doi: 10.17221/204/2015-AGRICECON

The optimal capital structure in agricultural cooperatives under the revolving fund cycles

Yung-Chang WANG

Department of Banking and Finance, Chinese Culture University, Taipei, Taiwan

Abstract Due to the financial features specific to agricultural cooperatives, the paper constructs a constrained-maximizing model under the assumption that the financial objective of an agricultural cooperative is to maximize the present value of the patron after-tax total income on an infinite time horizon by choosing the dividend rate, the cash patronage refund rate, and the length of the revolving fund cycles. The model is solved numerically in a numerical illustration. In equilibrium, the optimal capital structure is derived for the agricultural cooperative. The effects of the changes in personal tax rates and discount rates are also explored.

Keywords: cash patronage refund rate, constrained-maximizing model, dividend rate, present value

According to the International Cooperative Alliance (ICA), a cooperative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise.[1] The cooperative is owned, controlled, and used by its member patrons. The capital structure that maximizes the share price is the optimal one sought by the investor-owned firm. However, the optimal capital structure defined is not adequate for the cooperative. The capital structure of cooperatives has been extensively discussed theoretically and empirically (Dahl and Dobson 1976; Beierlein and Schrader 1978; Barton et al. Parcell et al. 1998; Diaz-Hermelo et al. 2001; Hailu et al. 2007; Russell 2013). This paper attempts to address the cooperative optimal capital structure in a constrained-maximizing model in which the member patrons seek to maximize their after-tax total income on an infinite time horizon.

LITERATURE REVIEW

Dahl and Dobson (1976) calculate the least cost financial structure by applying the linear programming model to the financial data of 189 Wisconsin farm supply cooperatives, Beierlein and Schrader (1978) discuss the discounted cash flows, the effects of different capital structures on the growth rate and the member benefit in an agricultural cooperative. It is noted that they treat the dividend rate, the cash patronage refund rate, and the length of the revolving fund cycles as exogenous variables. They show that, given the 50% tax bracket, if the cash patronage refund rate is 20% and the length of revolving fund cycle is 10 years or longer, the member will lose money using a discount rate of 10%.

VanSickle and Ladd (1983) calculate the optimal cash patronage refund rate and the members' after-tax total profits, based on the financial data of marketing cooperatives and supply cooperatives in 1979. They find that the members' after-tax total profits increase with the length of the revolving fund cycles. The VanSicle-Ladd model is basically an equilibrium analysis, ignoring the process toward equilibrium, which could significantly affect the members' benefit.

Barton et al. (1996), maximizing the farmers' expected utility function, derive the optimal solvency ratio that is related to the risk aversion, the rate of return on assets, interest rates, the variance of the return on assets, the variance of the interest rate and the correlation between the rate of return on assets and the interest rate. They further find that the optimal solvency ratio is positively correlated with the variance of the return on assets, the variance of the interest rate, and the interest rate while it is negatively correlated with the rate of return on assets. Parcell et al. (1998), using a capital structure model incorporating stochastic interest rates, address

[1]The definition of a cooperative is given by the International Co-operative Alliance (http://ica.coop/en/whats-co-op/co-operative-identity-values-principles).

doi: 10.17221/204/2015-AGRICECON

that the optimal equity-to-asset ratio for Kansas and Midwestern agricultural cooperatives was sensitive to the changes in the business risk, but less sensitive to the changes in the interest rate risk.

Harris (1998) suggests that, for most cooperatives, a reasonable cycle for revolving the allocated equity is 5 to 10 years, while the actual cycles depend on the nature of the cooperative's operations, the business cycle and the type of capital acquired. Diaz-Hermelo et al. (2001) argue that the value of equity credits is a function of the expected incremental value of cash patronage refunds and dividends plus the discounted book value of equity credits paid to members. Ananiadis et al. (2003) suggest that the Greek dairy cooperatives should increase the contribution of retained profits to capital in order to achieve the capital intensity and the economies of scale.

Hailu et al. (2007) reveal that the financial structure and the firm size have probably contributed to the variations in the cost efficiency and obtaining a sufficient equity capital is expected to improve the cooperative efficiency. Dahlgren (2007) indicates that the "Pay As You Go" plan provides a far more attractive value proposition for the member patrons than the "Pay Later" plan. The former has higher cash patronage refunds and shorter revolving fund cycles even though the latter allocates more patronage refunds. Russell (2013) argues that even a large deviation in the current effective tax rates is not likely to affect the optimal share of the allocated earnings. He suggests that the board members focus on understanding the member risk preferences. Royer (2014) formulates an equation to show that the cost of equity is positively correlated with growth whereas it is negatively correlated with the length of the revolving period and the proportion of patronage refunds paid in cash.

