Part 610 – Natural Resource Economics Handbook

Subpart C – Discounted Cash Flow Analysis

610.20 Introduction

A. Benefits and costs of conservation practices do not necessarily occur at the same time. Certain costs and benefits (such as installation costs, which occur only during the installation period) may occur at one point in time, while other costs and benefits may occur over an extended period of time. A one-time value can occur today or at some point in the future. Costs and benefits that occur over an extended period are called annual cash flows, or annuities. Annuities can be constant, decreasing, or increasing over time, depending on their characteristics. Many of the benefits from conservation occur as annuities.

B. The time value of money means that cash flows at different points of time differ in value and thus are not directly comparable. Discounted cash flow (DCF) method is a tool commonly used in investment analysis to evaluate projects with benefits and costs occurring at different time. In DCF analysis, benefits are considered positive cash flows and costs are considered negative cash flows. To compare them, we would need to discount all future cash flows back to the present to find their present values (PV).

C. In this subpart, we will first introduce the DCF method and then apply the DCF method to analyzing conservation practices. We will also discuss about how to conduct DCF analyses using Microsoft Excel spreadsheets (see note below). Excel is a convenient tool for conducting a DCA analysis. It has 90 separate financial functions that can be used for DCA, with the Excel help function explaining each.

Note: All Excel functionalities described in this handbook are based on Microsoft Excel 2007 edition.

610.21 Decision Criteria

A. Net Present Value Approach

(1) The economic evaluation of prospective conservation systems requires a comparison of the benefits and costs of the alternatives under consideration. The standard criterion for deciding whether a conservation project can be justified on economic principles is net present value—the discounted monetized value of expected net benefits from the project (i.e., discounted benefits minus discounted costs).

(i) Net present value is computed by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement.

(ii) Projects with positive net present value increase social resources and are generally preferred. Projects with negative net present value should generally be avoided (technical details about discounting are discussed in the next sections).

(iii) When comparing two or more alternative projects, the project with the greatest net present value is generally the preferred alternative.

(2) Although some benefits and costs cannot be expressed in dollars, efforts to measure them can produce useful insights as demonstrated in figure 610C-1. In these cases, a comprehensive enumeration of the different types of benefits and costs, monetized or

not, can be helpful in identifying the full range of project effects. Other summary effectiveness measures can provide useful supplementary information to net present value, and analysts are encouraged to report them also. Examples include a project's internal rate of return, threshold or break-even cost or benefit, payback ratio, etc. Analytical details for these measures will be discussed further later.

B. Cost Effectiveness Approach

(1) A conservation project is cost effective if, on the basis of cost analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits. Cost-effectiveness analysis is appropriate whenever it is unnecessary or impractical to consider the dollar value of the benefits provided by the alternatives under consideration (Office of Management and Budget (OMB) Circular No. A-94). This is the case whenever either of the following apply:
(i) Each alternative has the same conservation benefits expressed in monetary terms.
(ii) Each alternative can produce the required conservation effects, but monetary values cannot be assigned to their benefits.

(2) Cost effectiveness analysis can also be used to determine the least cost alternative to deliver the same amount of benefits at the same time period, regardless of whether we know the monetary values of the benefits. In addition, cost-effectiveness analysis can be used to compare projects with identical costs but differing benefits. In this case, the decision criterion is the discounted present value of benefits. The alternative project with the largest benefits would normally be favored.

(3) When using cost-effectiveness analysis, the landowner must be cognizant of the economic factors described in the previous section. Differences between alternatives in potential conservation effects can be evaluated by first identifying the respective future with and without conditions of the alternatives and by then comparing those alternative conditions on an equal time basis.

(4) Example – Water Quality.—Consider an example in which laws, such as the 1972 Clean Water Act as amended (section 208), are used to enforce minimum standards for water quality and maximum standards for permissible discharge. For a landowner such as a dairy operator to stay in business, the range of alternatives may be reduced to bringing the operation into compliance, facing a substantial fine, or being sentenced to jail. Assuming that neither paying a large fine nor spending time in jail is a desirable option, the conservation alternative is to find the least-cost option for bringing the operation into compliance.

610.22 Major Factors for Discounted Cash Flow Analysis

A. The Useful Life of Conservation Practices

(1) Official NRCS conservation practice lifespans are contract lifespans that are established and maintained in the NRCS Conservation Practice Standards (CPS) Web application. A contract lifespan of a conservation practice is defined as the time period in which the conservation practice is to be used and maintained for its intended purposes as defined by NRCS technical references. All conservation practices established through a NRCS financial assistance program contract are expected to be maintained for their established contract lifespans.

(2) The useful lifespan of a practice, however, may extend beyond the length of the program contract. The life expectancy of a conservation practice will impact the estimation of the stream of expected benefits of the conservation practice and will also impact the estimated annual cost and the depreciation of the practice. Therefore,

consistently defined life expectancy of conservation practices or systems is important in the evaluation of benefits and costs of applying proper conservation, especially in comparing alternatives with benchmark scenarios. When applying a system of conservation practices to treat a specific resource concern or problem, the local actual useful life of the system should be determined by careful identification and evaluation of the critical practices within the system.

B. Period of Analysis

(1) The length of time over which costs and conservation effects are considered is called the period of analysis. Two analytical concerns in decisionmaking are determining the period of analysis and using a standard time horizon. The period of analysis determines the length of the analysis, whether it is 1 year or 10 years, for example. The standard time horizon determines how to partition the period of analysis, whether the analysis is done by monthly, quarterly or annually, for example.

(i) A period of analysis is established so that gains and losses may be compared on the same or equivalent time basis. A standard time horizon assures that these effects are considered on a common time basis. For example, benefit-cost analysis of a conservation project can be done for a time period of 2012-2022 with annual data.

(ii) For a private benefit-cost analysis, the landowner is responsible for identifying the period of analysis. General factors affecting the landowner's decision on the period of analysis include demographic data, such as the age of the landowner and his children or heirs, and whether the landowner's children or heirs will continue to farm.

