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A TEACHING-EXTENSION APPROACH TO LOAN COST COMPARISONS

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ABSTRACT

This article presents a systematic procedure for comparing three common types of loans--declining balance, add-on and discount--which have unequal and different types of finance charges. The procedure can be applied using handheld calculators, microcomputers or host computers. Its basic appeal is twofold: it provides a method useful in applied research and for teaching undergraduate students and agricultural extension clientele. A method is presented for calculating an adjusted total loan cost and an adjusted APR for each type of loan. The adjusted APR's provide the most appropriate basis for a cost comparison of potential loans.

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As the costs for borrowed capital fluctuate, agricultural producers are learning the value of shopping for a loan. Basically, they are looking for an acceptable total loan cost and a reliable lender. Most producers can successfully evaluate the lender, but they often become confused when comparing different types of loans with unequal and different loan fees. This is particularly true for add-on and discount loans as well as for various types of loan fees which are being used more frequently as financial institutions pay higher costs for money.

The objectives of this paper are: (1) to review alternative methods for comparing loans with unequal contract interest rates and different and/or unequal finance charges, and (2) to present a procedure for comparing loans that can be taught readily to undergraduate students and producers and also developed into a microcomputer program. The procedure presented allows students and other users (particularly farm managers) to compare loans by calculating an adjusted total loan cost and/or an index which includes all loan costs. If both a financial calculator and a computer are available, the manager may use either to make the calculation. Individuals using simple calculators will probably wish to calculate only the adjusted total loan cost.

METHODS TO COMPARE LOANS: BRIEF REVIEW

Since 1969, federal legislation has required lenders to inform borrowers of the annual percentage rate (APR) to the nearest 0.25 percent and the total finance charge. This law reduces the likelihood of fraudulent lending practices and improves the ability of borrowers to compare loans. However, in 1974, non-real estate agricultural loans exceeding $25,000 were exempted from truth-in-lending requirements. This was a crucial change since even small production units often require short- and intermediate-term financing in excess of this amount.

The APR, sometimes referred to as the nominal rate, is found by expressing the actuarial interest rate on an annual basis. The actuarial rate is the interest paid per payment period. For example, if the actuarial or true rate is one percent per month, the APR is 12 percent (.01 x 12).

Most financial calculators--when given the payment amount, number of payments, and the loan amount--will calculate the APR [Hewlett-Packard and Texas Instruments]. Lenders have tables which list the APR, excluding certain non-interest loan costs, by loan length and the number of payments [Board of Governors]. Normally, the borrower will not have access to a financial calculator or APR tables, or else will be unable to use them. Most producers do, however, own calculators that will perform simple mathematical functions. Consequently, it is the thesis of this article that most borrowers can calculate the APR via an equation, provided the equation is well delineated and explained.

Several equations to approximate the APR are presented in finance textbooks. The accuracy of the equations are directly related to the equation's complexity [Brake, pp. 15-18]. When several installments ($n > 4$) are involved, the actuarial rate on which the APR is based cannot be uniquely and directly determined [Barry et al., pp. 314-315]. It must be determined by trial and error by making extensive use of present value (of annuity) table or formulas. Because this approach is difficult and cumbersome, it is unacceptable to most managers. Thus, simple formulas are used to roughly approximate the APR.

One of the simpler and least accurate equations is the Constant Ratio Formula [Barry et al., p. 315]. The Direct Ratio Equation gives closer approximation of the APR, however, it is more complex [Stelson, p. 79; Brake, p. 17]. The Direct Ratio Equation is:

$$(1) \quad APR^* = \frac{(6)IN(100)}{3B(n + 1) + (n - 1)I}$$

where:

APR^* = the approximate APR,

B = beginning principal,

N = number of payments per year,

I = total amount of interest paid,

n = total number of payments to repay the loan.

The Direct Ratio Equation assumes that the interest in each payment is distributed on the basis of the sum of digits.

If a manager can mathematically solve the Constant Ratio Equation, he can, without much more effort, solve the Direct Ratio Equation.

Although it has been used only sparingly in the past, the Direct Ratio Equation can be explained as easily to students and extension clientele as the Constant Ratio Equation.