This paper formulates a constrained-maximizing model under the assumption that the financial objective of a cooperative is to maximize the present value of the patron after-tax total income on an infinite time horizon. The model is established for the cooperative under the revolving fund plans with the dividend rate, the cash patronage refund rate, and the length of revolving fund cycles as endogenous variables. If the present value of the patron after-tax total income is calculated into the infinite time horizon, the model will reach equilibrium after some time periods of dynamic adjustments. The optimal length of the revolving fund cycles and the optimal debt ratio are thus obtained, thereby deriving the optimal capital structure of cooperatives.

MODEL

Boland and Barton (2013) summarize the equity management programs into five types: estate settlements, age-of-patron, revolving funds, percentage pools, and base capital plans. Barton et al. (2011) suggest that the revolving funds and base capital redemptions are the preferred methods because the equity investment of the individual patrons is maintained as close to the proportions of their use as possible. Based on the USDA Rural Business Cooperatives Programs survey of agricultural cooperatives conducted in 2008, Eversull (2010) finds that 44% of the local cooperatives used the revolving fund method of the equity redemption with the revolving fund length averages from 6 years in service cooperatives to 20 years in farm supply cooperatives and the average cash patronage refunds range from 40.43% in farm supply cooperatives to 68.26% in cotton and cotton gins cooperatives.

According to Dahl and Dobson (1976), under the Revenue Act of 1962, cooperatives must pay at least 20% of their patronage refunds in cash if they wish to deduct the total member patronage refunds from the gross income when computing the federal income tax obligations. However, both cash refunds and retained earnings must be included in the patron taxable income. Hence, a patron may lose money if she/he is in the high income tax bracket, the cash patronage refund rate is low, and the revolving fund length is long. Both the equity capital and the revolving fund capital are qualified for a claim to dividends. The dividend rate cannot exceed 8% per annum or the limit specified by state regulations, whichever is greater. (VanSicle and Ladd 1983: 275) However, most cooperatives do not pay dividends on their revolving fund capital. Cooperatives may tend to use more revolving fund capital than is necessary because it is obtained at zero cost from the standpoint of management.

From the patron point of view, the financial objective of an agricultural cooperative is to determine the dividend rate, the cash patronage refund rate, and the revolving fund length that maximize the present value of the patron after-tax total income on an infinite time horizon. The total income includes the dividend income, the cash patronage refund and equity redemption from the revolving funds. With the unallocated equity ignored, the net operating income of an agricultural cooperative is allocated among such uses as interest expenses on the long-term debt, dividends on the equity capital, the revolving fund capital, and the cash patronage refunds.

doi: 10.17221/204/2015-AGRICECON

For simplicity, it is assumed that the cooperative is a firm with a zero growth and is exempt from taxation at the firm level because it meets the legal requirements. The net operating income is thus expected to be fixed at some level in each of the future periods. The net operating income is used to pay interests on the debt and allocated to member patrons via dividends and patronage refunds. Its allocation in period j is, therefore, written as:

$$\begin{aligned} NOI &= r_j D_j + i_c CS + (1-s)PR_j + sPR_j \\ &= r_j D_j + i_c CS + PR_j \qquad j = 0,\ldots,\infty \end{aligned} \tag{1}$$

where *NOI* is the expected value of the net operating income, r_j is the cost of the long-term debt, D_j is the amount of the long-term debt, i_c is the dividend rate, *CS* is the amount of the common stock or equity capital, *PR*, the patronage refund, is the net income after dividend payment, 1-s is the percentage of *PR* allocated to the revolving fund capital, and s is the cash patronage refund rate or the proportion of the patronage refunds paid in cash. Furthermore, the cost of debt is assumed to be the increasing function of the long-term debt given by:

$$r_j = D(D_j) \qquad D' > 0 \tag{2}$$

If the total assets are fixed at an amount of *K* and financed by the long-term debt and equity capital, the following equation holds in period 0.

$$K = CS + D_0 \tag{3}$$

where D_0 is the long-term debt in the period 0. Under the revolving fund plans, the capital structure constraint is established in each period.

