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DISTORTIONS IMPOSED BY INFLATION ON HISTORICAL-COST DEPRECIATION

Boris E. Bravo-Ureta

ABSTRACT

The use of historical-cost depreciation in periods of persistent inflation decreases the present value of depreciation deductions, thus understating the true economic cost of capital and increasing the real after-tax rate of return required by potential investors. Efforts to correct these problems by adopting depreciation methods that allow for artificially short recovery periods or accelerated rates do not provide an adequate solution. Distortions imposed by inflation on historical-cost depreciation can be adequately corrected by indexing the historical-cost basis.

INTRODUCTION

During the 1970's and early 1980's the United States has experienced a continuous escalation in the general price level. The causes, effects and possible solutions to this problem have been the subject of considerable controversy among economists and politicians. In spite of this controversy, it has become clear that persistent inflationary pressures impose serious distortions on the tax system (Fellner, Clarkson and Moore). This paper analyzes some firm-level distortions stemming from the use of historical-cost depreciation under inflation.

Historically, United States tax policy has undergone significant changes since the enactment of the first modern income tax system in 1913. Nevertheless, tax laws since 1921 have specified that deductible depreciation allowances must be based on the asset's historical-cost (Tax Foundation).

The use of the historical-cost as the basis for depreciation is a practice well suited for periods when prices are stable or inflation rates are relatively low. During inflationary times, however, depreciation deductions based on historical-cost become progressively inadequate as a means to recover the asset's cost in dollars which have the same purchasing power as they did when the asset was originally purchased (Schiff).

In addition, the failure of tax rules to recognize that during inflationary periods firms are unable to replace their capital when depreciation allowances are based on historical costs leads to an understatement of true capital costs,

The author is an Assistant Professor in the Department of Agricultural Economics and Rural Sociology, University of Connecticut, Storrs, Connecticut.

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to an overstatement of taxable income, and therefore to an over taxation of the firm's nominal income.

If the major objective of depreciation policy is to recover the original cost of the asset in real terms over its useful life, then an adequate depreciation method can be defined as one that "attempts to secure under conditions of inflation, the same results that conventional depreciation yields under stable conditions" (Terborgh, p. 119). This concept of depreciation is the basis of this paper.

DEPRECIATION ADJUSTMENTS FOR INFLATIONS

Several alternatives have been proposed to account for deficiencies introduced by inflation when depreciation deductions are based on historical-cost.¹ One of these alternatives calls for the use of accelerated depreciation rates (Cost Accounting Standards Board [CASB]). This concept was first introduced into the U.S. tax system in 1954 when the Internal Revenue Service authorized the use of double-declining-balance, sum-of-the-years digits, or any other depreciation method which would yield deductions not in excess of the double-declining-balance method during the initial two-thirds of the asset's service-life (Tax Foundation).

The Accelerated Cost Recovery System (ACRS) provision in the Economic Recovery Act of 1981, instituted by the Reagan Administration, offers a second approach to correct the distortions imposed by inflation on the use of historical-cost depreciation. This provision, as its name suggests, permits the accelerated recovery of capital investment costs through the use of artificially short tax lives.

It should be noted that the Reagan Administration maintained historical-cost as the basis for computing depreciation deductions, even though the inadequacy of this basis under inflation was fully recognized. The administration's view on this matter is well summarized in the following statement: "High inflation causes a large discrepancy between the historic and the current replacement costs of physical assets of business. Thus, corporate financial records, utilizing historic costs and current dollar sales figures, significantly overstate nominal profits and understate true economic costs" (Reagan, p. 37).

Some analysts have rejected the use of artificially short asset tax lives and accelerated depreciation rates as a remedy for inflationary distortions. Instead, they have proposed that the historical-cost basis be adjusted directly to assure that depreciation deductions yield the same results, in real terms, independent of the rate of inflation (CASB).

¹ For a discussion of some of these alternatives see: Tax Foundation Chapter 5; Shoven and Bulow pp. 557-566; Terborgh 1954, Chapter 12.

Two alternatives that have been suggested for adjusting the historical-cost basis to calculate depreciation allowances under inflation are: (1) using the asset's replacement-cost; and (2) expressing the historical-cost depreciation in terms of current dollars.² Even though conceptual arguments have been advanced in favor of each of these alternatives, difficulties associated with the determination of replacement-cost strongly favor the second option.

