

**Interest Rates on Loans**  
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Lending institutions frequently cite an annual percentage rate or APR. This is based on an approximate formula for the interest rate, and it can be close to the correctly computed interest rate. For example, a lender might claim an APR of 12.41% per year, whereas an engineering economist might compute the interest rate to be 1% per month, so the effectively yearly rate is 12.68% ( $1.01^{12}-1$ ). The difference between the claimed rate of 12.41% and the computed rate of 12.68% is small in this case. However, major differences in claimed versus computed interest rates occur if lenders and borrowers use different sets of cash flows, as explained in the following section.

### **Lender and Borrower Cash Flows**

Suppose that a lender charges \$20 for administrative costs and another \$30 for a credit check associated with a \$1,000 loan for which \$1,100 is to be repaid after one year. The lender might claim that the interest rate is  $(1,100-1,000)/1,000$  or 10% per year. This claim is based on the profit the lender realizes, assuming that the administrative and credit checking costs are accurate.

The viewpoint of the borrower is different. He or she is justified in asserting that any required additional payments beyond the amount borrowed are a cost of the loan, or interest. Suppose that the lender requires the borrower to pay the \$50 noted above before receiving the loan. Then the lender hands the borrower \$1,000 and receives \$1,100 after a year. From the viewpoint of the borrower, \$1,000 is received in exchange for a payment of \$50 at time 0 and another payment of \$1,100 at time 1. The borrower's net cash flow at time 0 is \$950 ( $1,000-50$ ), in exchange for \$1,100 a year hence, for an interest rate of  $(1,100-950)/950$  or 15.79% per year.

A similar example occurs if the lender hands the borrower \$1,000 at time 0, but bases the loan on \$1,050 ( $1000+50$ ) and requires a payment of \$1,155 ( $1,050$  plus 10% of  $1,050$ ) a year hence. In this case the borrower's net cash flow at time 0 is \$1,000, in exchange for \$1,155 a year hence for an interest rate of  $(1,155-1,000)/1,000$  or 15.5% per year.

The prudent borrower discovers all cash flows, and then computes the interest rate based on those cash flows. On the other hand, lenders might wish to exclude certain categories of payments, such as credit checks, from the interest computations or use approximate formulas. The Truth in Lending Law does not effectively address these issues.

### **Cash Flows Associated With Loans**

Borrowers always should compute the interest rate from their viewpoint and shop for the lowest rate that they can find, if all other aspects of the loan are equal. Provided below are *some* cash flows of which borrowers should be aware. Some lenders do not initially disclose all of

these items unless they are directly asked, so just shopping for loans based on newspaper ads can be misleading and is not advised. Moreover, a borrower should always insist upon reading the loan contract before signing it.

1. **Loan charges:** These are charges associated with processing the loan, typically payable at the time of the loan. For example, "origination fees" on a house loan, might be 3 points, or 3% of the amount borrowed.
2. **Credit checks:** These checks are paid for by the borrower to reduce the risk to the lender.
3. **Additional costs for services:** If legal work is required, such as checking the title on a house, then some lenders require that only approved lawyers can be used. Similarly, sometimes only approved surveyors can be used. If the costs of these restricted services should be \$1,500 higher than available elsewhere, then this extra \$1,500 would be an additional cost imposed by the lender.
4. **Credit life insurance:** Some lenders require, as a condition of the loan, a credit life policy that pays off the loan in event of the borrower's death. If the borrower would not purchase such a policy unless forced to do so, then this becomes a cost of the loan. For example, some borrowers might feel that their life insurance is adequate to pay off a loan, but have to buy credit life insurance anyway.
5. **Title insurance:** Home loans usually require title insurance payable at the time of the loan. The policy usually is set up to pay the lender if the house is lost due to a bad title. Borrowers frequently want such a policy, so it can be questionable if this is an additional cost of the loan. However, if the lender requires a specific, more expensive insurer, then any *extra* costs of insurance would be a cost of the loan from the viewpoint of the borrower.
6. **Other insurance:** Lenders might require fire insurance on a house or collision insurance on an automobile. Premiums in excess of whatever coverage the lender would normally buy should be considered costs of the loan.
7. **Escrow payments:** Some lenders require monthly payments into a non-interest-paying account called an escrow account that is used to pay insurance premiums or taxes. Such accounts should be avoided if possible, and an interest bearing account should be used. Suppose that taxes and insurance are \$1,200 per year, so the lender requires monthly escrow payments of \$100 per month. If the borrower could have \$1,200 at the end of the year by putting \$98 per month into an interest-paying account, then \$2 has been added to the monthly cost of the loan.
8. **Early repayment penalties:** A borrower might plan on paying off the loan early or making early principal payments to reduce either the note or the number of payments. Some lenders impose a penalty for doing this, and this is a cost of the loan.
9. **Other charges:** The prudent borrower checks for cash flows such as those described above and always asks, "Are there any other charges or expenses associated with the loan?" Moreover, one should always ask for copies of any work sheets and insist upon reading the loan contract before signing it.