LOAN COSTS OUTLINED

Methods to increase a lender's return on loans seem to be restricted only by the imagination. The methods fall into one of two categories: (1) interest rate calculations or (2) finance charges (non-interest costs). Interest rate calculations are normally classified as interest or remaining balance, add-on, or discount loans. The more common finance charges are: (1) loan fees, (2) compensating balances, (3) required stocks, and (4) points.

Interest Rate Calculations

Total interest cost is affected by the length of the loan, number of payments, and the method used to calculate the interest charge. Interest cost for remaining balance (IORB) loans is calculated on the current principal balance at the end of each payment period. The interest cost for add-on loans is calculated for the initial loan amount over the life of the loan. With discount loans, the interest is calculated and subtracted "off the top" of the loan.

Finance Charges

Service fees and other non-interest loan costs are usually incurred by borrowers at the time of loan closing. These fees increase the APR but do not affect the contract interest rate. They may or may not be

included in the initial loan amount. If viewed from an opportunity cost perspective and if capital markets are efficient, whether these fees are borrowed or paid in cash will not affect the APR.

Loan fees or closing costs usually refer to legal expenses for a title search, recording fees, title insurance, and other miscellaneous expenses. Closing costs may be charged as a fixed amount, a percentage of the loan amount, or some combination of both. Points, which are a specified percentage of the loan, affect the loan costs in the same manner as closing costs. Both points and closing costs are equivalent to payments paid "off the top" of the loan.

Compensating balances and required stock purchases affect loan costs similarly. A compensating balance means that during the duration of the loan a minimum cash deposit must be maintained at the lending institution. With required stocks, borrowers must purchase stocks in proportion to the loan amount. In both cases, the funds or stock value are returned to the borrower at the end of the loan.

Lenders cannot require borrowers to purchase a life insurance policy. However, lenders may recommend that borrowers purchase insurance. This cost can be easily included in the analysis, but since the cost is voluntary, insurance cost is not addressed in this paper.

LOAN COMPARISONS: A TEACHING-EXTENSION EXPLANATION

Approaches for comparing loans are presented in agricultural finance tests [Barry et al., pp. 306-310; Lee et al., pp. 130-133; and Penson and Lins, pp. 176-168]. Total capital costs are affected by (1) opportunity

costs of equity funds, (2) timing of loan fee payments, (3) inclusion of loan fees in the loan amount, and (4) the timing of reimbursement of compensating balance or required stocks.

Loan comparisons are made by determining the adjusted total loan costs and by modifying the Direct Ratio Equation to include all loan costs. The method used by managers will depend on the computing hardware and knowledge available. If the manager is using a calculator, only the adjusted total loan costs normally are compared. If a computer and appropriate algorithm are available, both the adjusted loan costs and an adjusted APR* can be calculated.

An approximation of the APR which includes all loan costs can be calculated by modifying the Direct Ratio Equation. The adjusted equation is:

$$(2)\quad \text{Adjusted APR*} = \frac{(6)CN(100)}{(3)M(n+1) + (n-1)C}$$

where:

Adjusted APR* = the estimated APR,

C = finance charges + interest charges,

N = number of payments per year,

M = the money available for borrower use,

n = the total number of payments to repay the loan.

The money available for borrower use is defined as the principal amount available for borrower use at loan closing. Thus for remaining balance loans, "M" is the beginning principal minus the finance charges. For add-on and discount loans, "M" is the beginning principal minus the finance charges and the interest costs.

Several equations must be used to derive the adjusted loan costs. In this article, the following equations are used:

(3) % FINANCE CHARGE = % LOAN FEES + % POINTS + % COMPENSATING BALANCE + % REQUIRED STOCKS

(4) A. NOTE (IORB) = DESIRED LOAN/ (1 - % FINANCE CHARGE/100)

B. NOTE (ADD-ON) = (DESIRED LOAN/(1 - % FINANCE CHARGE/100)) (1 + (CONTRACT INTEREST RATE)(TERM/100)

C. NOTE (DISCOUNT) = DESIRED LOAN/(1 - ((CONTRACT INTEREST RATE) (TERM/100)) + (% FINANCE CHARGE/100))

(5) A. COST OF A FINANCE CHARGE = (NOTE)(% FINANCE CHARGE ÷ 100)

B. FOR ADD-ON LOANS = (NOTE - INCLUDED INTEREST)(% FINANCE CHARGE ÷ 100)

where:

CHARGE = closing costs, points, compensating balance or required stocks.