In this paper, an approach proposed by CASB is presented as a method consistent with the objective of depreciation policy expressed earlier and is used to evaluate the adequacy of other depreciation options. This method consists of indexing⁴ historical-cost depreciation allowances according to a general-purchasing power indicator such as the GNP deflator. This indexation procedure is applied to straight-line historical-cost depreciation allowances, based on the assumption that straight-line is the method "viewed as generally appropriate by management" to reflect economic depreciation (Shoven and Bulow, p. 570). Following Shoven and Bulow, this indexed method is hereinafter referred to as Straight-Line General-Value (SLGV) depreciation.

OBJECTIVES

In light of the difficulties brought about by the combination of inflation and historical-cost depreciation, and given that the most recent program instituted to deal with these problems still relies on the historical-cost provision, the following question arises: Can depreciation methods based on historical-cost, but allowing for the accelerated recovery of the investment or accelerated depreciation rates, fully correct for distortions imposed by inflation? The purpose of this paper is to examine this question. The specific objectives are:

- (1) To determine the effect of inflation on the present value of depreciation deductions using alternative computation methods; and
- (2) To determine the combined effect of inflation, investment tax credit and choice of depreciation method on the rate of return on investment.

² For a discussion of these two approaches see CASB: Shoven and Bulow; Terborgh, Chapter 12; Tideman and Tucker.

³ The determination of replacement-cost is difficult primarily due to the absence of adequate markets for used assets. This lack of markets would require the reliance on several price indexes for specific capital goods to approximate replacement costs. In addition, accurate information on the composition of the firm's capital stock would be needed.

⁴ Indexing or indexation means expressing amounts of money in real terms, that is, in terms of dollars of constant purchasing.

ASSUMPTIONS AND PROCEDURES

To accomplish the first objective, the present value of depreciation deductions for six alternative methods applied to the five-year class property are compared assuming: (1) inflation rates equal to 0, 5, 10 and 15 percent; (2) economic lives equal to 5, 10, and 15 years; and (3) a four percent real after-tax discount rate. It is also assumed that the purchase of the asset is fully financed from equity capital and that its salvage value is zero.

The depreciation methods to be compared are the following:

- | | |
|---|---------|
| (1) Straight-Line Historical-Cost: | SLHC; |
| (2) Double-Declining-Balance: | DDB; |
| (3) Accelerated Cost Recovery System,
5-year Recovery: | ACRS5; |
| (4) Alternate ACRS, 5-year Recovery: | AACR5; |
| (5) Alternate ACRS, 12-year Recovery: | AACR12; |
| (6) Straight-Line General-Value: | SLGV. |

The present value of depreciation deductions for these depreciation methods are given⁶ in continuous time by the following expressions:

- 1) Present Value Straight-Line Historical-Cost:

$$PVSLHC = \frac{1}{T} \int_0^T e^{-ns} ds;$$

- 2) Present Value Double-Declining-Balance:

$$PVDDDB = \frac{2}{T} \int_0^{T/2} e^{-ns-2s/T} ds + \frac{2}{T} \int_{T/2}^T e^{-ns-1} ds;$$

- 3) Present Value Accelerated Cost Recovery

$$PVACRS5 = .15 \int_0^1 e^{-ns} ds + .22 \int_1^2 e^{-ns} ds \\ + .21 \int_2^5 e^{-ns} ds;$$

⁵ For a discussion of the provisions of the ACRS that are of significance to agriculture see Durst, Rome and Hrubovcak; U.S. Department of Treasury.

⁶ The expressions for the present value of depreciation deductions for methods (1), (2) and (6) were adapted from Gramlich. The expressions for the remaining methods were derived by the author.

4) Present Value Alternate ACRS, 5-year Recovery:

$$PVAACR5 = .1 \int_0^1 e^{-ns} ds + .2 \int_1^5 e^{-ns} ds \\ + .1 \int_5^6 e^{-ns} ds;$$

5) Present Value Alternate ACRS, 12-year Recovery:

$$PVAACR12 = .042 \int_0^1 e^{-ns} ds + .0833 \int_1^{12} e^{-ns} ds \\ + .042 \int_{12}^{13} e^{-ns} ds;$$

6) Present Value Straight-Line General-Value:

$$PVSLGV = \frac{1}{T} \int_0^T e^{-rs} ds;$$

where:

T = asset tax life;

n = nominal discount rate;⁷

s = asset age;

r = real discount rate.