(iii) A short-term analysis usually refers to an analysis with a period of time during which the land user is committed to at least one fixed cost of production, such as a lease or a loan payment, that is not adjustable. If all production costs are variable, the analysis period is defined as long-term.

(2) Economic factors that constrain the period of analysis include the physical deterioration of capital investment (farm equipment and conservation practices) and prospective obsolescence due to technology improvements. The period of analysis should not exceed the shorter of the planning horizons, such as the repayment period or the physical life of the alternative. If the selected planning horizon is shorter than the physical life of the alternative, however, any benefits that accrue beyond the period analyzed must still be carefully analyzed.

C. Treatment of Inflation

(1) An increase in the general price level of an economy is called "inflation." The inflation rate is the percent annual increase in the general price level. Inflation occurs when the quantity of money in circulation and the velocity (frequency) of money in circulation rise relative to the quantity of goods and services available. Inflation erodes the purchasing power of income and investments. The inverse of inflation is deflation, as occurred in 2009. Deflation has not occurred for longer than 2 years since the early 1930s.

(2) It is recommended that, in most cases, economic analyses for conservation projects and programs are conducted using real values, rather than nominal values. Using real or constant values allows the analyst to avoid making risky estimates of future inflation rates and to simplify the analytical procedures. Where future benefits and costs are given in nominal terms, however, the analysis should use these values rather than convert them to constant dollars. Nominal and real values must not be combined in the same analysis. Logical consistency requires that analysis be

conducted either in real dollars or in terms of nominal values. This may require converting some nominal values to real values, or vice versa.

(3) Such conversion between nominal and real values can be accomplished using gross domestic product (GDP) deflator or price indexes.

(i) The GDP deflator measures the ratio of the nominal (or current-price) GDP to the real (or chain volume) measure of GDP and is produced by the Bureau of Economic Analysis.

(ii) A price index is a weighted average of the prices of preselected baskets of goods and services. Price indexes usually use a specific year (e.g., 1991) as the price base year by assigning that year the index value of 100 (e.g. 1991=100). Indexes could be adjusted to a new base by dividing the prices for all other years into the prices for the selected base year.

(iii) The Consumer Price Index (CPI) and the Producer Price Index (PPI) are the two most common economy-wide price indices in the United States. The PPI measures inflation for the producer goods such as machinery. The CPI measures inflation for the consumer goods such as food and clothes. The CPI and PPI are both generated by the Department of Labor Bureau of Labor Statistics.

(4) The conversion between nominal and real values using the GDP deflator, CPI or PPI assumes that inflation will affect equally the values of all goods and services used to derive these costs and benefits. In most cases, the value differences between these indexes are very small. More selective conversions of benefits or costs of conservation programs and projects between nominal and real values can be accomplished using sector-specific price indexes. The most commonly used of such prices include the Producer Prices Paid by Farmers Index (PPPI), the Producer Prices Received by Farmers Index (PPRI), and the Engineering News Record – Construction Cost Index (CCI).

(5) Both the PPPI and the PPRI are calculated monthly by the National Agricultural Statistics Service (NASS). These indexes are published in the Agricultural Prices Report by NASS and are available on its website. The PPPI can be used to convert conservation costs between nominal and real values, and the PPRI can be used to convert conservation benefits. The CCI is commonly used to convert costs in watershed plans and similar types of projects. When using more than one price index for a conversion between nominal and real values, it is important that the indexes are applied using the same base year to make the adjusted total costs and total returns readily comparable.

(6) The process of converting benefits or costs between nominal and real values using a price index is explained here with an example. Assuming the installation cost of a conservation practice is $3500.00 in 2010 nominal value, to convert it into a 1991 based real value using the PPRI so that it can be comparable with the real values of other costs and benefits of the project, we need to multiply $3500.00 by the PPRI for 1991 (100.00), and then divide it by the PPRI for 2010 (159.00), as follows:

$$\$3{,}500.00 \text{ x } \frac{100.00}{159.00} = \$2{,}201.26$$

D. Depreciation of Assets

(1) Depreciation is the anticipated reduction in the value of an asset over time, caused through physical use or obsolescence. In accounting, depreciation refers to the process of amortizing or allocating a portion of the original cost of a fixed asset, such as a tractor, to each accounting period. The value is gradually used up (written off) during the estimated useful life of the asset. Allowance may be made for the ultimate

estimated resale or salvage value of the fixed asset (its residual value) expected to remain at the end of its useful life. There are several different depreciation methods (or schedules). The two principal types of depreciation methods are:

(i) Straight-Line Depreciation.—Allocates the cost of a fixed asset in equal amounts for each accounting period.

(ii) Accelerated Depreciation.—Allocates a larger proportion of the original cost to earlier accounting periods and a smaller proportion to later periods.

(2) Depreciation of assets is linked to the assumption that as each productive asset is worn out over time, its owner will simultaneously set aside money or an alternative financial asset into an interest-bearing account—a sinking fund—so that when the asset has been depreciated down to zero, the account will contain sufficient funds to replace the asset without its owner having to borrow money.

E. Discount Rate Policy

(1) Time Value of Money and Discounting

(i) Money can be invested to make more money over time. One dollar invested in a worthy project today could be worth more than one dollar a year from now. This is known as the time value of money. Invested money increases in value over time because of the extra value generated from the use of production factors such as machines, land, and labor. When a landowner considers investing in conservation, the time value of money concept applies. Because money spent on conservation work could be spent on an alternative investment, the interest cost for the money invested in a conservation practice must be considered as part of an economic analysis of the project.

(ii) Interest is the measure of earning power of money, the value of money when in use. It could be either what someone would pay you for the use of your money, or the rent you are willing to pay for the use of someone else's money. If a landowner borrows to pay for a conservation practice, the interest cost will be the interest that must be paid on the loan. Otherwise, the interest cost is equal to the best return that the money would have earned on some other investment. In economic analyses of conservation projects, interest is usually expressed as an annual rate or a monthly rate. You can convert an annual rate to a monthly rate by dividing it by 12.

