THE TIME VALUE OF MONEY

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One of the earliest authorities in support of discounting future losses to present value is found in Chesapeake & Ohio Railway Co. v. Kelly in 1916. The Supreme Court stated that "... where future payments are to be anticipated and capitalized in a verdict the plaintiff is entitled to no more than their present worth ... 11 (Kelly at 493) Subsequent case law continues to affirm this ruling. Despite the ubiquity of discounting in business and in litigation, relatively few understand the principles behind the practice; fewer still can perform the calculations without a pre-programmed calculator. The purpose of this article is to offer a primer on the mathematics of compounding present values into future values and of discounting future values into present values, both of which fall under the heading of "the time value of money. "

Money has time value simply because it can be invested rather than left idle (Fabozzi, p. 58). In other words, money has the capacity to generate earnings. Therefore, a dollar in hand today is worth more than a dollar received tomorrow because the dollar in hand can be invested immediately to earn a return in the form of interest, dividends and/or capital appreciation. To illustrate this basic principle of finance, compare the choice of receiving $100 today to receiving $100 one year from today. Let us assume that the $100 today can be invested to earn a guaranteed 8 percent per year with no risk to principal. At the end of one year, the initial investment of $100 will be returned, plus interest of $8. Your choice, after adjusting for timing differences, is between receiving that which will become $108 in one year or receiving only $100 in one year. Clearly, $108 is preferable t o $100, so $100 today is worth more than $100 one year from today.

The mathematics associated with the time value of money facilitates the conversion of values at one point in time into equivalent values at another point in time (Tapley, p. 6-2). Compounding is the process of calculating the future value of money invested today. Discounting is compounding in reverse. It is the process of calculating the present value, the value today, of future money. Discounting answers the question, "What is a sum of money to be received at a future point in time worth today?" Put another way, "What sum of money must be invested today

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in order to have a specific sum of money at a given point in time in the future?" Both compounding and discounting are predicated on the critical assumption that interest is compounded (interest is earned on interest); more generally, that returns on the initial principal can be reinvested at the stated rate of return.

As previously illustrated, investing $100 for one year at 8 percent will yield $108. This can be demonstrated arithmetically as follows:

(1)	$108	=	$100 + ($100 x 8%), or
(2)	$108	=	$100 x 1.08

The future value of $100 invested for one year at 8 percent per year is, therefore, $108. What is the future value of $100 invested today at 8 percent, compounded annually, for two years? Investing $100 for one year at 8 percent yields $108, as shown above. Reinvesting the $108 at 8 percent for another year will yield $116.64. The future value of $100 invested for two years at 8 percent per year is, then, $116.64. The proof is shown as follows:

(2)	$108	=	$100 x 1.08
(3)	$116.64	=	$108 x 1.08, or
(4)	$116.64	=	$100 x 1.08 x 1.08

The general formula for calculating the future value of money is:

$$(5) \quad FV = PV\,(1+r)^n$$

where,

FV	=	future value
PV	=	present value
r	=	interest rate or discount rate
n	=	the period of time, usually expressed in years, between the present and the future value

To use the general formula to calculate the future value of $100 invested today at 8 percent, compounded annually, for two years, we set PV equal to $100, r to 8 percent and n to 2.

Hence,

$$(6) \quad FV = \$100\ (1.08)^2$$
$$(7) \quad FV = \$100\ (1.1664)$$
$$(8) \quad FV = \$116.64$$

To calculate the present value of future money, we simply rearrange the general formula as follows:

$$(9) \quad PV = \frac{FV}{(1+r)^n}$$

What is the present value of $116.64 to be received at the end of two years, given the opportunity to invest funds today at 8 percent per year, compounded annually, for the term of investment? The answer is:

$$(10) \quad PV = \$116.64 \div (1.08)^2$$
$$(11) \quad PV = \$100 \div (1.1664)$$
$$(12) \quad PV = \$100$$

The principle is the same for a series of future sums. Each future sum is discounted individually to its present value by the appropriate discount rate. The present values are, then, added to equal the present value of the series (Fabozzi, p. 60).

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