1986

Effects of Inflation and after-tax present values where business costs are capitalized

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EFFECTS OF INFLATION ON AFTER-TAX PRESENT VALUES WHERE COSTS ARE CAPITALIZED

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Introduction

Business investments often span periods of time with significant inflation. If taxes are not considered, inflation can be ignored in computing the present value of future net income. Inflation should not be ignored, however, in *after-tax* analyses of rates of return or net present values of potential investments. Inflation affects the present value of business costs which are capitalized for tax purposes, and the influence must be considered for present value calculations to be accurate.

After-tax analyses must include the tax savings which result from being able to deduct business-related costs from taxable income. Costs which are expensed, of course, are deducted entirely in the tax year in which they are incurred. Capitalized costs, however, are deducted later through depreciation, depletion, or as in the case of land, simply by deducting initial costs when the land is sold. After-tax present values where investment or business costs are capitalized are simply present values after taxes have been accounted for, where all or a portion of the costs are capitalized for tax purposes. In such analyses, present values are decreased by inflation. After reviewing the most relevant previous work, the nature and potential degree of this decrease and its relationship with investment period length were examined.

Review

In analyses where taxes are not considered, present values are equivalent whether or not inflation is included. Business decisions based on pre-tax present net values are not affected by inflation since the terms simply cancel out of the present value expression. If a certain income, for example, is expected in year n, when discounted with a real interest rate, the present value is found simply by dividing the future income by the compound interest factor $(1 + r)^n$, where r is the real or uninflated interest rate. If, however, the present value is calculated in inflated terms, both the income and the discount factor are multiplied by the inflation factor.

The two present values are equivalent since inflation simply cancels out of the expression (Gregersen [1], Hanke et al. [2], Harou [3]). Nelson [5], however, showed that present values with and without inflation are not necessarily equal when taxes are considered. Klemperer [4] showed that, after capital gains taxes, present values decline with increasing inflation. Here his results are generalized to include *all* capitalized costs; note that the decline increases, reaches a maximum, and decreases as the investment period is lengthened. The effect of inflation may be significant or may be trivial, depending on all the economic parameters in the present value analysis. Business decisions based on present value analyses should consider this influence. Investments are less attractive on an after-tax basis when inflation occurs, and if inflation is ignored, poor investment decisions may result.

Effects of Inflation

The impact of inflation on after-tax investment decisions can be derived in two ways. Each is illustrated for an example in Figure 1. The example is for an initial cost of $200, a tax rate of 30.0 percent, a real discount rate of 2.0 percent, inflation rates of 0 and 5.0 percent, and a real rate of appreciation for the investment of 4.0 percent. Figure 1a shows V_0 as the present value of the investment when inflation is 0 percent, and V_0^I as the present value when inflation is 5.0 percent. V_0 minus V_0^I is the difference between the two and is also plotted in Figure 1a.[1]

Figure 1b derives the present value difference by showing the tax savings from being able to deduct the costs from future income with and without inflation. Deducting costs from taxable income represents tax