(iii) When reinvested, interest from invested capital will in turn become a part of the capital stock and will itself earn interest. This process is called compounding. With compounding, the earned interest in one period is immediately added in the subsequent period, resulting in a larger principal, on which an even larger amount of interest is earned for that period.

(iv) In order to compute a net present value, it is necessary to discount future benefits and costs. Discounting reflects the time value of money and is compounding in reverse. Discounting is the process of calculating the initial investment capital needed to generate a certain amount of future value. In standard analysis, benefits and costs are usually treated as if they are worth more if they are experienced sooner. When analyzing conservation practices, all future benefits and costs, including non-monetized benefits and costs, should be discounted. The higher the discount rate, the lower is the present value of future cash flows or non-monetized returns. For typical investments—with costs concentrated in early periods and benefits following in later periods—raising the discount rate tends to reduce the net present value.

(2) Real Versus Nominal Discount Rate

The proper discount rate to use depends on whether the benefits and costs are measured in real or nominal terms. A real discount rate is one that has been adjusted to eliminate the effect of expected inflation and should be used to discount constant-dollar or real benefits and costs. A real discount rate can be approximated by subtracting expected inflation from a nominal interest rate. A nominal discount rate that reflects expected inflation should be used to discount nominal benefits and costs. Market interest rates are nominal interest rates in this sense and should not be used in place of a real discount rate.

(3) Public and Private Investment

(i) Discount rates for either public or private investments should reflect the shadow price of capital, or the opportunity cost of money (i.e., the rate of return for the alternative best investment project), to evaluate benefits and costs. To define discount rates accurately, the analyst must be able to compute how the benefits and costs of a program or project affect the allocation of private consumption and investment.

(ii) When preparing an economic analysis for projects or programs with public investment, the analyst should use the appropriate discount rate from OMB Circular No. A-94, or a different discount rate approved by OMB. For NRCS water resource projects, one should use the currently approved discount rate for Federal water resource project analyses, which is issued each fiscal year by the U.S. Department of the Treasury.

(iii) The discount rate used for evaluating private investments should reflect the reality of the landowner or land user in question. When resources owned or borrowed by the landowner are committed to the implementation of a conservation option, the potential earnings of those resources in their best alternative use must be forgone. Therefore, the rate of return for the forgone alternative best investment project will be the appropriate discount rate.

(iv) When considering using a loan interest rate as discount rate, it is important to understand that loan interest rate is a nominal rate and it needs to be converted to real term before it can be used as a real discount rate.

(4) Other Discount Rates

(i) After performing an economic analysis with an appropriate discount rate as discussed above, the analysis should show the sensitivity of the discounted net present value and other outcomes to variations in the discount rate. The importance of these alternative calculations will depend on the specific economic characteristics of the conservation project or program under analysis.

(ii) Analyses may include among the reported outcomes the internal rate of return implied by the stream of benefits and costs. The internal rate of return is the discount rate that sets the net present value of the program or project to zero. While the internal rate of return does not generally provide an acceptable decision criterion, it does provide useful information, particularly when budgets are constrained or there is uncertainty about the appropriate discount rate.

610.23 Discounting Formulas

A. Basic Discounting Formulas

(1) Present Value

(i) There are four variables involved in discounting. They are the present value (PV) and future value (FV) of invested capital, the discount rate (r), and the number of investment periods (n). Any one of the four variables can be

calculated from the other three variables. For example, the present value formula is:

$$PV = FV \frac{1}{(1+r)^n} \qquad \text{(C-1)}$$

(ii) This formula can be used to calculate the present value of any future cash flows.

(iii) Example: $4,000 will be needed 5 years from now. Assuming the interest rate is 10 percent, what is the amount of initial investment needed?

(iv) Using the present value formula, the present value of the future value is $4,000 / (1 + 10%) ^ 5 = $2,483.69.

(2) Future Value

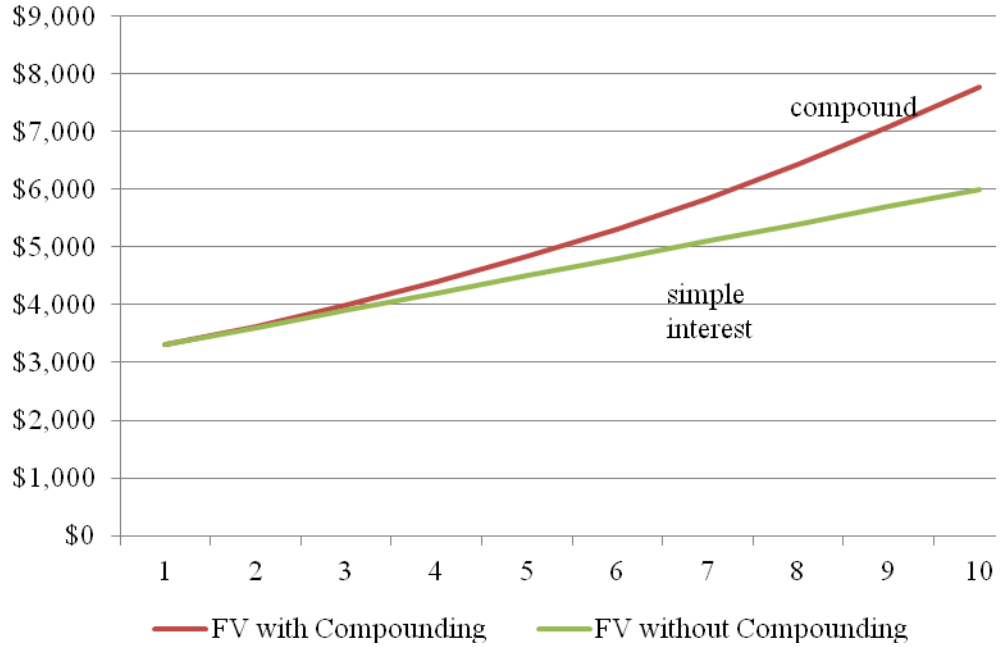
(i) Equation C-1 is the basic discounting formula. Several other formulas that are useful in DCF analysis can be derived from the basic discounting formula. Among them, formulas for future value, annuity, and capitalization are explained below.