The second objective is pursued by estimating the real before-tax rate of return required to yield an after-tax real rate of return of four percent for selected inflation rates, economic lives, investment tax credit allowances, and depreciation methods.

The real before-tax rates of return are estimated using the cost-of-capital formula developed by Hall and Jorgenson. This formula is given by the following expression:

$$\rho = [(R + d)(1 - k - uz)] / (1 - u) - d$$

where:

ρ = required real before-tax rate of return net of economic depreciation;

R = firm's required real after-tax rate of return assumed at four percent;

d = economic rate of depreciation assumed to be $1/E$, where E is defined as the asset economic life;

k = rate of investment tax credit assumed at zero or 10 percent;

u = firm's marginal tax rate assumed at 30 percent

z = present value of depreciation deductions for one dollar of the asset's initial cost. The different values of z are calculated using the present value expressions shown above.

RESULTS

Table 1 shows the present value of depreciation deductions as a percent of original cost for six depreciation methods, three asset economic lives and four selected inflation rates, assuming a four percent real after-tax discount rate. The data indicate that for a given rate of inflation, the present value of depreciation deductions declines as the economic life of the asset increases. More importantly, the data show that the present values of depreciation deductions are inversely related to the rate of inflation for all depreciation methods except SLGV. For the latter method the present value of depreciation deductions is invariant with the rate of inflation.

As stated earlier, a desirable objective of depreciation policy is to assure that methods used to estimate deductions produce the same results regardless of the rate of inflation. Of the six depreciation methods reported in Table 1, only SLGV consistently meets this objective, and thus conforms to the definition of an adequate depreciation method given above. It should be emphasized that SLGV is the only method in Table 1 that does not rely on nominal historical-cost as the basis for calculating depreciation.

The adequacy of different depreciation methods can be compared by estimating the ratio of the present value of depreciation deductions for each method to the corresponding value using the SLGV approach. When this ratio is greater than one, it reflects overdepreciation; when it is equal to one, it means that depreciation deductions are adequate; and when it is less than one, it reflects underdepreciation.

Figure 1 is a graphical illustration of the ratios measuring the adequacy of alternative depreciation methods for an asset with an economic life of five years. The diagram reveals that the DDB method leads to slight overdepreciation when inflation is less than one percent and to underdepreciation whenever inflation exceeds one percent. The SLHC, ACRS5 and AACR5 methods lead to greater levels of underdepreciation than DDB for

⁷ In continuous time the nominal discount rate (n) is exactly equal to the real discount rate (r) plus the rate of inflation (g). In short, $n = r + g$.

⁸ Note that the present values for ACRS5 and AACR5 do not change with asset economic life because tax life remains constant as specified by the ACRS program. Also note that the AACR12 option is not applicable for 5-year and 10-year economic lives.

Table 1. Present Value of Depreciation Deductions as a Percent of Original Cost (\$1) from Six Depreciation Methods for Selected Asset Economic Lives and Inflation Rates (g), Assuming a Real After-Tax Discount Rate of Four Percent.

Asset Economic Life	g	Depreciation Methods ^{a/}					
		SLHC	DDB	ACRS5	AACRS5	AACR12	SLGV
		percent				percent	
<u>5 years</u>	0	90.6	92.3	90.2	88.9	b/	90.6
	5	80.5	84.0	79.6	77.0	"	90.6
	10	71.9	76.7	70.7	67.3	"	90.6
	15	64.6	70.5	63.1	59.0	"	90.6
<u>10 years</u>	0	82.4	85.5	90.2	88.9	"	82.4
	5	65.9	71.7	79.6	77.0	"	82.4
	10	53.8	61.2	70.7	67.3	"	82.4
	15	44.8	53.2	63.1	59.0	"	82.4
<u>15 years</u>	0	74.9	79.4	90.2	88.9	77.8	74.9
	5	54.9	62.1	79.6	77.0	58.6	74.9
	10	41.8	50.4	70.7	67.3	45.3	74.9
	15	33.8	42.2	63.1	59.0	36.0	74.9

a/ SLHC: Straight-Line Historical-Cost
 DDB: Double-Declining-Balance
 ACRS5: Accelerated Cost Recovery System (ACRS), 5-Year Recovery
 AACRS5: Alternate ACRS, 5-Year Recovery
 AACR12: Alternate ACRS, 12-Year Recovery
 SLGV: Straight-Line General-Value

b/ Not applicable.

all inflation rates.

