ECONOMICS

Calculating Loan Interest   no. 3.758
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Any time money is borrowed, interest is charged. How interest is computed often is confusing, as is the manner in which the interest rate is stated. The federal Truth in Lending Act of 1968 (and its successor, the Truth in Lending Simplification and Reform Act of 1980) "was enacted in order to assure a meaningful disclosure of credit terms and to protect the consumer against inaccurate and unfair credit billing and credit card practices. The act imposes detailed reporting requirements on lenders. However, agricultural transactions are fully excluded from its application." (Uchtmann, D.L., J. W. Looney, N.G.P. Krausz, and H.W. Hannah, *Agricultural Law: Principles and Cases*. New York: McGraw-Hill, Inc., 1981, p. 362.) Despite exclusion from the act, most agricultural lenders follow its spirit and intent.

A main provision of the Truth in Lending Act was that lenders must calculate and show borrowers total finance charges over the life of the loan, as well as the annual percentage rate (APR). The APR provides a common basis to compare interest charges associated with the loan. The APR may or may not be the same as the contractual rate (the rate actually stated on the loan contract). The difference between the two rates is due to the different methods of computing the total interest charge.

Methods of Computation

Lenders use three major methods to calculate interest charges:
1. the add-on method,
2. the discount method, and
3. the remaining balance method.

The first two methods are not commonly used by major agricultural lenders, but are used by finance companies that may make some agricultural loans.

Add-On Method

Under the add-on method, the lender calculates the total interest charge by multiplying the entire loan amount by the contractual interest rate, and then multiplying the total interest cost by the period (months, years) covered by the loan. The interest charge is added to the principal to determine the total amount to be repaid. This amount is then divided by the number of repayment periods to determine each payment. The total interest charge is thus: $I = A \times i_c \times N$ where I = total interest charge over the life of the loan, A = amount of loan, i_c = contractual interest rate per time period, and N = number of periods covered by the loan.

The periodic payment is: $B_n = (A + I) / N$, where B = total payment and n = repayment periods under consideration.

For an example of add-on interest, assume a $3,000 loan to be repaid in two annual installments. The annual contractual interest rate is 6 percent. Then,

Quick Facts...

The annual percentage rate provides a common basis to compare interest charges associated with the loan. The contractual rate is the interest rate actually stated on the loan contract.

Lenders use the add-on method, the discount method and the remaining balance method to calculate interest charges. Agricultural lenders do not commonly use the first two methods.

The annual percentage rate stated for loans also should reflect all loan service costs and stock purchase requirements.

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the total interest charge is: $I = \$3,000 \times .06 \times 2 = \$360$ and the annual payments will be: $B = (\$3,000 + 360) / 2 = \$1,680$.

Discount Method

The discount method calculates total interest the same way as the add-on method, with one exception. The interest is subtracted from the loan amount and the borrower receives the balance. The total interest charge is: $I = A \times i_c \times N$

The amount the borrower receives is: $L = A - I$ where L=loan proceeds and the periodic payment is: $B_n = A / N$. Using the same data as before (\$3,000 loan amount, 6 percent annual interest rate, over 2 years), the total interest charge is again \$360: $I = \$3,000 \times .06 \times 2 = \$360$.

The borrower would receive \$2,640: $L = \$3,000 - \$360 = \$2,640$ and would repay two installments of \$1,500 each: $B_n = \$3,000 / 2 = \$1,500$

Remaining Balance Method

When the remaining balance method is used, the interest charge is computed in each period by multiplying the contractual interest rate by the principal balance remaining at the beginning of the period (the unpaid balance). The major difference between this method and the previous two, beyond the complexity of the mathematical calculations, is that interest is not charged on principal that has been repaid.

The total interest charge, the periodic interest payment, and the periodic principal payment all depend on the method selected for repayment. Two methods are commonly used: the equal total payment plan (Standard plan) and the equal total principal plan (Springfield plan). To illustrate interest computation for these two repayment methods, assume a \$10,000 loan at a 12 percent annual contractual rate to be repaid in eight annual payments.

Equal Total Payments. Under the equal total payment method, the annual payment for this loan is \$2,013.03 for each of the 8 years. This was determined by multiplying the amortization factor (see Table 3) for 12 percent interest and 8 year payment period times the loan amount. The portion of each payment that is interest and the portion that is principal will vary with each payment. At the end of the first year, interest is charged on the full \$10,000 principal outstanding: $I_1 = \$10,000 \times 0.12 = \$1,200$.