The following equation is applicable in the periods before the equity redemption:

$$K = CS + \sum_{i=0}^{h-1}(1-s)PR_i + D_h \qquad h = 1, \ldots, m \tag{4}$$

where *m* denotes the revolving fund length. For instance, *m* = 4 means that the revolving fund in period 0 has to be returned to the member patrons at the beginning of the period 4, the revolving fund in the period 1 has to be returned at the beginning of the period 5, and so on. The revolving fund capital accumulates up to $(1-s)(PR_0 + PR_1 + PR_2 + PR_3)$ at the beginning of the period 3, and $(1-s)(PR_1 + PR_2 + PR_3 + PR_4)$ at the beginning of the period 4. Hence, after the equity redemption, the capital structure constraint is written as

$$K = CS + \sum_{i=j-m}^{j-1}(1-s)PR_i + D_j \qquad j = m+1, \ldots, \infty \tag{4a}$$

From the period *m* on, in computing the total income, the repayment of the revolving fund capital retained in *t* – *m* has to be added to the dividend income and the cash patronage refund in t. For instance, the revolving fund capital in the period 0 has to be returned in the period m and its present value equals $(1-s)(PR_0/(1+d)^m$. The dividend income and patronage refunds, paid in cash or retained for the revolving fund capital, are subject to personal taxes.

The sum of the present values of the patron after-tax total income in the infinite time horizon is given by

$$\begin{aligned} PV\pi = &\sum_{i=0}^{\infty}[(1-\tau)i_c CS + sPR_i - \tau PR_i]/(1+d)^i + \\ &+ \sum_{i=0}^{\infty-m}(1-s)PR_i/(1+d)^{m+i} \end{aligned} \tag{5}$$

where τ is the personal tax rate applicable to member patrons and *d* is the discount rate for capitalization.

To exempt the total allocated savings from taxation at the firm level, we need the following constraint:

$$0.2 \le s \le 1.0 \tag{6}$$

One more constraint is added when a ceiling on the dividend rate is introduced.

$$i_c \le 0.1 \tag{7}$$

Under the revolving fund plans, the agricultural cooperative, facing the constraints given by Equations (1)–(4), (4a), (6), and (7), seeks to maximize Equation (5) by choosing the dividend rate, the cash patronage refund rate, and the revolving fund length. The constrained-maximizing model is given by:

$$\begin{aligned} \max PV\pi = &\sum_{i=0}^{m}[(1-\tau)i_c CS + sPR_i - \tau PR_i]/(1+d)^i + \\ &+ \sum_{i=0}^{\infty-m}(1-s)PR_i/(1+d)^{m+i} \\ s.t. \quad & NOI = r_j D_j + i_c CS + PR_j, \qquad j = 0,\ldots,\infty \\ & r_j = D(D_j) \\ & K = CS + D_0 \\ & K = CS + \sum_{i=0}^{h-1}(1-s)PR_i + D_h, \qquad h = 1,\ldots,m \\ & K = CS + \sum_{i=j-m}^{j-1}(1-s)PR_i + D_j, \qquad j = m+1,\ldots,\infty \\ & 0.2 \le s \le 1.0 \\ & i_c \le 0.1 \end{aligned} \tag{8}$$

In the model specified above, the endogenous variables include i_c, *s*, and *m*, while the exogenous vari-

doi: 10.17221/204/2015-AGRICECON

Table 1. Cost of debt ($10 000

D	0–100	100–200	200–300	300–400	400–500	500–600	600–700	>700
r	0.08	0.085	0.09	0.095	0.10	0.11	0.12	0.13

ables include *NOI, CS, K, d*, and τ. This model will be solved with a numerical illustration in the next section.

NUMERICAL ILLUSTRATION

Suppose a zero-growth agricultural cooperative with the total assets fixed at $10 000 000 in each period and financed by the equity capital and long-term debt. In the period 0, the common stock amounts to $1 800 000 and the long-term debt amounts to $8 200 000. The cost of debt increases along with the debt as it is shown in Table 1.

The value of the net operating income in each of the future periods is fixed at $1 746 700. Initially, it is assumed that there are no personal taxes (τ = 0) and the discount rate is 10%. Under the revolving fund plans, what dividend rate, cash patronage refund rate, and revolving fund length should the cooperative choose such that the present value of the patron total income is maximized on an infinite time horizon?

For simplicity, it is assumed that there are only 11 dividend rates (0, 0.01, 0.02, ..., 0.09, 0.10), 9 cash patronage refund rates (0.2, 0.3, ..., 0.9, 1.0), and 12 revolving fund lengths measured in years (1, 2, ..., 11, 12). So we have a feasible set of 1 188 (11 × 9 × 12) cells. A cell consists of a dividend rate, a cash patronage refund rate, and a revolving fund length. Given the exogenous variables, each of the cells is substituted into the model and the present value of the patron total income is computed period by period on an infinite time horizon. Of the 1188 cells, the optimal one is (m = 8, i_c = 0.1, s = 0.3) with the present value of $7 478 000. The present values of the selected 99 cells are listed in Table 2. Table 3 shows that, for the optimal cell (m = 8, i_c = 0.1, s = 0.3), long-term debt reaches equilibrium as of the period 58 due to the fact that the amount retained for the revolving fund capital approximately equals the amount retired to member patrons. In equilibrium, the amount of the long-term debt is $2 559 000. Hence, the optimal debt ratio at which the present value of the patron total income is maximized would be 25.59% ($2 559 000/$10 000 000).