Figure 2 is a graphical representation of the ratios measuring the adequacy of the various depreciation methods for assets with economic lives of 10 and 15 years. This figure shows that SLHC leads to underdepreciation whenever inflation is greater than zero, regardless of economic life.

Figure 2 also shows that the DDB and the three ACRS methods initially lead to overdepreciation and then to underdepreciation as the rate of inflation increases. Each of these methods will result in an adequate level of depreciation deductions only at a specified annual rate of inflation.

Table 2 shows before-tax real rates of return that are required to yield a four percent after-tax real rate of return for selected inflation rates, asset economic lives, investment tax credit rates, and depreciation methods. An investment tax credit rate of 10 percent is included in some of the results to reflect prevailing policy.

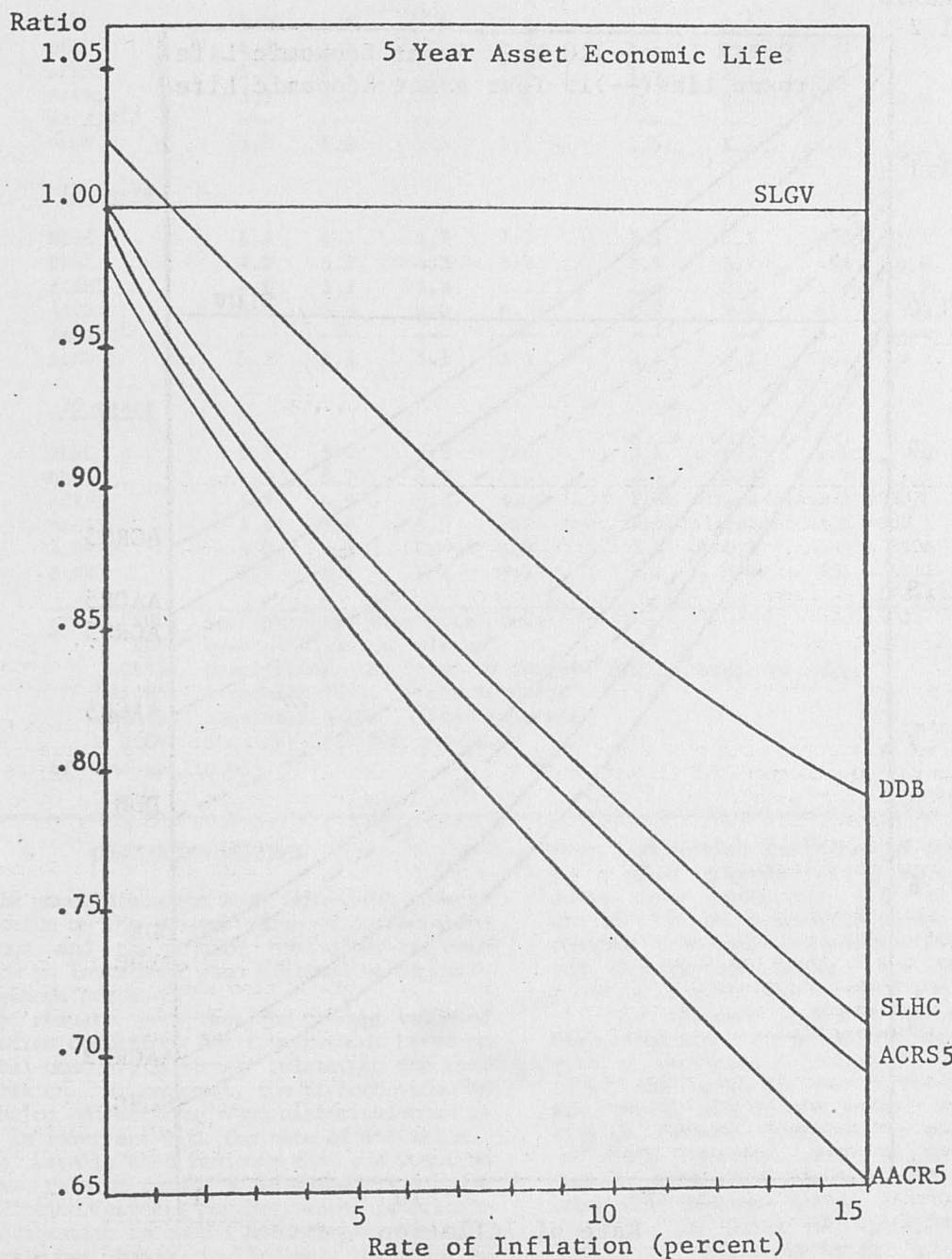
A major implication derived from the data displayed in Table 2 is that the choice of depreciation method can have a marked effect on the required rate of return on investment under inflation. For a given economic life, the required rate of return on investment is directly related to the rate of inflation for all depreciation methods except SLGV. When this latter method is used, the required rate of return is invariant with the rate of inflation.

