

205

Depreciation and Corporate Taxes

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The government levies taxes on corporations and individuals to meet its cost of operations. Regulations on depreciation allowances are part of taxation policy. The tax laws promulgated by the federal government profoundly influence capital investments undertaken by private corporations. Economic valuation of the after-tax cash flows of an investment project based on projected tax rates and inflation effects provides a rational basis for accepting or rejecting investment projects.

205.1 Depreciation as Tax Deduction

Depreciation refers to the decline in value of physical assets over their estimated useful lives. In the context of tax liability, *depreciation allowance* refers to the amount allowed as a deduction in computing taxable income, and *depreciable life* refers to the estimated useful life over which depreciation allowances are computed. The depreciation allowance is a systematic allocation of the cost of a physical asset over time. A *fully depreciated* asset has received depreciation allowances equal to its original purchase price.

The methods of computing depreciation and the estimated useful lives for various classes of physical assets are specified by government regulations as a part of the tax code, which is subject to periodic revisions. Different methods of computing depreciation lead to different annual depreciation allowances and hence have different effects on taxable income and the taxes paid.

Let P be the purchase cost of an asset, S its estimated salvage value, and N the depreciable life in years. Let D_t denote the depreciable allowance in year t , and T_t denote the accumulated depreciation up to and including year t . Then for $t = 1, 2, \dots, N$,

$$T_t = D_1 + D_2 + \dots + D_t \quad (205.1)$$

An asset's book value B_t is simply its historical cost less any accumulated depreciation. Then

$$B_t = P - T_t \quad (205.2)$$

TABLE 205.1 Modified Accelerated Cost Reduction System (MACRS)
Depreciation for Personal Property

Recovery Year	3-Year Period	5-Year Period	7-Year Period	10-Year Period
1	33.33	20.00	14.29	10.00
2	44.45	32.00	24.49	18.00
3	14.81	19.20	17.49	14.40
4	7.41	11.52	12.49	11.52
5		11.52	8.93	9.22
6		5.76	8.92	7.37
7			8.93	6.55
8			4.46	6.55
9				6.56
10				6.55
11				3.28

Source: Internal Revenue Service. 2002. *Instructions for Form 4562 Depreciation and Amortization*. U.S. Department of the Treasury, Washington, DC.

or

$$B_t = B_{t-1} - D_t \quad (205.3)$$

Among the depreciation methods acceptable under the tax regulations, the straight-line method is the simplest. Using this method, the uniform annual allowance in each year is

$$D_t = (P - S) / N \quad (205.4)$$

Other acceptable methods, known as *accelerated depreciation methods*, yield higher depreciation allowances in the earlier years of an asset and less in the later years than those obtained by the straight-line method. Examples of such methods are sum-of-the-years'-digits depreciation and double-declining-balance depreciation [Au and Au, 1992]. For example, the double-declining-balance depreciation allowance in any year t is:

$$D_t = \frac{2P}{N} (1 - 2/N)^{t-1} \quad (205.5)$$

Under the current IRS regulations on depreciation, known as the Modified Accelerated Cost Reduction System (MACRS), the estimated useful life of an asset is determined by its characteristics that fit one of the eight specified categories. Furthermore, the salvage value S for all categories is assumed to be zero and all assets with a life of 10 years or less are assumed to be purchased and sold at mid-year. The MACRS schedules are generally double-declining balance switching to straight-line depreciation or straight-line depreciation alone for the longer property life periods. The MACRS depreciation schedules for 3-, 5-, 7- and 10- year recovery periods are shown in Table 205.1, where each entry in the table is the allowable percentage of the purchase cost depreciation allowance in that year. Table 205.2 shows some example assets for the 3- to 10-year recovery schedules. Note that the MACRS schedule can be changed at any time, so accessing up-to-date information for computing allowable depreciation amounts is advisable.

205.2 Tax Laws and Tax Planning

Capital projects are long-lived physical assets for which the promulgation and revisions of tax laws may affect tax liability. For the purpose of planning and evaluating capital projects, it is important to under-

TABLE 205.2 Recovery Period and Examples of Property Class for MACRS Depreciation

Recovery Period	Examples of Depreciable Assets
3 years	Qualified rent-to-own property, race horse
5 years	Automobiles, office equipment
7 years	Office furniture, railroad track
10 years	Vessels, barges, and tugs, fruit- or nut-bearing trees or vines

Source: Internal Revenue Service. 2002. *Instructions for Form 4562 Depreciation and Amortization*. U.S. Department of the Treasury, Washington, DC.

stand the underlying principles, including adjustments for the transition period after each revision and for multiyear “carry-back” or “carry-forward” of profits and losses.