With the imposition of personal taxes at a rate of 20% for all member patrons, the optimal cell turns to be (m = 11, i_c = 0.1, s = 0.3). The present value of the patron after-tax total income declines to $5 452 500. The long-term debt remains constant at the amount of $4 260 700 in the period 81 and thereafter. Thus, the optimal debt ratio increases to 42.61% ($4 260 700/$10 000 000). What if the tax rate rises to 40%, other things being equal? The optimal cell is the one (m = 4, i_c = 0.1 and s = 0.8) with an even lower present value of $3 834 100 about 51% of that in the baseline cell (m = 8, i_c = 0.1, s = 0.3). The equilibrium is attained in the period 11 and thereafter with the long-term debt fixed at the amount of $7 916 700. The optimal debt ratio rises to a height of 79.17%. The cooperative tends to rely more heavily on the debt capital as a result of higher personal tax

Table 2. Present values for selected cells (m = 8) ($10 000)

i_c, s	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
00	682.80	714.12	719.46	719.05	702.30	672.60	640.64	629.44	576.57
0.01	698.81	717.97	722.70	721.59	703.85	675.73	643.59	632.40	579.54
0.02	704.74	723.02	726.22	721.62	695.81	678.86	640.92	635.35	582.51
0.03	710.41	724.08	728.40	724.25	699.20	681.99	643.87	633.66	585.48
0.04	715.22	725.15	732.81	726.97	701.01	682.10	646.81	636.61	588.45
0.05	718.82	729.48	736.77	727.29	701.66	685.21	649.76	639.56	591.42
0.06	724.63	732.07	736.11	729.30	701.78	685.57	652.71	642.52	594.39
0.07	729.77	736.18	740.10	728.10	695.35	686.18	655.65	645.47	597.36
0.08	730.75	740.86	738.83	725.94	695.27	686.99	658.60	648.42	600.33
0.09	733.25	745.05	742.34	717.86	698.47	686.13	661.54	647.15	603.30
0.10	737.94	**747.80**	744.36	719.57	701.66	680.05	664.49	650.09	606.27

doi: 10.17221/204/2015-AGRICECON

Table 3. Long-term debt in periods 1–69 ($10 000)

	0	1	2	3	4	5	6	7	8	9
0	820.00	794.02	761.14	725.73	687.57	642.38	593.95	538.54	505.48	
1	477.15	446.66	417.10	392.83	369.17	351.16	335.76	321.66	311.45	302.48
2	294.76	288.34	282.91	278.21	274.13	270.63	267.51	264.74	263.13	261.79
3	260.65	259.71	258.94	258.32	257.82	257.45	257.15	256.90	256.70	256.54
4	256.41	256.31	256.23	256.16	256.11	256.07	256.03	256.00	255.98	255.90
5	255.95	255.94	255.93	255.92	255.92	255.91	255.91	255.91	**255.90**	255.90
6	255.90	255.90	255.90	255.90	255.90	255.90	255.90	255.90	255.90	255.90

rates because the member patrons choose to receive more cash flows in recent periods.

Finally, other things being equal, the discount rate (d) increases, say, from initially 10% to 16%. The best cell turns out to be the one (m = 3, i_c = 0.1, s = 0.3) with the present value of $4 195 700. The solution is expected. Since the member patrons value future cash flows less, they tend to choose a shorter revolving cycle and a higher cash patronage refund rate in comparison with the baseline cell (m = 8, i_c = 0.1, s = 0.3). The equilibrium attains in the period 8 and thereafter with a long-term debt of $7 916 700. The optimal debt ratio rises to 79.17% which happens to be as high as it is in the case of τ = 40%.

Distinct from the present value methods used in other studies, e.g. Beierlein and Schrader (1978) and Dahlgren (2007), this paper treats the dividend rate, the cash patronage refund rate, and the patronage refund length as endogenous variables and their optimal levels can be obtained, given exogenous variables like the personal tax rates and discount rates. More importantly, the optimal capital structure can be thus obtained when the system attains equilibrium. Moreover, Barton et al. (1996) derive the optimal solvency ratio via the maximization of the farmers' expected utility function in which the cash patronage refund rate and the patronage fund length are not addressed.