(ii) Using the same notation as in equation C-1, the future value (or compounding formula) is:

$$FV = PV(1+r)^n \qquad \text{(C-2)}$$

(iii) Example: For a $3,000 loan with 10-percent annual interest rate, what will be the total capital and interest at the end of 10 years? Using the future value formula, the borrower will need to pay $3,000 * (1 + 10%) ^ 10 = $7,781.23 at the end of 10 years, without paying anything before that. If the borrower pays all interest accrued each year, the simple interest formula applies. The total capital and interest the borrower will need to pay according to the simple interest formula is $3,000 + $3,000 * 10% * 10 = $6,000. See figure 610C-1 for a comparison of the capital accumulation process with compound interest and with simple interest in 10 years. The comparison shows the power of compounding. The difference of the two lines can be quite significant. A longer investment period will amplify the compounding effect.

Figure C-1 Comparison of Compound and Simple Interests over 10 Years



(iv) For time value of money calculations, you should always use compound interest. You must adjust the interest rate and the number of periods to be consistent with compounding periods. For example, a 6-percent interest rate, compounded semiannually for 5 years, should be entered as 3% (6 / 2) for 10 (5 * 2) periods. When using a calculator, a 6-percent interest rate is expected to be entered as the whole number 6, whereas formulas typically use a decimal value of 0.06.

(3) Annuity

(i) An annuity, or periodic constant payments, is defined as a "series of payments at fixed intervals, guaranteed for a fixed number of years or the lifetime of one or more individuals" such that the same level of cash flow occurs repeatedly over time at a fixed time interval. In the DCF analysis for conservation practices, certain cash flow items such as annual maintenance cost, and annual benefits may be the same over a certain period. The formulas for the future value and present value of annuity are (where FV is the future value, PV is the present value, A is the annuity, r is the interest rate, and n is the number of years since first payment):

$$FV = A\frac{(1+r)^n - 1}{r} \qquad \text{(C-3)}$$

$$PV = A\frac{(1+r)^n - 1}{r(1+r)^n} \qquad \text{(C-4)}$$

(ii) Example: A conservation project with a useful life of 10 years needs $75 annual maintenance fee. Assuming a 10 percent discount rate, what is the present value and the future value of the total annual maintenance fee of the project? Using the formula for the future value of annuity, the future value of the total maintenance fee at the end of the project is $75 * ((1 + 5%) ^ 10-1)/5% = $943.34. Using the formula for the present value of annuity, the present value of the total maintenance fee at the beginning of the project is $75 * ((1 + 5%) ^ 10-1)/(5%*(1+5%)^10) = $579.13. Note that the total cash flow of the maintenance

fee for 10 years is $75*10= $750, which is smaller than the future value and bigger than the present value of the annuity, demonstrating the power of compounding in the future value formula and the power of discounting in the present value formula.

(iii) Given the future value or present value of an annuity, the amount of an annuity can easily be derived from the two equations above.

$$A = FV \frac{r}{(1+r)^n - 1} \qquad \text{(C-5)}$$

$$A = PV \frac{r(1+r)^n}{(1+r)^n - 1} \qquad \text{(C-6)}$$

(iv) When the number of investment periods is infinitely large, equation C-4 reduces to:

$$PV = \frac{A}{r} \qquad \text{(C-7)}$$

(v) This is called the capitalization formula. Using the capitalization formula, we can calculate periodic constant land rents from the land value and the interest rate, or we can calculate the land value from periodic constant land rents and the interest rate. For example, if a piece of cropland with $50 per acre in annual net income is converted into a wildlife reserve, assuming a 5-percent discount rate, the farmer's lost land value with losing crop production on the land is $50/5 percent=$1,000/acre.

B. The Net Present Value (NPV) Criterion

(1) An NPV is the summation of all positive and negative present values for an investment project. This is the sum of the present values discussed above; namely, the present value of benefits minus the present value of costs. The NPV of a project is also called the net worth of the project. If N is the number of cash flows in a project, the formula for NPV is:

$$NPV = \sum_{i=1}^{N} \frac{FV_i}{(1+r)^i} \qquad \text{(C-8)}$$

(2) Note that this formula is the aggregated PV formula in equation C-1 with both the positive and negative cash flows of a project.

(3) An investment project is feasible if its NPV is positive. For two or more exclusive investment projects, the one with the highest NPV is the best choice. This is called the NPV criterion.

(4) In addition to the NPV criterion, there are other criteria that can be used for evaluating a conservation practice, which will be discussed later in this subpart. The NPV criterion is a better criterion than the internal rate of return for ranking investment decisions.

C. Internal Rate of Return

(1) An internal rate of return (IRR) is the discount rate that sets the NPV of a series of cash flows equal to zero over the period of analysis or specified time period. Some State agencies require calculation of the IRR in the analysis of proposed conservation projects.

$$IRR = r(NPV = 0) = r(\sum_{i=1}^{N} \frac{FV_i}{(1+r)^i} = 0) \qquad \text{(C-9)}$$

(2) To calculate the IRR of a project, set the NPV of the project to zero and solve for r, as the cash flow amounts and the years at which they occur are known variables.

(3) A simple example: Assume only one initial capital investment of $100 in conservation tillage for an expected conservation benefit of $120 at the end of the first year. The calculation of R could be: 120/(1+R) -100 = 0. Thus R = 120/100 – 1 = 1.20 – 1 = = 0.20, so the internal rate of return is equal to 20 percent. Note: Care must be taken when calculating IRR; there may be two solutions because i is solved for on both sides of the equation.

610.24 Excel Financial Functions

A. Microsoft Excel and other spreadsheets and financial calculators have many powerful financial functions that simplify financial analysis. We would like to introduce the five most common Excel financial functions that will be used in the investment analysis for conservation practices in this handbook. These functions are PV, FV, PMT, NPV, and IRR. We will cover the basics of these functions in this handbook. More details about these and other financial functions can be found in Excel Help. Once you are familiar with these five Excel financial functions, it will be easy for you to learn other Excel financial functions. Many "smart" "smart phones" also have free financial calculator apps with these basic financial functions available for download.

