SOCIETY OF ACTUARIES

The Future is Math. Literally.

Financial Mathematics: An actuarial science lesson plan

Actuaries have used Interest Theory and Financial Mathematics for a long time in their work. A Supreme Court decision referred to Actuarial Methods when working with Interest Rates.

Here's a sample question: You are a High School student aged 15 investing $100 in a bank that promises an investment return of 6% every year. How much money will you have at age 65 (50 years from now) when you want to retire?

Answer: $\$100 \cdot (1 + .06) \text{ ^ } (65 - 15) = \$100 \cdot 1.06^{50} = \$1{,}842.02$

Students would need the formula in a book and a High School Math Teacher to explain it.

How much money would you have in one year if your bank promised you a 6% return over one year?

- $100 contribution (also called the principal)
- Interest earned in one year on $100 = $100 · 6% = $6.00
- Total money in one year = $100 principal + $6 interest = $106 in total
- Using the distributive property, you get $100 · (1 + .06) = $100 · 1.06 = $106
    - The 1 is for the return of your initial contribution and the 0.06 is for your 6% interest earnings.

How much money would you have in two years, if the bank promised 6% for both years?

- $100 initial contribution yield $106 contribution after one year, per the above calculation
- Do the same calculation for the 2nd year.
- Interest earned in one year on $106 = $106 · 6% = $6.36
- Total money in one year = $106 + $6.36 = $112.36
- You can determine that directly by multiplying $106 · (1 + .06) = ($100 · 1.06) · 1.06 = $100 · 1.06^2 = $112.36
    - A generalized formula is: Money at end of n years = Contribution x $(1+\text{interestrate})^n = C \cdot (1+i)^n$

How much money would you have at age 65 = 50 years, if the bank promises 6% for all those years?

- Instead of multiplying the $100 contribution by 1.06 for 50 times, use exponents to get the answer faster.
- Money at end of 50 years = $C \cdot (1+i)^{n} = \$100 \times 1.06^{50} = \$1{,}842.02$

What if you waited until age 35 to start saving, but you invested $200? How much would you have at age 65?

- Money at end of 30 years = $C \cdot (1+i)^{65-35} = \$200 \times 1.06^{30} = \$1{,}148.70$
- Notice that even though you invested twice as much money, you'd have less money at age 65, compared to the example where you started investing at age 15. Why is that? It's because it is so much better to start saving money for retirement as soon as you can!

What if the bank promised only 5% annual return for all 50 years?

- Money at end of 50 years = $C \cdot (1+i)^{n} = \$100 \times 1.05^{65-15} = \$1146.74$
- That is not as much as in the 6% example above. Thus, you won't do as well with lower interest rates, so you will want to find a bank with higher interest rates, as long as it's not a risky bank that could go bankrupt. Bank deposits are often guaranteed by the FDIC (Federal Deposit Insurance Corporation) up to $250,000, but their investment returns may not be as good. You can also invest in bonds or stocks but they are more risky and are not guaranteed by anyone. They would be too risky for anyone to guarantee.