The federal income tax is important to business operations because profits are taxed annually at substantial rates on a graduated basis. Except for small businesses, the corporate taxes on ordinary income may be estimated with sufficient accuracy by using the marginal tax rate. *Capital gain*, which represents the difference between the sale price and the book value of an asset, is taxed at a rate lower than on ordinary income for private individuals if it is held longer than a period specified by tax laws. For corporations in 2003, capital gains are taxed at the same rate as other taxable income.

Some state and/or local governments also levy income taxes on corporations. Generally, such taxes are deductible for federal income tax to avoid double taxation. The computation of income taxes can be simplified by using a combined marginal tax rate to cover the federal, state, and local income taxes. If F is the federal marginal rate on taxable income, R is the state marginal tax rate and X is the combined rate, then:

$$X = F + R - F \cdot R \quad (205.6)$$

Tax planning is an important element of private capital investment analysis because the economic feasibility of a project is affected by the taxation of corporate profits. In making estimates of tax liability, several factors deserve attention: (1) number of years for retaining the asset, (2) depreciation method used, (3) method of financing, including purchase versus lease, (4) capital gain upon the sale of the asset, and (5) effects of inflation. Appropriate assumptions should be made to reflect these factors realistically.

205.3 Decision Criteria for Project Selection

The economic evaluation of an investment project is based on the merit of the *net present value (NPV)*, which is the algebraic sum of the discounted net cash flows over the life of the project to the present. The discount rate is the minimum attractive rate of return specified by the corporation.

The evaluation of proposed investment projects is based on NPV criteria, which specify the following: (1) an independent project should be accepted if the NPV is positive and rejected otherwise; and (2) among all acceptable projects that are mutually exclusive, the one with the highest positive NPV should be selected.

205.4 Inflation Consideration

Consideration of the effects of inflation on economic evaluation of a capital project is necessary because taxes are based on then-current dollars in future years. The year in which the useful life of a project begins is usually used as the baseline of price measurement and is referred to as the *base year*. A *price index* is the ratio of the price of a predefined package of goods and service at a given year to the price of the same package in the base year. The common price indices used to measure inflation include the

consumer price index, published by the Department of Labor, and the gross domestic product price deflator, compiled by the Department of Commerce.

For the purpose of economic evaluation, it is generally sufficient to project the future inflation trend by using an average annual inflation rate j . Let A_t be the cash flow in year t , expressed in terms of base-year (year 0) dollars, and A'_t be the cash flow in year t , expressed in terms of then-current dollars. Then

$$A'_t = A_t(1 + j)^t \quad (205.7)$$

$$A_t = A'_t(1 + j)^{-t} \quad (205.8)$$

In the economic evaluation of investment proposals in an inflationary environment, two approaches may be used to offset the effects of inflation. Each approach leads to the same result if the discount rate i , excluding inflation, and the rate i' , including inflation, are related as follows:

$$i' = (1 + i)(1 + j) - 1 = i + j + ij \quad (205.9)$$

$$i = (i' - j) / (1 + j) \quad (205.10)$$

The NPV of an investment project over a planning horizon of n years can be obtained by using the constant price approach as follows:

$$NPV = \sum_{t=0}^n A_t (1 + i)^{-t} \quad (205.11)$$

Similarly, the NPV obtained by using the then-current price approach is

$$NPV = \sum_{t=0}^n A'_t (1 + i')^{-t} \quad (205.12)$$

In some situations the prices of certain key items affecting the estimates of future incomes and/or costs are expected to escalate faster than the general inflation. For such cases the differential inflation for those items can be included in the estimation of the cash flows for the project.

205.5 After-Tax Cash Flows

The economic performance of a corporation over time is measured by the net cash flows after tax. Consequently, after-tax cash flows are needed for economic evaluation of an investment project. Since interest on debts is tax deductible according to the federal tax laws, the method of financing an investment project could affect net profits. Although the projected net cash flows over the years must be based on then-current dollars for computing taxes, the depreciation allowances over those years are not indexed for inflation under the current tax laws.