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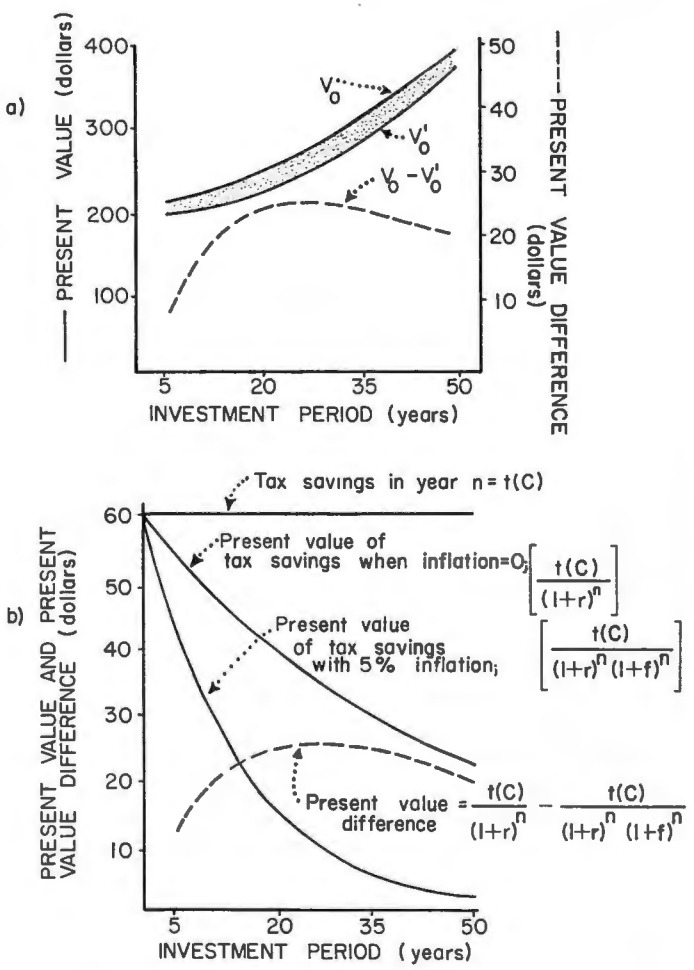
Figure 1. Example Present Values and Present Value Differences



savings of t(C) in the year the deduction is made (n). Since by current law the basis cannot be inflated, the future tax savings are constant in nominal terms and should be discounted at a nominal interest rate. When inflation is zero, however, the savings are discounted at a real rate, thereby yielding a higher present value for the tax savings. The present value difference in Figure 1b is identical to the expression for $V_0 - V_0^I$ in Footnote 1, yet is derived merely from the present value of tax savings in year n.

The primary result is that the present value difference is positive when inflation is positive. This means that present values are lower when inflation occurs, in *any* analysis where initial costs are capitalized. Ignoring inflation can, therefore, result in accepting bad investments, since present values may be positive without inflation but negative if inflation is considered.

The present value reduction from inflation applies to any situation in which business costs are deducted (in whole or in part) after an inflationary period. In periods of positive inflation, present values calculated with zero inflation (or underestimated inflation) will be too high in *any* analysis with capitalized costs. For any combination of tax rate and discount rate, the difference increases with the rate of inflation and the deducted basis. The difference increases with the tax rate and is completely independent of total income in year n and the rate of return generated by the investment (see Figure 1b). The investment period, however, does affect the degree of error and is considered below in more detail.

Investment Period and After-Tax Present Values

When adding inflation to after-tax analyses with capitalized costs, the reduction in present value increases, reaches a maximum, and decreases with n, the investment period. The influence of time on the present value reduction depends on the rate of inflation and the real rate of discount. Present value differences *per dollar* of tax savings are plotted in Figure 2. They increase, reach a maximum, and decrease for longer investment periods. Differences are greater with higher inflation and lower discount rates, and for any given combination there is an investment period which results in the maximum difference (Table 1). If r = .02 and f = .02, for example, differences increase until n = 35. Although the bias from omitting inflation is greater with higher inflation, the point of culmination for $V_0 - V_0^I$ decreases with f (Figure 2 and Table 1).

Figure 2. Present Value Differences Per Dollar of Tax Savings for Inflation Rates of 4.0 and 8.0 Percent and for Real Discount Rates of 2.0, 5.0, and 8.0 Percent