(6) PAYMENTS

A. IORB PAYMENTS = (NOTE AMOUNT) $\frac{\text{CONTRACT INTEREST RATE}}{1 - (1 + \text{CONTRACT INTEREST RATE})^{-\text{TERM}}}$

B. DISCOUNT & ADD-ON PAYMENTS = NOTE AMOUNT ÷ TERM

(7) A. INTEREST COSTS (IORB) = (PAYMENT)(# OF PAYMENTS) - (DESIRED LOAN + Σ FINANCE CHARGES)

B. INTEREST COSTS (OTHER) = NOTE AMOUNT - (DESIRED LOAN + Σ FINANCE CHARGES)

(8) TOTAL LOAN COSTS = INTEREST COSTS + Σ FINANCE CHARGES

(9) PRESENT VALUE OF COMPENSATING BALANCE OR REQUIRED STOCKS =

$$(\text{VALUE OF ITEM})(1 + \text{APR}^*)^{-\text{TERM}}$$

(10) ADJUSTED LOAN COSTS = TOTAL LOAN COSTS - PRESENT VALUE OF COMPENSATING BALANCE OR STOCKS

In the equations above, it was assumed that the loan is large enough to cover the finance charges. The percentage in (3) are percentages of the loan principal. The desired loan in (4) is the cash amount desired by the borrower i.e., the loan principal less finance charges as stipulated by 4(a), 4(b), and 4(c). If the borrower pays the finance charges, in cash, Equation 4 and Equation 7 would be modified as follows:

(4) A. NOTE (IORB) = DESIRED LOAN

B. NOTE (ADD-ON) = DESIRED LOAN (1 + (% CONTRACT INTEREST RATE) (TERM/100))

C. NOTE (DISCOUNT) = DESIRED LOAN/(1 - (% CONTRACT INTEREST RATE) (TERM/100))

(7) INTEREST COST = (PAYMENT)(# PAYMENTS) - DESIRED LOAN

To compare loans, several calculations must be made. However, it is not difficult to develop a computer program for this purpose or to complete the calculations on a calculator. The calculations from these equations can be explained to undergraduate students, farm managers, and other extension clientele.

Each loan must first be organized to allow the borrower to obtain the DESIRED LOAN AMOUNT. Equations 3 and 4 facilitate this. Equations 5, 6, 7, and 8 are used to calculate the TOTAL LOAN COSTS. PAYMENTS AND INTEREST COSTS are determined using the appropriate formulae of Equations 6 and 7.

Because the dollar value of the compensating balance or required stocks is returned to the borrower at the end of the loan, the analysis must be modified to credit the borrower for this return. This credit must be reflected on an annuity equivalence in order to correctly calculate an adjusted APR*. There are several methods to accomplish this. This value of the compensating balance or required stocks can be discounted and (1) added to the desired loan before calculating the APR or (2) subtracted from the total loan costs. Because the second method produced more precise results, it was used in the following analysis. INTEREST RATE in Equation 9 is the contract interest rate for IORB loans. As demonstrated in the examples, APR* must be estimated for add-on and discount loans. The Direct Ratio Equation (1) facilitates calculating this estimate.

COMPUTER MODIFICATIONS

If a computer program is being constructed to calculate the APR, the net present value (NPV) equation can be used. The NPV equation is used to find the APR that equates the equation to zero. This APR value will be identical to the internal rate of return (IRR). Since the NPV is a dollar value, the magnitude of the calculated NPV will be directly related to the size of the loan and the difference between APR and adjusted APR*. The magnitude of the error measurement can be "standardized" by dividing the calculated NPV by the desired loan amount. Thus, the computational steps are:

(1) Subsitute adjusted APR* for i in the NPV equation

$$NPV = D - \sum_{n=0}^{N} \frac{P}{(1 + i)^n} + \frac{S}{(1 + i)^N}$$

where:

D = desired loan,

P = payment,

S = stocks or compensating balance,

n = payment number and

N = total number of payments.