It is possible to separate the cash flows of a project into an operating component and a financing component for the purpose of evaluation. Such separation will provide better insight to the tax advantage of borrowing to finance a project, and the combined effect of the two is consistent with the computation based on a single combined net cash flow. The following notations are introduced to denote various items in year t over a planning horizon of n years:

A_t = net cash flow of operation (excluding financing cost) before tax

A_f = net cash flow of financing before tax

$A_t = A_t + A_t =$ combined net cash flow before tax
 $Y_t =$ net cash flow of operation (excluding financing cost) after tax
 $Y_t =$ net cash flow of financing after tax
 $Y_t = Y_t + Y_t =$ combined net cash flow after tax
 $D_t =$ annual depreciation allowance
 $I_t =$ annual interest on the unpaid balance of a loan
 $Q_t =$ annual payment to reduce the unpaid balance of a loan
 $W_t =$ annual taxable income
 $X_t =$ annual marginal income tax rate
 $K_t =$ annual income tax

Thus, for operation in year $t = 0, 1, 2, \dots, n$,

$$W_t = A_t - D_t \quad (205.13)$$

$$K_t = X_t W_t \quad (205.14)$$

$$Y_t = A_t - X_t(A_t - D_t) \quad (205.15)$$

For financing in year $t = 0, 1, 2, \dots, n$,

$$I_t = Q_t - A_t \quad (205.16)$$

$$Y_t = A_t + X_t I_t \quad (205.17)$$

where the term $X_t I_t$ is referred to as the *tax shield* because it represents a gain from debt financing due to the deductibility of interest in computing the income tax.

Alternately, the combined net cash flows after tax may be obtained directly by noting that both depreciation allowance and interest are tax deductible. Then,

$$W_t = A_t - D_t - I_t \quad (205.18)$$

$$Y_t = A_t - X_t(A_t - D_t - I_t) \quad (205.19)$$

It can be verified that Equation (205.19) can also be obtained by adding Equations (205.15) and (205.17), while noting $A_t = A_t + A_t$ and $Y_t = Y_t + Y_t$.

When an asset is sold, capital gains taxes must be paid on the difference between the sale price and the book value (as calculated by Equations (205.1) and (205.2)). If the sale price is less than the book value, a capital loss is incurred. Capital losses can be used to offset capital gains.

205.6 Evaluation of After-Tax Cash Flows

For private corporations, the decision to invest in a capital project may have side effects on the financial decisions of the firm, such as taking out loans or issuing new stock. These financial decisions will influence the overall equity-debt mix of the entire corporation, depending on the size of the project and the risk involved.

Traditionally, many firms have used an adjusted cost of capital, which reflects the opportunity cost of capital and the financing side effects, including tax shields. Thus, only the net cash from operation Y_t obtained by Equation (205.15) is used when the NPV is computed. The after-tax net cash flows of a proposed project are discounted by substituting Y_t for A_t in Equation (205.11), using after-tax adjusted

cost of capital of the corporation as the discount rate. If inflation is anticipated, Y_t' can first be obtained in then-current dollars and then substituted into Equation (205.12). The selection of the project will be based on the NPV thus obtained without further consideration of tax shields, even if debt financing is involved. This approach, which is based on the adjusted cost of capital for discounting, is adequate for small projects such as equipment purchase.

In recent years another approach, which separates the investment and financial decisions of a firm, is sometimes used for evaluation of large capital projects. In this approach, the net cash flows of operation are discounted at a risk-adjusted rate reflecting the risk for the class of assets representing the proposed project, whereas tax shields and other financial side effects are discounted at a risk-free rate corresponding to the yield of government bonds. An adjusted NPV reflecting the combined effects of both decisions is then used as the basis for project selection. Detailed discussion of this approach may be found elsewhere [Brealey and Myers, 2000].

205.7 Effects of Various Factors

Various depreciation methods will produce different effects on the after-tax cash flows of an investment. Since the accelerated depreciation methods generate larger depreciation allowances during the early years, the NPV of the after-tax cash flows using one of the accelerated depreciation methods is expected to be more favorable than that obtained by using the straight-line method.

If a firm lacks the necessary funds to acquire a physical asset that is deemed desirable for operation, it can lease the asset by entering into a contract with another party, which will legally obligate the firm to make payments for a well-defined period of time. The payments for leasing are expenses that can be deducted in full from the gross revenue in computing taxable income. The purchase-or-lease options can be compared after their respective NPVs are computed.