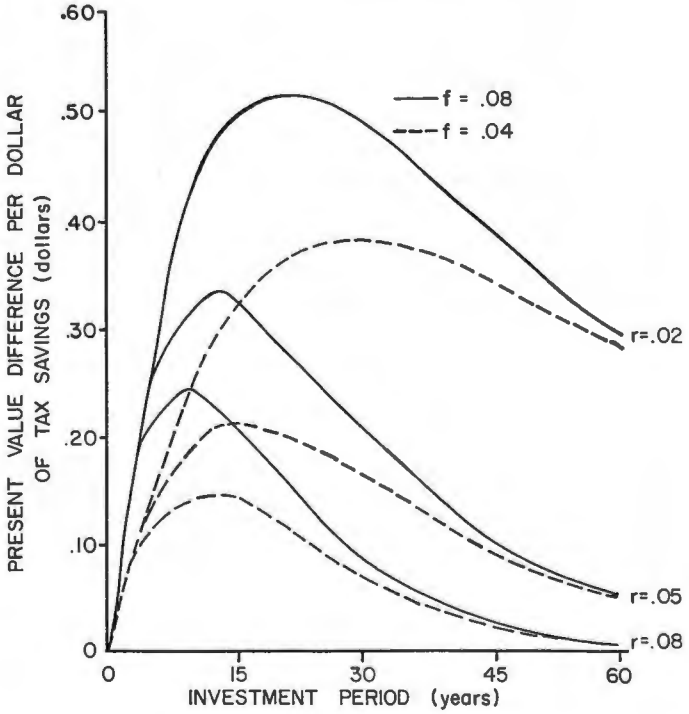


Table 1

INVESTMENT PERIODS FOR SELECTED INFLATION AND DISCOUNT RATES

r = Real Discount Rate	f = Rate of Inflation						
	.02	.04	.06	.08	.10	.12	.14
	n* (years)[1]						
.02	35.00	27.85	23.54	20.61	18.47	16.81	15.50
.04	20.64	17.67	15.63	14.11	12.93	11.99	11.20
.06	14.77	13.12	11.90	10.94	10.17	9.53	8.79
.08	11.56	10.50	9.67	9.01	8.45	7.99	7.59
.10	9.53	8.79	8.19	7.69	7.27	6.91	6.60
.12	8.13	7.58	7.12	6.73	6.40	6.12	5.86
.14	7.11	6.68	6.31	6.00	5.74	5.50	5.29

[1]n* = the investment period which results in the maximum difference between present values calculated with and without inflation, where costs are capitalized.

Conclusions

Where business costs are deducted after an inflationary period, after-tax present values are too high if inflation is assumed to be zero. Tax savings from deducting costs are constant in nominal terms, and their present value is overestimated if a real discount rate is used (unless the basis is deflated as mentioned in Footnote 1). The degree of bias can be predicted and may be significant or trivial, depending on all of the variables pertinent to an investment (discount rate, inflation rate, tax rate, initial cost, and investment period). The inflation-induced reduction in present value rises with lower discount rates or with greater inflation, tax rates, and deductible costs. The reduction may increase or may decrease, however, for lengthening investment periods.

Evaluating present values after capital gains taxes, Klemperer [4] correctly concluded that the present value reduction caused by inflation was likely to be trivial for investments with payoff periods longer than 30 years, assuming historic inflation rates and typically acceptable industrial real alternative rates of return in the U.S. Since the present value reduction does not necessarily decrease for longer investments, however, and since the reduction is fairly sensitive to real interest rates, it is recommended that present values after income taxes be calculated with a projected inflation rate, for all investment lives, incorporating the same inflation rate in the cash flows and the discount rate.

FOOTNOTES

[1]An alternative would be to deflate the initial cost term. The result is equivalent and represents another means of correctly incorporating inflation in after-tax analyses. Generalized expressions for the terms are given below:

Present values with and without inflation and the difference between them in analyses where investment costs are capitalized:

- r = real interest rate (in decimal percent), excludes inflation
- f = average annual rate of inflation (in decimal percent)
- n = investment period (years)
- V_0 = present value excluding inflation
- V_0^I = present value with inflation
- I_n = real income in year n, excluding inflation
- t = tax rate (decimal present)
- C = cost basis, to be deducted from taxable income in year n

For depreciation or depletion, the expressions below can be applied to each year in which a deduction is made; in such cases C is the portion of initial costs deducted in year n:

$$V_0 = \frac{I_n - t(I_n - C)}{(1 + r)^n}$$

$$V_0^I = \frac{I_n (1 + f)^n - t(I_n (1 + f)^n - C)}{(1 + r)^n (1 + f)^n}$$

$$V_0 - V_0^I = t(C)\left[\frac{1}{(1 + r)^n} - \frac{1}{(1 + r)^n (1 + f)^n}\right]$$

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