CONCLUSION

The capital structure that maximizes the share price is no more applicable to the cooperative, a business model owned, controlled, and used by its member patrons. The cooperative capital structure has long been addressed with a focus on the equity management including equity accumulation and equity redemption. Barton et al. (1996) derive the optimal capital structure from the expected utility function rather than the present value of the member patrons' benefits.

The model is solved in a numerical illustration. It is found that, other things being equal, the optimal debt ratio goes up as the personal tax rate rises, e.g. 25.59% for τ = 0, 42.61% for τ = 20%, and 79.17% for τ = 40%. It is evident that the cooperative chooses to use more debt capital rather than equity capital from retained patronage refund because either cash or the retained patronage refunds are subject to personal taxes. A lower equity capital implies that more patronage refunds are paid in cash, thereby monotonically increasing the patronage refund rates from 0.3, 0.6 to 0.8 as the personal tax rates increase. The dividend rate is not affected by changes in the personal tax rate in this illustration. However, the patronage fund cycles rise from 8 periods, 11 periods, to 4 periods as the personal tax rates rise from 0%, 20%, to 40%.

It is also found that, other things equal, the optimal debt ratio goes up as the discount rate rises, e.g. 25.59% for d = 10% and 79.17% for d = 16%. The cooperative also tends to use more debt and less allocated equity because the member patrons value the future cash flows less, thereby taking a shorter revolving cycle and a higher cash patronage refund rate. The dividend rate is not affected by changes in the discount rate either in this illustration.

REFERENCES

Ananiadis Y., Notta O., Oustapassidis K (2003): Cooperative competitiveness and capital structure in the Greek dairy industry. Journal of Rural Cooperation, 31: 95–109.

Beierlein J. G., Schrader L. F. (1978): Patron valuation of a farmer cooperative under alternative finance policies. American Journal of Agricultural Economics, 60: 636–641.

doi: 10.17221/204/2015-AGRICECON

Boland M., Barton D. (2013): Overview of research on cooperative finance. Journal of Cooperatives, 27: 1–14.

Barton D., Parcel J., Featherstone A. (1996): Optimal Capital Structure in Centralized Agricultural Cooperatives. In: WAEA Meetings, Reno/Sparks, Nevada, July 13–16.

Barton D., Boland M, Chaddad F., Evelsull E. (2011): Current challenges in financing agricultural cooperatives. Choices, 26: 12–16.

Dahl W.A., Dobson W.D. (1976): An analysis of alternative financing strategies and equity retirement plans for farm supply cooperatives. American Journal of Agricultural Economics, 58: 198–208.

Dahlgren J.J. (2007): A question of value proposition and capital structure in search of a more satisfying approach. In: The Law of Cooperatives: Business, Structure, and Legal Issues. Stoel Rives LLP press, Minneapolis, Minnesota.

Diaz-Hermelo F., Gray A., Smith E. (2001): Modeling member responses to farmer owned cooperative's alternative capital management strategies. In: The 2001 Annual Meeting of the American Agricultural Economics Association, Chicago, Illinois, August 5–8.

Eversull E. (2010): Cooperative Equity Redemption. Research Report 220. Rural Business-Cooperative Programs, United States Department of Agriculture, Washington, DC.

Hailu G., Jeffrey S.R., Goddard E.W. (2007): Capital structure, firm size, and efficiency: the case of farm petroleum and animal feed cooperatives in Canada. Agricultural Finance Review, 67: 279–293.

Harris A. (1998): Financing Agricultural Cooperatives: An Overview. A Project funded by Canada/British Columbia Farm Business Management Program.

Parcell J.L., Featherstone A.M., Barton D.G. (1998): Capital structure under stochastic interest rates: an empirical investigation of the midwestern agricultural cooperative. Agricultural Finance Review, 58: 49–61.

Royer J.S. (2014): Determining Your Cooperative's Cost of Equity. Cornhusker Economics, Department of Agricultural Economics, University of Nebraska-Lincoln Extension.

Russell L.A. (2013): Cost Efficiency and Capital Structure in Farms and Cooperatives. Unpublished Dissertation, Kansas State University.

VanSickle J.J., Ladd G.W. (1983): A model of cooperative finance. American Journal of Agricultural Economics, 65: 273–281

Received: 28th June 2015
Accepted: 18th August 2015

Contact address:

Yung-Chang Wang, Chinese Culture University, Department of Banking and Finance, 55, Hwa-Kang Road, Yang-Ming-Shan, Taipei 11114, Taiwan
e-mail: ycwwang@yahoo.com.tw