(2) Divide NPV by the desired loan

INDEX = NPV ÷ D

(3) Adjust APR* (i) by a specified value (i.e., .001). If INDEX > 0 then i = i - .001 or INDEX < 0 then i = i + .001.

(4) Recalculate NPV and

(5) Continue steps until NPV approaches zero.

If the actual APR is needed, the computer can continue the process until NPV equals zero. Normally a small error (i.e., .001) would be acceptable.

LOANS: ILLUSTRATION

To illustrate the application of the above algorithm, three hypothetical loans are analyzed in (Table 1). The illustration includes an interest on remaining balance, add-on and discount loan. For each loan type, various methods to increase the APR by finance charges are included.

LOAN1 is an IORB type $20,000 loan with a contract interest rate of 12 percent (Table 1). Since the loan is an IORB type, the APR before finance charges, equals 12 percent. The term is five years with five equal payments, five points, and a three percent compensating balance or stock requirements. It is assumed that funds for finance charges are borrowed.

Using the equations (3)-(10) the loan costs and adjusted APR* were calculated as follows (Table 2):

(3) % FINANCE CHARGE = 5 + 3 = 8

(4) NOTE AMOUNT = $20,000 ÷ (1 - (8 ÷ 100)) = $21,739.13

(5) COST OF POINTS = ($21,739.13)(.05) = $1,086.96

(5) REQUIRED STOCKS = ($21,739.13)(.03) = $652.17

(6) $$\text{PAYMENT} = (\$21,739.13)\frac{.12}{1-(1+.12)^{-5}} = \$6,030.65$$

(7) INTEREST COSTS = ($6,030.65)(5) - ($21,739.13) = $8,414.10

(8) TOTAL LOAN COSTS = $8,414.10 + $1,086.96 + $652.17 = $10,153.23

(9) PV OF REQUIRED STOCKS = ($652.17) x $(1 + .12)^{-5}$ = $370.06

(10) ADJUSTED LOAN COSTS = $10,153.23 - $370.06 = $9,783.17

The approximate APR can be obtained by inserting the value from Equation 10 and the desired loan amount[1] into the Direct Ratio Equation

(1) $$\text{Approximate APR*} = \frac{(6)(9,783.17)(100)}{(3)(20,000)(6) + (9,783.17)(4)} = 14.17\%$$

The accuracy of the adjusted APR* was tested by comparing it with the internal-rate-of-return with uneven cash flows. For the cash flows, $20,000 was entered for time period zero, $6,030.65 at the end of each of the next

Table 1. Data Used For Loan Comparisons

ITEM	LOAN1	LOAN2	LOAN3
Loan Type	Remaining Balance	Add-on	Discount
Loan Amount[a]	$20,000	$20,000	$20,000
Loan Length (yrs)	5	5	5
Contract Interest Rate (%)	12	8	6
Closing Costs (%)	0	2	2
Points (%)	5	0	0
Compensating Balance (%)	0	5	0
Required Stocks (%)	3	0	0

[a]Amount available for use by the borrower (DESIRED LOAN).

Table 2. Calculated Values Used To Compare Loans

ITEM	LOAN1	LOAN2	LOAN3
Loan Type	Remaining Balance	Add-on	Discount
DESIRED LOAN	$20,000	$20,000	$20,000
NOTE	21,739.13	30,107.53	29,411.77
CLOSING COSTS	0	430.11	588.24
POINTS	1,086.96	0	0
COMPENSATING BALANCE	0	1,075.27	0
STOCKS	652.17	0	0
TOTAL LOAN FEES	1,739.13	1,505.38	588.24
INTEREST	8,414.10	8,602.15	8,832.53
TOTAL LOAN COSTS	10,153.23	10,107.53	9,411.77
PRESENT VALUE[a]			
STOCKS	0	581.37(13.09%)	0
COMP. BAL.	370.06(12%)	0	0
ADJUSTED LOAN COSTS	9,783.17	9,526.14	9,411.77
PAYMENTS	6,030.65	6,201.51	5,882.35
ADJUSTED APR	14.71	14.36	14.2
ACTUAL IRR[b]	14.77	14.26	14.4

[a]The discount factor used in each PV equation is the estimated APR without the finance charge.