Thus, the principal payment is the difference: $C_1 = \$2,013.00 - \$1,200 = \$813.00$, where C = the principal payment.

The remaining principal balance after the first payment is: $R_1 = \$10,000 - \$813.00 = \$9,187.00$, where R = the principal balance.

Interest in the second year is charged on the remaining balance: $I_2 = \$9,187.00 \times 0.12 = \$1,102.44$, which yields: $C_2 = \$2,013 - \$1,102.44 = \$910.59$ and $R_2 = \$9,187.00 - \$910.59 = \$8,276.41$.

A similar set of steps is followed each year thereafter.

Equal Principal Payments. Under the equal principal payment plan, interest charges are calculated in a similar manner. The primary difference is that equal principal payments are made. In addition, the annual total repayments will decline each year due to a declining principal balance upon which interest is calculated: $I_1 = \$10,000 \times 0.12 = \$1,200$.

But the principal payment is: $C_1 = \$10,000 / 8 = \$1,250$.

Thus, the total payment for the first year is: $B_1 = \$1,250 + \$1,200 = \$2,450$ and the remaining principal balance is: $R_1 = \$10,000 - \$1,250 = \$8,750$.

In the second year: $I_2 = \$8,750 \times 0.12 = \$1,050$, $C_2 = \$1,250$, $B_2 = 1,250 + \$1,050 = \$2,300$, and $R_2 = \$8,750 - \$1,250 = \$7,500$.

Table 1: Example of interest charge methods (principal $10,000, interest rate 12%, 8 annual payments).

| | | | Remaining Balance | |
| | | | Standard | Springfield |
	Add-On	Discount	Plan	Plan[1]
Amount received	$10,000	$ 400	$10,000	$10,000
Total repaid	19,600	10,000	16,104	15,400
Total interest paid	9,600	9,600	6,104	5,400
Equal annual payments	2,450	1,500	2,013	1,925[2]
APR (percent)	17.97	375.00	12.00	10.74

[1] Remaining balance method with equal principal payment
[2] Average annual payment.

Table 2: APR under different maturity and service charge assumptions ($10,000 loan, 10% interest rate).

Service charge (% of loan amt)	Length of loan repayment			
	3 yr	5 yr	10 yr	20 yr
0	10.00	10.00	10.00	10.00
1	10.58	10.40	10.24	10.15
2	11.16	10.80	10.48	10.30
3	11.74	11.20	10.72	10.45
4	12.32	11.60	10.96	10.96
5	12.90	12.00	11.20	10.75

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Comparison of Interest Charges

Given a contractual interest rate and the terms of the loan, total interest charges will vary significantly. To illustrate, assume a $10,000 loan is taken out at an annual contractual interest rate of 12 percent to be repaid in annual payments over 8 years. Table 1 shows how the different methods of computing interest charges affect the total interest cost.

The add-on and discount methods result in significantly higher interest charges and APRs, thus, the contractual interest rates substantially understate the true or annual percentage rate. In fact, the discount method produces ridiculous results for a loan of 8 years. But this method usually is used by finance companies only for short-term loans such as 30, 60 or 180 days. When either the add-on or discount method is used, lenders usually quote an interest rate substantially lower than rates quoted by other lenders, thus for short-term loans, the extremely high APR figures indicated in Table 1 will not be correct. Few agricultural loans are written using these methods, but some people may have consumer loans that use either add-on or discount interest.

Variable Interest Rates and Partial Year Loans

Interest rates usually are stated on an annual basis, but they are sometimes quoted on a monthly or even on a weekly or daily basis. In fact, most department store or bankcard charge accounts are stated on a monthly basis. Consequently, it is important to determine the time period for which the stated interest rate applies. Furthermore, even if an annual interest rate is stated, the length of most agricultural operating loans is less than a full year, and most credit card charges are paid off much more quickly than 1 year.

Partial Years

If interest is stated on an annual basis and is calculated using the remaining balance method, but the loan is paid off in less than 1 year, the amount of interest due can be calculated as: $I = A \times i$ (Number of months money is used / 12) or $I = A \times i_m \times$ (Number of days money is used / 365).