B. PV Function

(1) PV (rate, nper, pmt, fv, type)

(i) Rate.—The interest rate per period.

(ii) NPER.—The total number of payment periods in an annuity.

(iii) PV.—Specifies the present value, or the total amount that a series of future payments is worth now; also known as the principal.

(iv) PMT.—The payment made each period and cannot change over the life of the annuity. Typically, pmt includes principal and interest but no other fees or taxes. For example, the monthly payments on a $10,000, 4-year car loan at 12 percent are $263.33. You would enter -263.33 into the formula as the pmt. If pmt is omitted, you must include the fv argument.

(v) FV.—Specifies the future value, or a cash balance you want to attain after the last payment is made. If omitted, 0 is assumed.

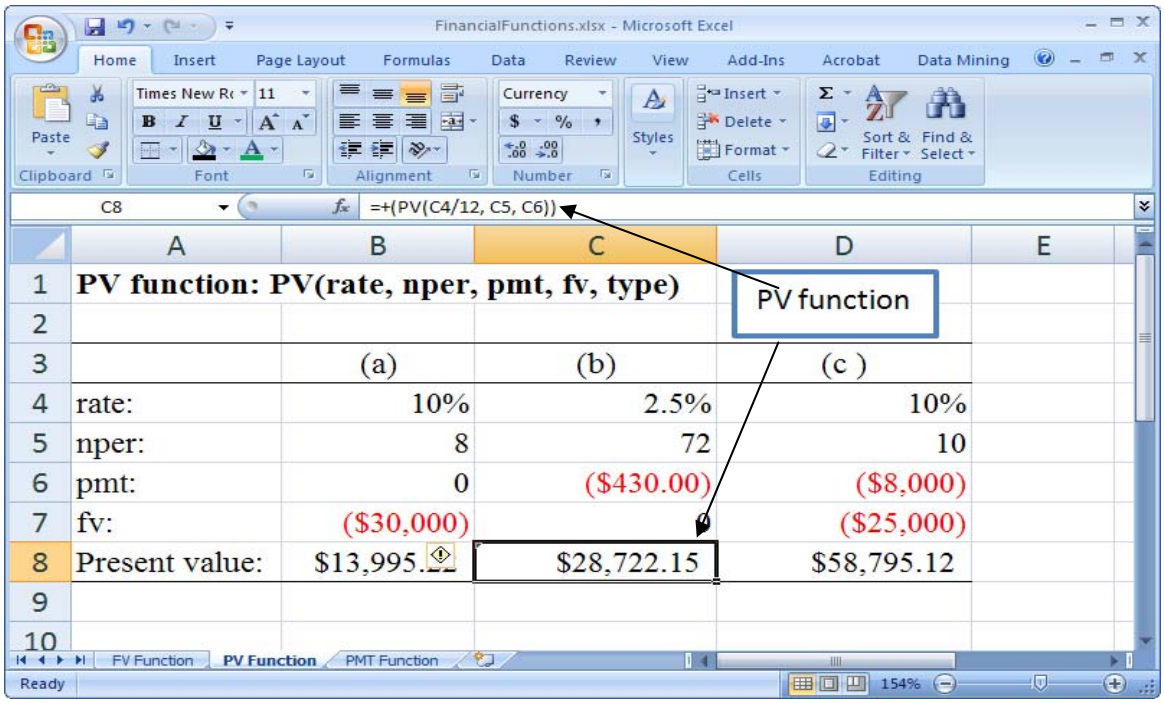
(vi) Type.—Enter 0 if payments are due at the end of the payment period, or 1 if payments are due at the beginning of the period. If omitted, 0 is assumed.

(vii) The PV function can be used for calculating an annuity or periodic constant payments for a present value, future value, or both. We will use the following three examples to demonstrate the three situations:

- Example: Use the PV function to calculate the amount of principle needed to generate $30,000 by the end of 8 years, assuming a 10-percent annual rate of return. The PV function takes the form: "=PV (10%,8,0,-30000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $13,995.22. This is the total capital needed to generate the future value (figure 610C-2a).
- Example: Use the PV function to calculate the amount of loan principle for a monthly payment of $430, with 2.5-percent annual interest rate for 6 years. The PV function takes the form: "=PV (2.5%/12, 6*12, -430)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $28,722.15. This is the total capital for the monthly payments (figure 610C-2b).

- Example: Use the PV function to calculate the present value of an investment project with an annual payment of $8,000 for 10 years and a one-time payment of $25,000 by the end of the project, assuming a 10-percent discount rate. The PV function takes the form: "=PV (10%,10,-8000,-25000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $58,795.12. This is the total capital needed to generate all the payments in the example (figure 610C-2c).

Figure C-2 Examples Using PV Function



(2) Note that the invested money is negative in the PV function. In Excel financial functions, a negative number means money paid out or invested, and a positive number means money received or entitled. This arrangement could be convenient in some settings, but troublesome in others. If necessary, we can use the ABS function to return the absolute value of a financial function. For example, "=ABS (PV(10%,10,8000,25000))" will generate the same positive value as using a negative pmt and fv value in the example above.

C. FV Function

(1) FV (rate, nper, pmt, pv, type)

(i) RATE.—The interest rate per period. For example, if you obtain a car loan at a 10-percent annual interest rate and make monthly payments, your interest rate per month is 10%/12, or 0.83 percent. You would enter 10%/12, or 0.83%, or 0.0083, into the formula as the rate.

(ii) NPER.—The total number of payment periods in an annuity. It needs to be an integer number. For example, if you get a 4-year car loan and make monthly payments, your loan has 4*12 (or 48) periods. You would enter 48 into the formula for the number of payments.

(iii) PMT.—The payment made each period and cannot change over the life of the annuity. Typically, pmt includes principal and interest but no other fees or taxes. For example, the monthly payments on a $10,000, 4-year car loan at 12 percent

are $263.33. You would enter -263.33 into the formula as the pmt. If pmt is omitted, you must include the pv argument.