## Example

Suppose that a lender will loan \$20,000 for a car at "9% per year" over 4 years. Then the claimed rate is 9%. The lender states that the monthly note on the loan is \$497.70. *If* there are no other cash flows, then the monthly interest rate can be determined from

$$497.70 = 20,000(A/P, i_m, 48).$$

to be 0.75% per month (i.e., 9% per year compounded monthly). This means that the actual yearly rate is 9.3807% ( $1.0075^{12} - 1$ ).

However, sometimes there are other cash flows, and determining the rate from the borrower's viewpoint requires determining *all* of them before solving for the unknown interest rate.

For example, suppose that the borrower obtains the following additional information:

1. Loan charges: Administrative costs for processing the loan are \$35.
2. Credit check: A credit check costs \$30.
3. Legal services: The borrower pays the lender \$123 for notary fees and processing the title. The lender requires your accepting this service as a condition of the loan, but you determine that this is \$47 *more* than you would have to pay elsewhere.
4. Insurance: The borrower must pay \$1,200 at time 0 to obtain the insurance required by the lender, and then begin making escrow payments of \$100 for the following year. The borrower would be satisfied with a policy costing \$980 at time 0, and thereafter paying \$80 per month into an interest bearing account that will accumulate to \$980 each year. Thus the extra costs are \$220 ( $1,200 - 980$ ) at time 0, and then \$20 ( $100 - 80$ ) per month.
5. Early repayment: The borrower plans on keeping the car for three years, and then paying off the balance. There is a \$150 early repayment penalty, which is a cost of the loan. The lender states that the total amount of the payoff would be \$5,841.17, including the \$150.

Now the yearly cash flows due to the loan can be computed. From the viewpoint of the borrower, they include any flows caused by the loan that would not have occurred if the borrower paid cash.

Time	Cash Flow
0	$19,668.00 = 20,000 - 35 - 30 - 47 - 220$
1-36	$-517.70 = -497.70 - 20$
36	$-5,621.17 = -5,841.17 + 220$

The \$220 at time 36 recognizes that the contents of the escrow account (\$1,200) would be returned to the borrower at time 36, providing \$220 more ( $1,200 - 980$ ) than the borrower would have had in the interest bearing account had not escrow payments been required. If the additional escrow payment of \$20 is counted as a cost, then the additional \$220 at time 36 must be recognized as a benefit.

The monthly interest rate is the solution of

$$19,668.00 = 517.70(P/A, i_m, 36) + 5,621.17(P/F, i_m, 36)$$

or 0.96289%. The effective yearly rate is

$$12.19\% = (1.0096459)^{12} - 1.$$

This is the computed rate from the viewpoint of the borrower.

## Records

It is required that complete records be kept of the offering of each potential lender. A reasonable format for this is shown below, using data from the above example where possible.

