	0.157	0.058	0.709	0.086
1988	14	0.142	0.052	0.687	0.091
1989	14	0.123	0.071	0.708	0.107
1990	14	0.094	0.052	0.703	0.100
1991	14	0.082	0.055	0.690	0.086
1992	14	0.080	0.032	0.715	0.063

[a] The E/A ratio represents the equity to asset ratio.

Table 2. Summary statistics by cooperative (averages of 1984-1992 period)

	Return on local assets	Standard deviation	E/A ratio[a]
Coop A	0.095	0.074	0.612
Coop B	0.095	0.050	0.739
Coop C	0.093	0.071	0.535
Coop D	0.095	0.042	0.696

Coop E	0.147	0.039	0.752
Coop F	0.106	0.031	0.535
Coop G	0.097	0.074	0.802
Coop H	0.122	0.039	0.791
Coop I	0.110	0.049	0.450
Coop J	0.112	0.052	0.533
Coop K	0.130	0.053	0.868
Coop L	0.109	0.184	0.642
Coop M	0.119	0.035	0.900
Coop N	0.110	0.042	0.726

[a] The E/A ratio represents the equity to asset ratio.

Table 3. Empirically determined E/A ratio and sensitivity analysis using a stochastic interest rate (1984-1992).[a]

RAC[b]	ROE[c]	Estimated E/A	Interest +10%	ROLA[d] +10%	Interest Var +10%	ROLA Var +10%
			Actual 9 year average 0.684			
5.0	0.161	0.243	0.533	0.148	0.248	0.263
10.0	0.129	0.461	0.951	0.287	0.468	0.499
15.0	0.119	0.657	1.000	0.417	0.663	0.712
20.0	0.113	0.835	1.000	0.540	0.839	0.904
25.0	0.110	0.997	1.000	0.654	0.997	1.000

[a] The E/A ratio represents the equity to asset ratio.
[b] RAC is defined to be the relative risk aversion coefficient.
[c] ROE is defined to be the rate of return on equity.
[d] ROLA is defined to be the rate of return on local assets.

Table 4. Empirically determined E/A ratio and sensitivity analysis with a non-stochastic Interest rate (1984-1992).[a]

RAC[b]	ROE[c]	Estimated E/A	Interest +10%	ROLA[d] +10%	Interest Var +10%	ROLA Var +10%
			Actual 9 year average 0.684			
5.0	0.170	0.213	0.527	0.127	N/A	0.234
10.0	0.132	0.426	1.000	0.254	N/A	0.468
15.0	0.119	0.638	1.000	0.381	N/A	0.702
20.0	0.113	0.851	1.000	0.508	N/A	0.936
25.0	0.109	1.000	1.000	0.635	N/A	1.000

[a] The E/A ratio represents the equity to asset ratio.
[b] RAC is defined to be the relative risk aversion coefficient.
[c] ROE is defined to be the rate of return on equity.
[d] ROLA is defined to be the rate of return on local assets.

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