(iv) PV.—Specifies the present value, or the total amount that a series of future payments is worth now; also known as the principal. For example, when you borrow money to buy a car, the loan amount is the present value to the lender of the monthly car payments you will make. If omitted, 0 is assumed.

(v) TYPE.—Enter 0 if payments are due at the end of the payment period, or 1 if payments are due at the beginning of the period. If omitted, 0 is assumed. For consistency and simplicity, we assume all payments are due at the end of the payment period and omit this variable in all Excel functions.

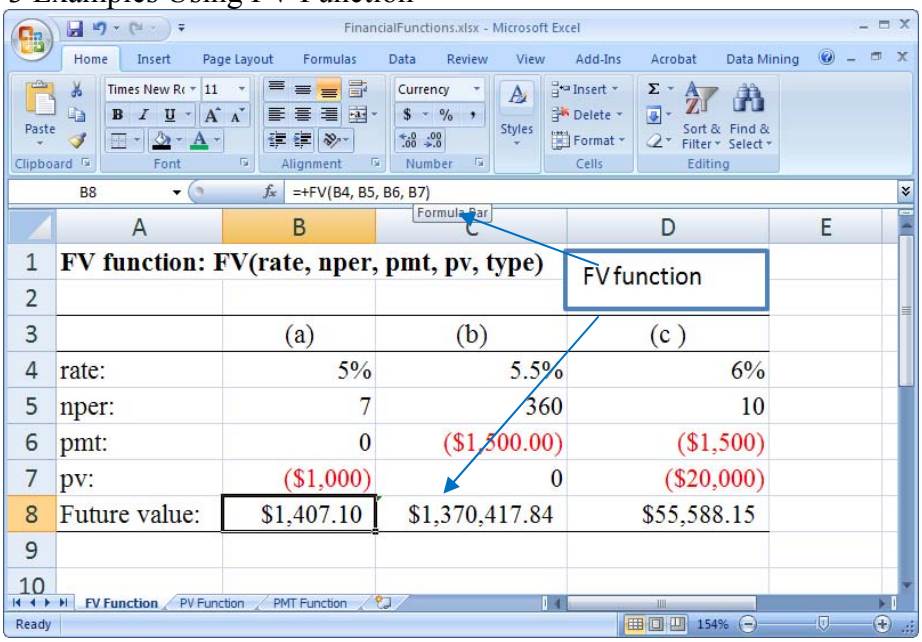
(2) The FV function can be used for calculating the future value of a one-time investment, an annuity, or both. We will use the following three examples to demonstrate the three situations:

(i) Example: Use the FV function to calculate the future value of a one-time investment of $1,000, at 5-percent annual interest rate, for 7 years. The FV function takes the form: "=FV(5%,7,0,-1000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the FV function returns a value of $1,407.10. This is the total capital and interests that the investor should receive by the end of the investment period (figure 610C-3a).

(ii) Example: Use the FV function to calculate the total future value of a mortgage payment of $1,500 per month, at 5.5-percent annual interest rate, for 30 years. The FV function takes the form: "=FV(5.5%/12, 30*12, -1500)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the FV function returns a value of $1,370,417.84. This is the future value of all mortgage payments. It is equivalent to the total amount that the mortgagee would have received by the end of the mortgage term if he or she had put the same monthly payment into an investment account with the same interest rate (figure 610C-3b).

(iii) Example: Use the FV function to calculate the future value of a conservation practices with $20,000 installation cost and $1,500 annual maintenance cost, at 6-percent annual discount rate, for 10 years. The FV function takes the form: "=FV (6%, 10, -1500, -20000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the FV function returns a value of $55,588.15. This is the future value of all investment payments in the project (figure 610C-3c).

Figure C-3 Examples Using FV Function



D. PMT Function

(1) PMT(rate,nper,pv,fv,type)

(i) Rate.—The interest rate per period.

(ii) NPER.—The total number of payment periods in an annuity.

(iii) PV.—Specifies the present value, or the total amount that a series of future payments is worth now; also known as the principal.

(iv) FV.—Specifies the future value, or a cash balance you want to attain after the last payment is made. If omitted, 0 is assumed.

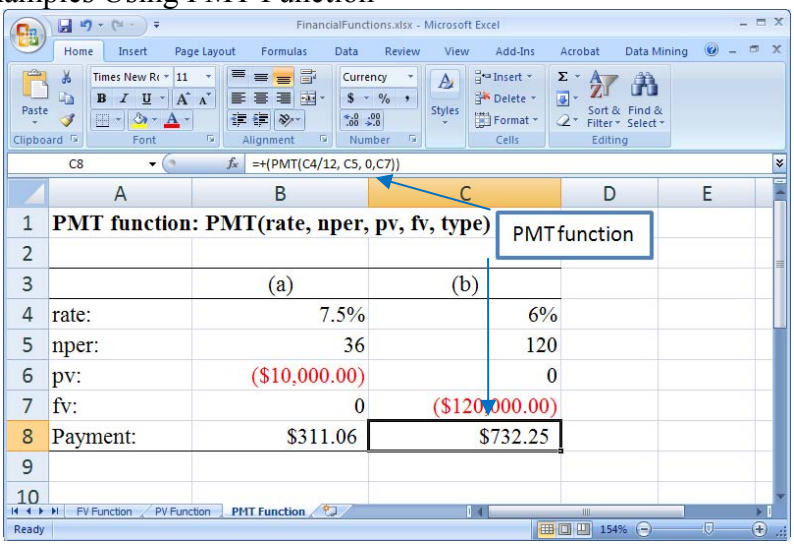
(v) type.—Enter 0 if payments are due at the end of the payment period, or 1 if payments are due at the beginning of the period. If omitted, 0 is assumed.

(2) The PMT function can be used for calculating the constant payments for a loan principle or a certain future amount desired. We will use the following two examples to demonstrate both situations:

(i) Example: Use the PMT function to calculate the monthly payments for a $10,000 loan, assuming a 36 month term for the loan with an annual interest rate of 7.5 percent. The PMT function takes the form: "=PMT(7.5%/12,36,-10000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $311.06. This is the monthly payment for the loan (figure 610C-4a).