### *Lending institution*

Address  
Phone number  
Person contacted  
Date

### *Loan*

The requested loan was \$20,000 for a new car, payable with monthly notes over 4 years. An early repayment after payment 36 is planned.

### *Lender's offering*

The lender offers to lend the \$20,000 at a rate of "9% per year."

### *Cash Flows*

1. Loan amount: The borrower will receive a check for \$20,000 at time 0.
2. Principal and interest: The borrower makes a principal and interest payment of \$497.70 per month.
3. Loan charges: Administrative costs for processing the loan are \$35.
4. Credit check: A credit check costs \$30.
5. Legal services: The borrower pays \$47 more than elsewhere for notary fees and processing the title.
6. Insurance and escrow: The borrower must pay \$1,200 at time 0 to obtain the insurance required by the lender, and then begin making escrow payments of \$100 for the following year. The borrower would be satisfied with a policy costing \$980 at time 0, and thereafter making paying \$80 per month into an interest bearing account for the following year. Thus the extra costs are \$220 at time 0, and then \$20 per month. The early repayment at time 36 will result in a return of \$1,200, or \$220 more than would have been in the interest paying account (\$980).
7. Early repayment: The borrower plans on keeping the car for three years, and then paying off the balance. There is a \$150 early repayment penalty, which is a cost of the loan. The lender states that the total amount of the payoff would be \$5,841.17.
8. Other charges: The borrower asked if there were any other charges, and the lender stated that there were not.
9. Documentation: The borrower asked for a copy of the any work sheets or loan contract used by the lender, and the lender provided a copy of a work sheet, but declined to provide a copy of the loan contract. The figures on the work sheet were in agreement with the figures cited above.

### Cash Flows

Time	Cash Flow
0	$19,668.00 = 20,000 - 35 - 30 - 47 - 220$
1-36	$-517.70 = -497.70 - 20$
36	$-5,621.17 = -5,841.17 + 220$

### Computed Rate

1. The monthly interest rate is the solution of

$$19,668.00 = 517.70(P|A, i_m, 36) + 5,621.17(P|F, i_m, 36)$$

or 0.96289%.

2. The effective yearly rate from the borrower's viewpoint is

$$12.19\% = (1.0096459)^{12} - 1.$$

3. The lender offered to lend the \$20,000 at a rate of "9% per year."

### Final Balance

In this case, it is assumed that all loans are for 36 months, so it is necessary to determine the change due to borrowing in a savings account paying 6% per year compounded monthly (1/2% per month).

For the current loan, the borrower must write a check to the car dealer for \$20,000. Since only a net of \$19,668 was received from the lender, the borrower must pay the remaining \$332 (20,000-19,668) to the car dealer out of savings. The effect of this loan on the final balance after 36 months of an account paying 6% per year compounded monthly (1/2% per month) is:

$$-\$26,382.77 = -332(F|P, 1/2\%, 36-0) - 517.70(F|A, 1/2\%, 36-0) - 5,621.17$$

If the borrower had taken \$20,000 out of savings to pay of the car, then the effect of paying cash on the account would be:

$$-\$23,933.61 = -20,000(F|P, 1/2\%, 36-0)$$

Choosing this loan instead of paying cash decreases the borrower's final balance by an additional:

$$\$2,449.16 = 26,382.77 - 23,933.61.$$

An alternative, and simpler, way of doing this computation is to recognize that the cash flows shown above equal the changes in the account due to borrowing *instead* of paying cash, so the change due to borrowing is:

$$-\$2,449.16 = 19,668.00(F|P, 1/2\%, 36-0) - 517.70(F|A, 1/2\%, 36-0) - 5,621.17$$

### Summary

Provide a brief summary on the first page of your report that describes the loan, identifies the lenders, and then presents the about results in a concise tabular format. Also indicate what your decision if one of the loans were chosen and why. If you think that it might be worthwhile to consider other alternatives, then suggest some possibilities – such as buying a used car. ☺