[b]The Internal Rate of Return was calculated with a financial calculator and cross-checked using net present value.

four periods, and $5,378.48 (payment - required stocks) in the fifth period. The actual APR calculated via an Internal-Rate-of-Return (IRR) algorithm is 14.77 percent. Thus the margin of error, 0.06 percent, is relatively small.

LOAN2 is a $20,000, five-year, eight percent add-on loan with five equal payments, closing costs of two percent and compensating balance of five percent. Using equations (3)-(10), the loan cost calculations and adjusted APR are calculated as follows:

(3) % FINANCE CHARGE = 2 + 5 = 7

(4) B. NOTE = ($20,000/(1 - 7/100))(1 + 8)(5/100)) = $30,107.53

(5) A. CLOSING COSTS = ($30,107.53 - $8,602.15)(.02) = $430.11

COMPENSATING BALANCE = ($30,107.53 - $8,602.15)(.05) = $1,075.27

(6) PAYMENT = ($30,107.53)/5 = $6,021.51

(7) INTEREST COSTS = ($30,107.53) - ($20,000 + $1,505.38) = $8,602.15

(8) TOTAL LOAN COSTS = $8,602.15 + $1,505.38 = $10,107.53

(9) $$APR^* = \frac{(6)(8,602.15)(100)}{(3)(20,000)(6) + (8,602.15)(4)} = 13.09\%$$

$$PV = (\$1,075.27)(1 + .1309)^{-5} = \$581.39$$

(10) ADJUSTED TOTAL LOAN COSTS = $10,107.53 - $581.39 = $9,526.14

The major difference between the calculations for the add-on loan and the remaining balance loan is the interest rate used to determine the present value of the compensating balance. Since the contract interest rate is not equivalent to an estimate of the APR, APR* must be estimated. Thus, the Direct Ratio Equation was used to estimate the APR* before the

calculations for Equation 9. A summary of the loan costs and APR* is presented in Table 2. Calculation of the adjusted APR* is as follows:

$$\text{ADJUSTED APR*} = \frac{(6)(9,526.14)(100)}{(3)(20,000)(6) + (9,526.14)(4)} = 14.36\%$$

LOAN3 is a six percent discount, five-year, $20,000 loan with a two percent closing cost. The calculation of the adjusted APR* is as follows:

(3) % FINANCE CHARGE = 2

(4) NOTE = ($20,000)/(1 - ((6)(5/100)) - (2/100) = $29,411.77

(5) A. CLOSING COSTS = ($29,411.77)(.02) = $583.24

(6) PAYMENT = ($29,411.77)/(5) = $5,882.35

(7) INTEREST COSTS = ($29,411.77) - ($20,000 + $538.24) = $8,823.53

(8) TOTAL LOAN COSTS = $8,823.53 + $588.24 = $9,411.77

The calculation for the discount loan differs from the previous loan types in Equation 9 only. Because there are no required stocks or compensating balance, Equation 9 is not used. The adjusted APR* is 14.20 percent as shown in Table 2 and the calculation is as follows:

$$\text{ADJUSTED APR*} = \frac{(6)(9,411.77)(100)}{(3)(20,000)(6) + (9,411.77)(4)} = 14.20$$

The adjusted APR* for LOAN2 is 14.36 percent and the actual APR via the IRR method is 14.24 percent. Thus, the margin of error is minor, 0.12 percent. For LOAN3 the approximate APR is 14.2 and the actual IRR is 14.4. Thus, the margin of error is only 0.20 percent.

Loan Examples: Summary

There is only a $371.41 difference in the adjusted loan costs and a 0.51 percent difference in the approximate effective APR for these loans (Table 2). Because the initial loan or before finance charge APR was

used to discount the required stock or compensating balance value, the adjusted loan costs for LOANS 1 and 2 could be underestimated by $42.55 for LOAN1 and $63.66 for LOAN2. However, these errors are marginal and should not affect the loan decision. Based on the adjusted loan costs, payments, and the approximate effective APR, LOAN3 would be selected.