(ii) Example: Use the PMT function to calculate the constant monthly investment needed for a $120,000 college fund in need 10 years from now, assuming a 6 percent rate of return on the investment. The PMT function takes the form: "=PMT(6%/12, 10*12, 0,-120000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $732.25. This is the constant monthly payment for the future fund (figure 610C-4b).

Figure C-4 Examples Using PMT Function



E. NPV Function

(1) NPV (rate, value1, value2, ...)

RATE: The discount rate over the investment period. Value1, value2, are values representing positive and negative cash flows. Value1, value2, must be equally spaced in time and occur at the end of each period.

(2) The NPV function returns the net present value of a series of future cash flows in an investment project. The setup of the cash flows for applying the NPV function must follow three rules:

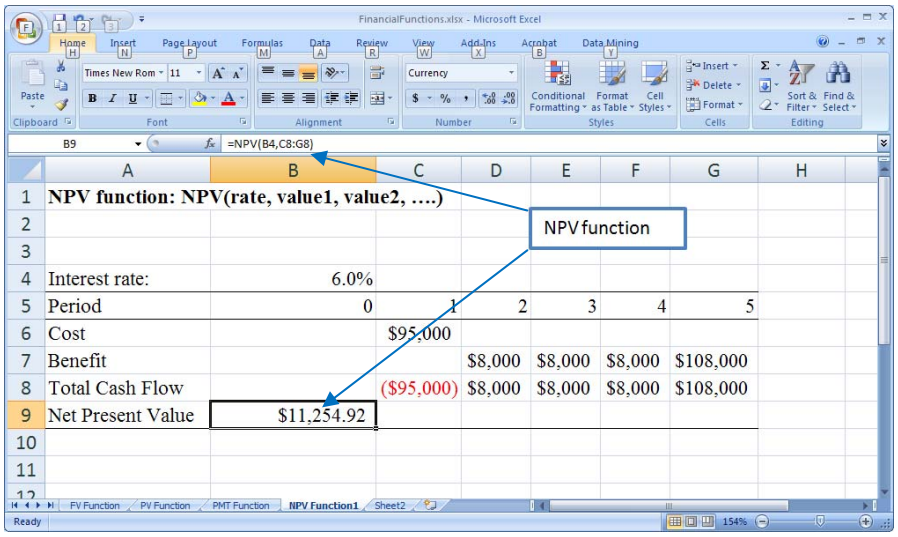
(i) Benefits are represented by positive cash flows and costs are represented by negative cash flows;

(ii) The NPV function uses the order of value1, value2, to interpret the order of cash flows. Cash flows must be equally spaced in time. If there is no cash flow during a period in the investment project, the period should still be included and use 0 as a place holder.

(iii) The investment begins one period before the date of the value1 cash flow and ends with the last cash flow in the list. If your first cash flow occurs at the beginning of the first period, the first value must be added to the NPV result, not included in the values arguments.

(3) Example: Suppose that Susan's son Eric is going to college 1 year from now and Susan is considering buying a condo 1 year from now for Eric to live in during his 4-year college and selling it afterwards. The purchase price of the condo 1 year from now is $95,000 and its expected selling price 5 years from now is $100,000. By living in the condo, Eric will avoid paying $8,000 in annual rent for an apartment for 4 years. The mortgage rate is 6 percent, which will be used as the discount rate in this case. Use the NPV function to analyze the financial feasibility of the investment project. The NPV function takes the form: "=NPV(6%, -95000, 8000, 8000, 8000, 108000)". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $11,254.92. This is the NPV of the project. The positive NPV of the project shows that purchasing the condo is a worthwhile investment in comparison with renting. See figure 610C-5, which shows how the setup follows the three rules of applying the NPV function.

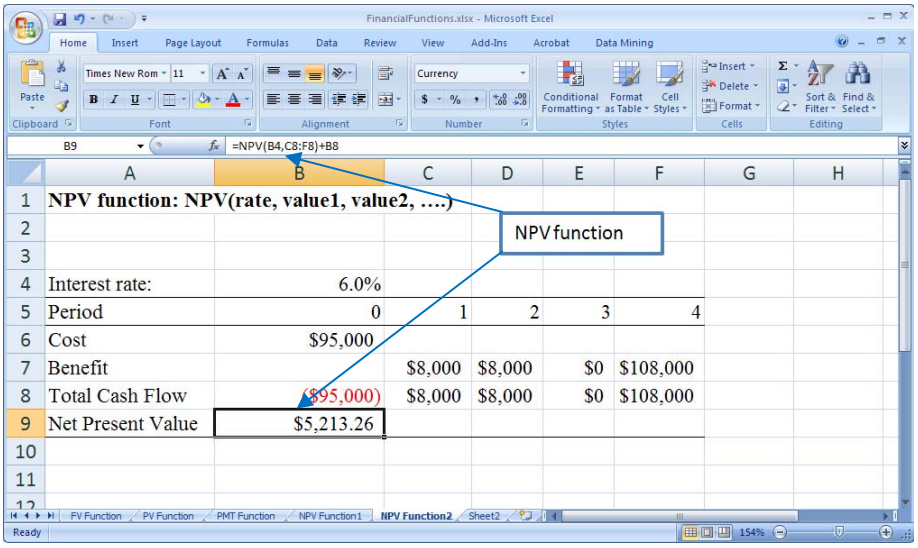
Figure C-5 Example No. 1 Using NPV Function



(4) Example: Suppose that Susan's son Eric is going to college now, rather than a year from now. Again, Susan is considering buying a condo immediately for Eric to live in during his 4 years of college and selling it afterwards. The purchase price of the condo today is $95,000 and its expected selling price 5 years from now is $100,000. By living in the condo, Eric will avoid paying $8,000 in annual rent for years 1, 2, and 4. Eric will be participating in an exchange student program in another city during his third year of college, and the condo will not be occupied during that year. The mortgage rate is 6 percent, which will be used as the discount rate in this case. Use the NPV function to analyze the financial feasibility of the investment project. The NPV function takes the form: "=NPV(6%, 8000, 8000, 0, 108000) -95000". Copy everything inside the quotation marks into an Excel spreadsheet cell; the function returns a value of $5,213.26. This is the NPV of the project. The positive NPV of the project shows that purchasing the condo is a worthwhile investment comparing to renting (figure 610C-6).