When an asset is held for more than a required holding period under tax laws, the capital gain is regarded as long-term capital gain. In a period of inflation the sale price of an asset in then-current dollars increases, but the book value is not allowed to be indexed to reflect the inflation. Consequently, capital gain tax increases with the surge in sale price resulting from inflation.

Example 205.1

Suppose a light, general-purpose truck is purchased for \$25,000 in February. This truck is expected to generate a before-tax uniform annual revenue of \$7,000 over the next 6 years, with no salvage value at the end of 6 years. According to the current IRS regulations, this truck is assigned to a 5-year property class with no salvage value after the depreciation period. The MACRS schedule in [Table 205.1](#) is used to compute the annual depreciation allowance. The combined federal and state income tax rate is 38%. Assuming no inflation, the after-tax discount rate of 8%, based on the adjusted cost of capital of the corporation, is used. Determine whether this investment proposal should be accepted.

Solution. Using the 5-year recovery period schedule in [Table \(205.1\)](#), the annual depreciation allowance D_t is found to be \$25,000 multiplied by the allowable percentage depreciation allowance in each year. We assume that the tax loss in year 2 may be offset by income elsewhere, so the loss results in a tax shield of \$380. Tax amounts are rounded to the nearest dollar.

Period T	Capital Investment	Before-Tax Cash Flow, A_t	Depreciation Allowance D_t	Taxable Cash Flow $A_t - D_t$	Taxes Kt	After-Tax Cash Flow Y_t'
0	-25,000		—	—	—	-25,000
1		7,000	5,000	2,000	760	6,240
2		7,000	8,000	-1,000	-380	7,380
3		7,000	4,800	2,200	836	6,164
4		7,000	2,880	4,120	1,566	5,434

Period T	Capital Investment	Before-Tax Cash Flow, A_t	Depreciation Allowance D_t	Taxable Cash Flow $A_t - D_t$	Taxes Kt	After-Tax Cash Flow Y_t
5		7,000	2,880	4,120	1,566	5,434
6		7,000	1,440	5,560	2,113	4,887

Using the adjusted cost of capital approach, the NPV of the after-tax net cash flows discounted at 8% is obtained by substituting Y_t for A_t in Equation (205.11),

$$\begin{aligned} \text{NPV} = & -25\,000 + (6240)(P|F, 8\%, 1) + (7380)(P|F, 8\%, 2) + (6194)(P|F, 8\%, 3) \\ & + (5434)(P|F, 8\%, 4) + (5434)(P|F, 8\%, 5) + (4887)(P|F, 8\%, 6) = 2794 \end{aligned}$$

in which $(P|F, 8\%, t) = 1/(1.08)^t$ is the present worth factor of a future amount discounted at an 8% rate for t years. Since NPV = \$2,794 is positive, the proposed investment should be accepted.

Example 205.2

Consider a proposal for the purchase of a computer workstation that costs \$20,000 and has no salvage value at disposal after 4 years. This investment is expected to generate a before-tax uniform annual revenue of \$7,000 in base-year dollars over the next 4 years. An average annual inflation rate of 5% is assumed. The MACRS 5-year property depreciation schedule is used to compute the annual depreciation allowance. The combined federal and state income tax rate is 38%. Based on the adjusted cost of capital of the corporation, the after-tax discount rate, including inflation, is 10%. Determine whether this investment proposal should be accepted.

Solution. Depreciation in each year is calculated by multiplying the 5-year depreciation percentage in each year by \$20,000. This annual depreciation allowance will not be indexed for inflation, according to the IRS regulations. At the end of the 4 years, the computer has a book value of \$3,456 (as calculated from Equation 205.1 and 205.2). When the computer is disposed of with no salvage value, this amount would represent a capital loss that could be used to offset capital gains accumulated elsewhere in the business. Taxes in year 4 would then be \$3,509 multiplied by the combined marginal tax rate (0.38) less the capital-gain tax shield of \$3,456 multiplied by the combined marginal tax rate (0.38).

The annual before-tax revenue of \$7,000 in base-year dollars must be expressed in then-current dollars before computing the income taxes. From Equation (205.7),

$$A'_t = (7000)(1 + 0.05)^t$$

where $t = 1$ to 4 refers to each of the next 4 years. The after-tax cash flow Y'_t for each year can be computed by Equation (205.15). The step-by-step tabulation of the computation for each year is shown in the following table.

