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Long-term loan repayment methods

Paul H. Gutierrez and Norman L. Dalsted[1]

Quick Facts

Long-term loans can be repaid in a series of annual, semi-annual or monthly payments.

Payments can be calculated by equal total payments, equal principal payments or equal payments with a balloon payment at the end to repay the balance.

The Farmer's Home Administration usually requires equal total payments for intermediate and long-term loans.

An amortization table can determine the annual payment when the amount of money borrowed, the interest rate and the length of the loan are known.

Money borrowed for long-term capital investments usually is repaid in a series of annual, semi-annual or monthly payments. There are several different ways the amount of these payments can be calculated. For example, loans may be repaid in a series of 1.) equal total payments per time period (amortization); 2.) equal principal payments per time period; or 3.) equal payments over a specified time period with a balloon payment due at the end to repay the balance.

When the equal total payment method of amortizing a loan is used, each payment includes the accrued interest on the unpaid balance, plus some principal. The amount of the annual payment applied toward the principal will increase with each payment. Table 1 illustrates how the amounts of interest and principal in an equal total payment change over the loan period. The equal principal payment plan also provides for payment of accrued interest on the unpaid balance, plus an equal amount of the principal. The total payment will decline through time because, as the remaining principal balance declines, the amount of interest accrued declines. Table 2 illustrates interest and principal payments over the loan period.

These two payment plans are the most common methods financial institutions use to compute loan payments on long-term investments. Individual lenders will use both of these, but also may use a balloon system. The balloon payment method often is used to reduce the size of periodic payments, but also to shorten the total time period in which the loan is fully repaid. To accomplish this, a portion of the principal will not be amortized (paid off in a series of payments) but will be due in a lump sum at the end of the loan period. For many borrowers, this means the amount to be repaid in the lump sum must be refinanced, which may be difficult.

Borrower Use of Loan Repayment Principles

To calculate the amount of the loan payments, all terms of the loan must first be agreed upon. These include the interest rate, timing of payments (e.g., monthly, quarterly, annually), length of the loan (time period to repay the loan) and original amount of the loan. Commercial lenders can rapidly compute the loan repayment schedule and process the loan contract for the borrower of the current status of the loan.

It also is necessary for the borrower to understand how loans are amortized, how to calculate loan payment amounts and remaining principal balances as of a particular date, and how to calculate principal and interest portions of the next payment. This information is valuable for planning purposes before an investment is actually made, for tax management and planning pur-

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poses before the loan statement is received, and for preparation of financial statements. Because many farmers and ranchers now have electronic calculators or microcomputers, the calculations can be done easily and quickly. The use of printed tables is still common, but tables are less flexible because of the limited number of interest rates and time periods for which the tables have been calculated.

Regardless of whether the tables or a calculator is used, work through an example to help apply the concepts and formulas to a specific case.

Lenders Use of Different Methods

Different lenders use different methods to calculate loan repayment schedules depending on their specific needs, the needs of the borrower, the institution's interest rate policy (whether rates are fixed or variable), the time length of the loan, and the purpose of the borrowed money. Typically, home mortgage loans, automobile and truck loans, and consumer installment loans through banks, savings and loan institutions, finance companies, or dealerships will be amortized using the equal total payment method.

The Farmer's Home Administration usually requires equal total payments for intermediate and long-term loans.

The Federal Land Bank uses the equal total payment method for many loans. Under certain conditions the FLB may require more principal be repaid earlier in the life of the loan, so they will use the equal principal payment method. For example, in marginal farming areas or for ranches with high percentage of grazing land in non-deeded permits, the FLB may require equal principal payments.

Production Credit Associations usually schedule equal principal payment loans for intermediate term purposes. (Operating notes are calculated slightly differently.) Other commercial lenders use both methods.

Lenders often try to accommodate the desires and needs of their borrowers and let the borrower choose which loan payment method to use. A comparison of tables 1 and 2 indicates advantages and disadvantages of each plan. The equal principal payment plan incurs less total interest over the life of the loan because the principal is repaid more rapidly. However, it requires higher annual payments in the earlier years when money to repay the loan is typically shortest. Furthermore, because the principal is repaid more rapidly, interest deductions for tax purposes are slightly lower. Remember that principal payments are not tax deductible and the choice of repayment plans has no effect on depreciation.

The reason for the difference in amounts of interest due in any time period is simple; interest is calculated and paid on the amount of money that has been loaned but not repaid (the remaining unpaid principal balance of the loan). In other words, interest is almost always calculated as a percentage of the unpaid (or remaining) balance:

$I = i \times R$

Where

I = interest payment

i = interest rate

R = unpaid balance

Amortization Tables

An amortization table can determine the annual payment when the amount of money borrowed, the interest rate and the length of the loan are known. For example, an 8-year loan of $10,000 made at an annual rate of 12 percent would require $2,013 payment each year. Refer to Table 3 under the 12 percent column and across from 8 years and find the factor 0.20130. This indicates, for each dollar borrowed, the repayment for interest and principal to retire the loan in 8 years will require 0.20120 cents per year. Thus, the annual loan payment of $10,000 x 0.2013 = $2,013. Use Table 3 to determine the annual payments for loans with the interest rates from 8 percent to 15 percent financed for the period shown in column one.