Based on a time value or money basis as measured by the actual IRR, the borrower should select LOAN2. Again, the difference is small and the manager would base his decision on the lender's attributes rather than the loan costs.

CONCLUDING REMARKS

This article presents a systematic procedure for comparing the three most common types of agricultural loans--remaining balance, add-on and discount. The procedure is structured in such a manner that the calculation and use of loan costs and payments can be taught to undergraduate students or to agribusiness and farm users.

The calculation of equal periodic payments due only to interest costs can be explained using an annuity formula or an annuity table. This approach is shown in various finance texts and in extension-oriented instruction manuals. Texts also show the calculation of the APR using approximation formulas or by iteratively selecting interest values in the annuity formula. It is relatively simple to compare loans with equal payments and only interest costs.

The addition of various finance charges used by lenders to offset their costs on money complicates the comparison of loans. Fund inflows and/or outflows usually are unequal across periods and borrowers may

elect to borrow extra funds to cover some or all of the finance charges and to pay cash for the remaining charges. Consequently, the methods used in texts to calculate loan costs and the APR are not easily delineated, nor can they be taught easily to students or extension clientele. However, by modifying the procedures presented in texts, the loan costs and APR can be easily estimated and taught.

The method presented to calculate loan costs and the APR can be implemented via handheld calculators, microcomputers or dumb terminals connected to a host computer. Each approach uses Equations 2 through 9 to make the appropriate calculations. If a more accurate estimate of the APR is required, the procedure outlined in COMPUTER MODIFICATION can be implemented. The computer version (available upon request) is capable of handling income tax and inflationary effects allowing the APR to be presented on a before- and after-tax basis and in nominal or real units.

Feedback from user (extension clientele and students) has been positive. Users of the computer program require minimal instruction. The software is explained on an interactive user's network and educational material providing background loan information is available.

Most commercial bankers who studied the background publications for the software offered favorable comments. However, we do not have a good reading pertaining to the degree of learning and understanding by farmers and agribusinessmen. If one understands general principles of the time value of money and that front-end loan fees can increase the stated APR before such fees, then the understanding should be fairly complete. Our teaching-extension programs during the upcoming months will provide the opportunity to more fully monitor the usefulness of the approach presented in this article.

FOOTNOTE

[1]If all finance charges are included in the loan, the desired loan amount is the dollar amount requested by the borrower. If the borrower pays some or all finance charges in cash, then the desired loan amount is the requested dollar amount minus those finance charges paid in cash. The value entered is identified in the equation as the beginning principal.

REFERENCES

Barry, Peter J., John A. Hopkin and C. B. Baker. Financial Management in Agriculture. Second Edition. The Interstate Printers and Publishers, Inc., Danville, IL, 1979.

Board of Governors. Annual Percentage Rate Tables, Truth-in-Lending, Regulation 2. Vols. I and II, Federal Reserve System, Washington D.C., 1969.

Brake, John R., Interest Rate Terminology and Calculation. Agricultural Economics Report 13, Michigan State University, East Lansing, March 1966.

Hewlett-Packard. Your HP Financial Calculator: An Introduction to Financial Concepts and Problem Solving. Hewlett-Packard Company, Corvallis, Oregon. February 1978.

Lee, Warren F., Michael D. Boehlje, Aaron G. Nelson and William G. Murray. Agricultural Finance. Seventh Edition, The Iowa State Press, Ames, Iowa. 1980.

Penson, John B. Jr. and David A. Lins, Agriculture Finance: An Introduction to Micro and Macro Concepts. Prentice-Hall, Inc. Englewood Cliffs, N.J., 1980.

Stelson, H. E., Mathematics of Finance. D. Van Nostrand Co., Inc., Princeton, New Jersey, p. 76, 1963.

Texas Instruments. Business Analyst-II: Financial Calculator with Statistics. Texas Instruments Inc., Dallas, Texas, 1978.