Period T	Capital Investment	Before Tax Cash Flow (Base Year \$) A_t	Before Tax Cash Flow (Current Year \$) A'_t	Depreciation D_t	Taxable Income $A'_t - D_t$	Capital Loss	Taxes Kt	After Tax Cash Flow Y'_t
0	-20,000							-20,000
1		7,000	7,350	4,000	3,350		1,273	6,077
2		7,000	7,718	6,400	1,318		501	7,217
3		7,000	8,013	3,840	4,123		1,586	6,427
4		7,000	8,509	2,304	6,205	3,456	1,045	7,464

Using the adjusted cost of capital approach, the NPV of the after-tax cash flows discounted at $i' = 10\%$, including inflation, can be obtained by substituting the value of Y'_t for A'_t in Equation (205.10) as follows:

$$\begin{aligned} \text{NPV} &= -20\,000 + (6077)(1.1)^{-1} + (7217)(1.1)^{-2} + (6427)(1.1)^{-3} + (7464)(1.1)^{-4} \\ &= 1416 \end{aligned}$$

Since $\text{NPV} = \$1416$ is positive, the investment proposal should be accepted.

Example 205.3

A developer bought a plot of land for \$100,000 and spent \$1.6 million to construct an apartment building on the site for a total price of \$1.7 million. The before-tax annual rental income after the deduction of maintenance expenses is expected to be \$300,000 in the next 6 years, assuming no inflation. The developer plans to sell this building at the end of 6 years when the property is expected to appreciate to \$2.1 million, including land. Suppose the entire cost of construction can be depreciated over 32 years based on the straight-line depreciation method, whereas the original cost of land may be treated as the salvage value at the end. The tax rates are 34% for ordinary income and 28% for capital gain, respectively. Based on the adjusted cost of capital, the developer specifies an after-tax discount rate of 10%.

Solution. Using Equation (205.4), the annual depreciation allowance D_t over 32 years is found to be \$50,000. Noting that $P = 1\,700,000$ and $T_t = (6)(50\,000) = 300,000$, the book value of the property after 6 years is found from Equation (205.2) to be \$1.4 million.

Ignoring the assumption of mid-year purchase to simplify the calculation and assuming no inflation, the after-tax annual net income in the next 6 years is given by Equation (205.13):

$$Y_t = 300\,000 - (34\%)(300\,000 - 50\,000) = 215\,000$$

The capital gain tax for the property at the end of 6 years is

$$(28\%)(2\,100\,000 - 1\,400\,000) = 196\,000$$

Using the adjusted cost of capital approach, the NPV of after-tax net cash flows in the next 6 years, including the capital gain tax paid at the end of 6 years discounted at 10%, is

$$\begin{aligned} \text{NPV} &= -1\,700\,000 + (215\,000)(P|U, 10\%, 6) \\ &\quad + (2\,100\,000 - 196\,000)(P|F, 10\%, 6) \\ &= 311\,198 \end{aligned}$$

in which $(P|U, 10\%, 6)$ is the discount factor to present at 10% for a uniform series over 6 years, and $(P|F, 10\%, 6)$ is the discount factor to present at 10% for a future sum at the end of 6 years. Since $\text{NPV} = \$311,198$ is positive, the proposed investment should be accepted.

Defining Terms

Base year — The year used as the baseline of price measurement of an investment project.

Capital gain — Difference between the sale price and the book value of an asset.

Depreciable life — Estimated useful life over which depreciation allowances are computed.

Depreciation — Decline in value of physical assets over their estimated useful lives.

Depreciation allowance — Amount of depreciation allowed in a systematic allocation of the cost of a physical asset between the time it is acquired and the time it is disposed of.

Net present value — Algebraic sum of the discounted cash flows over the life of an investment project to the present.

Price index — Ratio of the price of a predefined package of goods and service at a given year to the price of the same package in the base year.

Tax shield — Gain from debt financing due to deductibility of interest in computing the income tax.

References

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Further Information

Up-to-date information on the tax code may be found at websites for individual state taxation departments and the following websites:

U.S. Internal Revenue Service, www.irs.gov

Federation of Tax Administrators, www.taxaadmin.org