If interest is stated on a monthly basis (i_m), calculate interest as: $I = A \times i_m \times$ (Number of months money is used).

Variable Interest

In recent years, it has become common for lending institutions to adopt a variable interest rate policy. Typically, the interest rate will be stated on an annual basis and will not change more often than once each month. If interest is calculated on the remaining balance method, it can be calculated in a way similar to the process for partial year loans. For example, if the interest rate was 12 percent for 2 months, 13 percent for 3 months and 14 percent for 7 months, the annual interest is: $I = A \times 0.12 \times (2 / 12) + A \times 0.13 \times (3 / 12) + A \times 0.14 \times (7 / 12)$.

If applied to the add-on or discount methods, a new calculation would have to be made each time the rate changed.

Table 3: Amortization table--Annual principal and interest paid per $1 borrowed by length of loan and interest rate.

No. of annual payments	Annual Interest Rate													
	8.00%	8.50%	9.00%	9.50%	10.00%	10.50%	11.00%	11.50%	12.00%	12.50%	13.00%	13.50%	14.00%	15.00%
3	0.38803	0.39154	0.39505	0.39858	0.40211	0.40566	0.40921	0.41278	0.41635	0.41993	0.42352	0.42712	0.43073	0.43798
4	0.30192	0.30529	0.30867	0.31206	0.31547	0.31889	0.32233	0.32577	0.32923	0.33271	0.33619	0.33969	0.34320	0.35027
5	0.25046	0.25377	0.25709	0.26044	0.26380	0.26718	0.27057	0.27398	0.27741	0.28085	0.28431	0.28779	0.29128	0.29832
6	0.21632	0.21961	0.22292	0.22625	0.22961	0.23298	0.23638	0.23979	0.24323	0.24668	0.25015	0.25365	0.25716	0.26424
7	0.19207	0.19537	0.19869	0.20204	0.20541	0.20880	0.21222	0.21566	0.21912	0.22260	0.22611	0.22964	0.23319	0.24036
8	0.17401	0.17733	0.18067	0.18405	0.18744	0.19087	0.19432	0.19780	0.20130	0.20483	0.20839	0.21197	0.21557	0.22285
9	0.16008	0.16342	0.16680	0.17020	0.17364	0.17711	0.18060	0.18413	0.18768	0.19126	0.19487	0.19851	0.20217	0.20957
10	0.14903	0.15241	0.15582	0.15927	0.16275	0.16626	0.16980	0.17338	0.17698	0.18062	0.18429	0.18799	0.19171	0.19925
11	0.14008	0.14349	0.14695	0.15044	0.15396	0.15752	0.16112	0.16475	0.16842	0.17211	0.17584	0.17960	0.18339	0.19107
12	0.13270	0.13615	0.13965	0.14319	0.14676	0.15038	0.15403	0.15771	0.16144	0.16519	0.16899	0.17281	0.17667	0.18448
13	0.12652	0.13002	0.13357	0.13715	0.14078	0.14445	0.14815	0.15190	0.15568	0.15950	0.16335	0.16724	0.17116	0.17911
14	0.12130	0.12484	0.12843	0.13207	0.13575	0.13947	0.14323	0.14703	0.15087	0.15475	0.15867	0.16262	0.16661	0.17469
15	0.11683	0.12042	0.12406	0.12774	0.13147	0.13525	0.13907	0.14292	0.14682	0.15076	0.15474	0.15876	0.16281	0.17102
20	0.10185	0.10567	0.10955	0.11348	0.11746	0.12149	0.12558	0.12970	0.13388	0.13810	0.14235	0.14665	0.15099	0.15976
25	0.09368	0.09771	0.10181	0.10596	0.11017	0.11443	0.11874	0.12310	0.12750	0.13194	0.13643	0.14095	0.14550	0.15470
30	0.08883	0.09305	0.09734	0.10168	0.10608	0.11053	0.11502	0.11956	0.12414	0.12876	0.13341	0.13809	0.14280	0.15230
35	0.08580	0.09019	0.09464	0.09914	0.10369	0.10829	0.11293	0.11760	0.12232	0.12706	0.13183	0.13662	0.14144	0.15113
40	0.08386	0.08838	0.09296	0.09759	0.10226	0.10697	0.11172	0.11650	0.12130	0.12613	0.13099	0.13586	0.14075	0.15056