In the absence of investment tax credit, the data in Table 2 also shows that as the rate of inflation increases required rates of return are biased in favor of long-lived assets. The only exception is SLGV depreciation which basically leads to a constant required rate of return regardless of economic life or inflation rate.

The adoption of a 10 percent investment tax credit significantly reduces the required rate of return under all depreciation methods. This reduction is much greater for short-lived assets as evidenced by the fact that the bias of higher inflation rates towards long-lived property, observed without an investment tax credit, is more than offset in almost all cases. As shown in Table 2, the bias in favor of long-lived assets is only partially offset for the ACRS methods when inflation is 10 percent or higher.

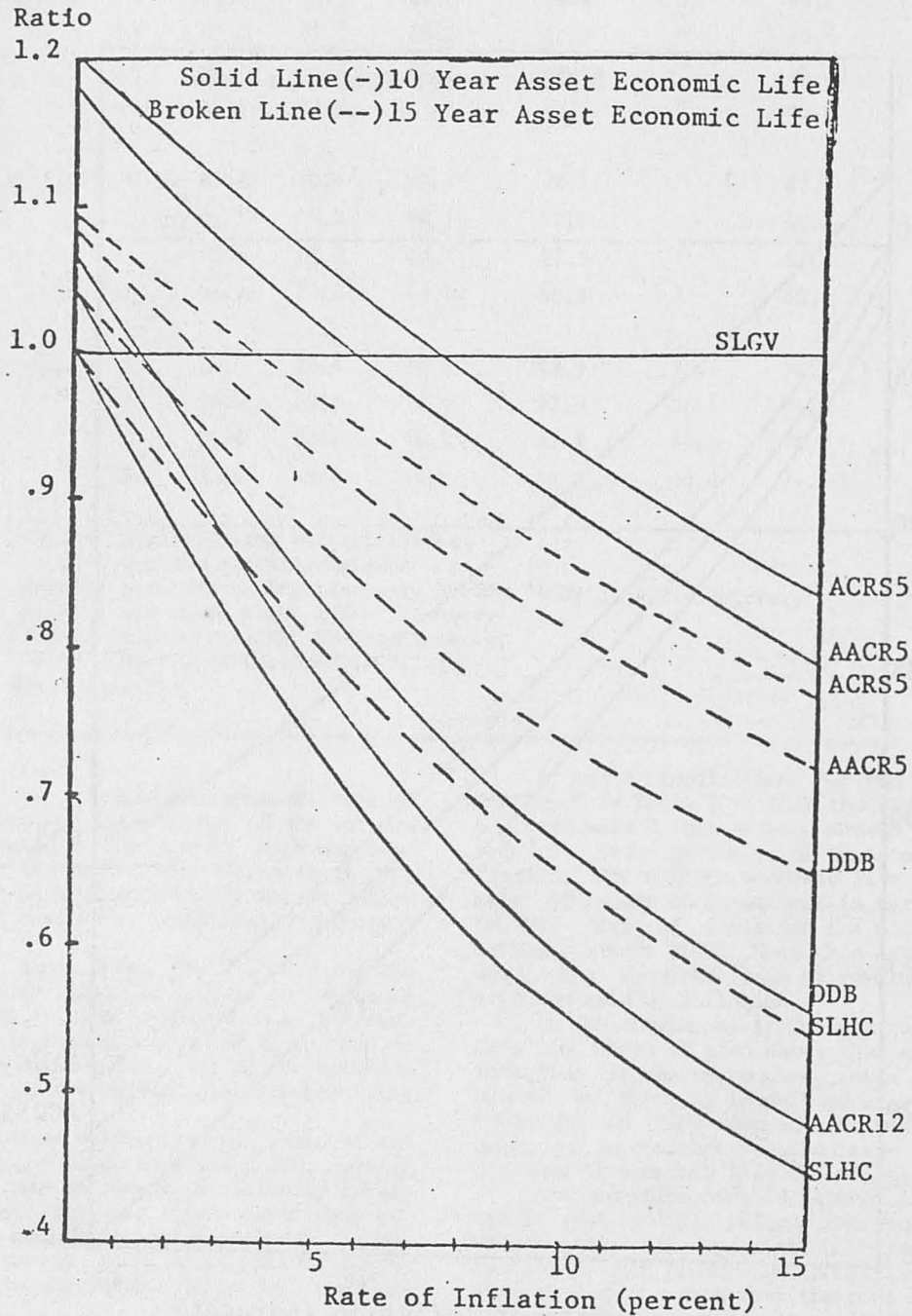
⁹ For details regarding prevailing policy on investment tax credit see Durst, Rome and Hrubovcak; U.S. Department of Treasury.