(5) There are two important differences between these two NPV examples. In the first example, the purchase cost of the condo occurs at the end of year 1 and thus is included inside of the NPV function. However, in the second example, the purchase cost of the condo occurs at the end of year 0 (now), and is added on outside of the NPV function. Also, the second example, although the avoided rent in year 3 is zero, we still need to include the value zero in the NPV function as a placeholder for year 3. Otherwise, the function would not know the $108,000 occurs in year 4, which would lead to a wrong result.

Figure C-6 Example No. 2 Using NPV Function



F. IRR Function

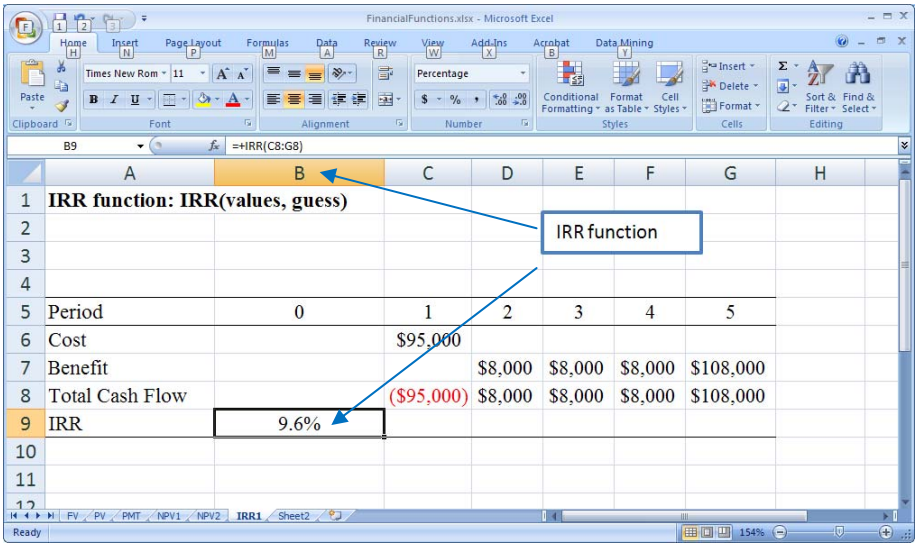
(1) IRR (values, guess)

(i) Values.—An array of positive or negative cash flows. Values must be equally spaced in time and occur at the end of each period and must contain at least one positive value and one negative value to calculate the internal rate of return.

(ii) Guess.—A number that you guess is close to the result of IRR. It is for assisting Excel in its iterative technique for calculating IRR. In most cases you do not need to provide guess for the IRR calculation. If guess is omitted, it is assumed to be 0.1. If IRR gives the #NUM! error value, or if the result is not close to what you expected, try again with a different value for guess.

(2) The IRR function provides the internal rates of return for a series of income or cash flows represented by the numbers in values. An IRR is the rate for which the NPV equals zero: NPV(IRR(), ...) = 0, or IRR()=r(NPV()=0). As is the case with the NPV function, these cash flows do not have to be even, but they must occur at the equal intervals, such as annually, monthly or daily. The resulting IRR will be at the same time intervals. For example, if you use annual cash flows, you will receive a annual IRR; and if you use monthly cash flows, you will receive a monthly IRR. You may convert monthly IRR to annual IRR by multiplying 12. Figure 610C-7 shows the calculation of an IRR for example no.1 showing in figure 610C-5.

Figure C-7 An Example Using IRR Function



610.25 Discount Factors

A. The standard compounding and discounting formulas and the Excel financial functions provide two methods for calculating the compounding or discounting effects of cash flows. In addition to these two methods, there is a third method for finding unknown cash flows and financial variables. In this method, various financial terms are converted from one form to another by means of "discount factors" as shown in figure 610C-8. For example, a PV can be converted to a FV by multiplying the PV by the applicable discount factor, which in this case is 1.6289. Each conversion factor is derived by one of six unique equations, also shown in figure 610C-8, in which the interest rate and period of investment are key terms. One may observe that each of equations C-1 to C-6 includes the interest rate and period of investment term $(1+r)^n$ on its right-hand side. The right-hand terms of the six standard financial equations are used to calculate the conversion factors. Assuming that the converting-from variable is X and the converting-to variable is Y, and the discount factor is d, then the relationship between the variables is the following:

Y=X*d

B. If the value of d can either be obtained from a standard discount factor table or be easily calculated using a calculator or a spreadsheet (based on the interest rate and the period of investment), then the exercise of compounding or discounting becomes a straightforward multiplication problem as shown in the above equation. The table below includes all six discount factors and their calculation formulas (with r=5% and n=10), corresponding to equations C-1 to C-6.

Figure C-8 Discount Factors

Fund Type	Value Conversion	Discount Factor Value (d)	Discount Factor Formula	Discount Factor Formula in Excel©
One-time	FV → PV	0.6139	$(1+r)^{-n}$	=PV(r,n,0,-1)
One-time	PV → FV	1.6289	$(1+r)^{n}$	=FV(r,n,0,-1)
Annuity	A → PV	7.7217	$((1+r)^{n}-1)/(r(1+r)^{n})$	=PV(r,n,-1)
Annuity	A → FV	12.5779	$((1+r)^{n}-1)/r$	=FV(r,n,-1)
Annuity	PV → A	0.1295	$r(1+r)^{n}/((1+r)^{n}-1)$	=PMT(r,n,-1)
Annuity	FV → A	0.0795	$r/((1+r)^{n}-1)$	=PMT(r,n,0,-1)

A calculator in the form of the table above is available in an Excel workbook on the NRCS Web site. The calculator computes discount factors automatically with the changes of interest rate and number of investment periods. Discount factor tables with common interest rates and investment periods are also available in the same Excel workbook for printing.