Using the Formulas

Because of the infinite number of interest rate and time period combinations it is easier to calculate with a calculator or microcomputer than use a printed table. This is especially true when fractional interest rates are charged and when the length of the loan is not standard. Variable interest rates and the use of interest rates carried out to two or three decimal places also makes the use of printed tables difficult.

Equal Total Payments

For equal total payment loans calculate the total amount of the periodic payment using the following formula:

$B = (i \times A) \div [1-(1+i)^{-N}]$

Where:

A = amount of loan

B = periodic total payment

N = total number of periods in the loan

The principal portion due in period n is:

$C_n = B \times (1+i)^{-(1 + N + n)}$

Where:

C = principal portion due

n = period under consideration

the interest due in period n is:

$I_n = B - C_n$

and the remaining principal balance due after period n is:

$R_n = (I_n \div i) - C_n$

Equal Principal Payments

For equal principal payment loans, the principal portion of the total payment is calculated as:
$C = A \div N$
the interest due in period n is:
$I_n = [A-C_{(n-1)}] \times i$
and the remaining principal balance due after period n is:
$R_n = (I_n \div i) - C$

Calculating Payments with Variable Interest Rates

Many lenders (especially the Farm Credit System) now use variable interest rates, which greatly complicates calculation of the amount of payment due. The most common way to amortize a loan under a variable interest rate calculates the amount of principal due, based on the interest rate in effect on the payment due date. The interest payment is then calculated in the normal fashion.

To illustrate, assume the loan terms used in tables 1 and 2: a $10,000 loan at 12 percent interest and an 8-year repayment schedule using the equal total payment method. Assume the interest rate is variable; it remains at 12 percent for the first six months of the year and then changes to 13 percent for the last six months. Instead of calculating the principal due at the end of the first year on the basis of 12 percent, it is calculated using 13 percent. Apply the formulas of the previous section to get:

$C_1 = i \times A \div [1-(1+i)^{-N}] \times (1 + i)^{-(1+N-n)} = \$783.87$
using i = 0.13. Consequently, the principal payment is $783.87 instead of $813.03. The interest payment is calculated at 12 percent for six months and at 13 percent for six months:
$I_1 = [\$10{,}000 \times 0.12 \times (6 \div 12)] + [\$10{,}000 \times 0.13 \times (6 \div 12) = \$1{,}250$
Thus the total payment for the first year is:
$B_1 = \$783.87 + \$1{,}250 = \$2{,}033.87$
and
$R_1 = \$10{,}000 - \$783.87 = \$9{,}216.13$

To carry this example one step further, assume the interest rate in the second year of the note remains at 13 percent for two months and then moves to 14 percent and stays there for 10 months. The same formula is used, but now C is calculated using
i = 0.14 and n = 2. Thus,
$C_2 = \$861.50$
and interest is:
$I_2 = [\$9{,}216.13 \times 0.13 \times (2 \div 12)] + [\$9{,}216.13 \times 0.14 \times (10 \div 12)]$
$= \$199.68 + \$1{,}075.22 = \$1{,}274.90$
$R_2 = \$9{,}216.13 - \$861.50 = \$8{,}354.63$
$B_2 = \$861.50 + \$1{,}274.90 = \$2{,}136.40$

This method computes the amount of principal and total payments and is used only for equal total payment loans. If the loan schedule was originally specified as the *equal principal payment* plan, the calculations are much easier because C (principal payments) remains the same for each period. Interest is calculated in the same manner as in the example above.

Table 1: Example of loan amortization—equal total payment plan.

Year	Annual payment	Principal payment	Interest	Unpaid balance
Loan amount $10,000, annual rate 12% 8 annual payments				
				$10,000.00
1	$ 2,013.03	$ 813.03	$1,200.00	9,186.87
2	2,013.03	910.59	1,102.44	8,276.38
3	2,013.03	1,019.86	993.17	7,256.52
4	2,013.03	1,142.25	870.78	6,114.27
5	2,013.03	1,279.32	733.71	4,834.95
6	2,013.03	1,432.83	580.20	3,402.12
7	2,013.03	1,604.77	408.26	1,797.35
8	2,013.03	1,797.35	215.68	0
Total	$16,104.24	$10,000.00	$6,104.24	0

Table 2: Example of loan schedule—equal principal plan.

Year	Annual payment	Principal payment	Interest	Unpaid balance
Loan amount $10,000, annual rate 12% 8 annual payments				
				$10,000.00
1	$ 2,450.00	$ 1,250.00	$1,200.00	8,750.00
2	2,300.00	1,250.00	1,050.00	7,500.00
3	2,150.00	1,250.00	900.00	6,250.00
4	2,000.00	1,250.00	750.00	5,000.00
5	1,850.00	1,250.00	600.00	3,750.00
6	1,700.00	1,250.00	450.00	2,500.00
7	1,550.00	1,250.00	300.00	1,250.00
8	1,400.00	1,250.00	150.00	0
Total	$15,400.00	$10,000.00	$5,400.00	0

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

No. of	Annual Interest Rate													
annual pymts	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