Figure 1. Ratio of the Present Value of Depreciation Deductions for SLHC, DDB, ACRS5, and AACR5 to the Corresponding Value Using SLGV.^{a/}



- ^{a/} SLHC: Straight-Line Historical-Cost
DDB: Double-Declining-Balance
ACRS5: Accelerated Cost Recovery System (ACRS), 5-Year Recovery
AACR5: Alternate ACRS, 5-Year Recovery
SLGV: Straight-Line General-Value

Figure 2 . Ratio of the Present Value of Depreciation Deductions for SLHC, DDB, ACRS5, AACR5, and AACR12 to the Corresponding Value Using SLGV.^{a/}



^{a/} SLHC: Straight-Line Historical-Cost; DDB: Double-Declining-Balance; ACRS5: Accelerated Cost Recovery System (ACRS), 5-Year Recovery; AACR5: Alternate ACRS, 5-Year Recovery; AACR12: Alternate ACRS, 12-Year Recovery; SLGV: Straight-Line General-Value.

DISTORTIONS IMPOSED BY INFLATION ON HISTORICAL-COST DEPRECIATION

Table 2. Real Before-Tax Rates of Return Required to Yield an After-Tax Real Rate of Return of Four Percent for Selected Depreciation Methods, Inflation Rates, Asset Economic Lives and Investment Tax Credit Rates.

Inflation Rates, Asset Economic Lives and Investment Tax Credit Rates.								
Depreciation Methods ^{a/}	Investment Credit = 0				Investment Credit = 10%			
Asset	Inflation Rates (g)				Inflation Rates (g)			
Economic Life	0	5	10	15	0	5	10	15
	- - - - percent - - - -				- - - - percent - - - -			
<u>5 years</u>								
SLHC	5.0	6.0	6.9	7.6	1.5	2.6	3.5	4.2
DDB	4.8	5.6	6.4	7.0	1.4	2.2	3.0	3.6
ACRS5	5.0	6.1	7.0	7.8	1.6	2.7	3.6	4.4
AACRS5	5.1	6.4	7.4	8.2	1.7	2.9	3.9	4.8
AACR12 ^{b/}	---	---	---	---	---	---	---	---
SLGV	5.0	5.0	5.0	5.0	1.5	1.5	1.5	1.5
<u>10 years</u>								
SLHC	5.1	6.1	6.8	7.3	3.1	4.1	4.8	5.3
DDB	4.9	5.7	6.3	6.8	2.9	3.7	4.3	4.8
ACRS5	4.6	5.2	5.8	6.2	2.6	3.2	3.8	4.2
AACRS5	4.7	5.4	6.0	6.5	2.7	3.4	4.0	4.5
AACR12 ^{b/}	---	---	---	---	---	---	---	---
SLGV	5.1	5.1	5.1	5.1	3.1	3.1	3.1	3.1
<u>15 years</u>								
SLHC	5.1	6.0	6.6	7.0	3.6	4.3	5.1	5.5
DDB	4.9	5.7	6.2	6.6	3.4	4.2	4.7	5.1
ACRS5	4.4	4.9	5.3	5.7	2.9	3.4	3.8	4.1
AACRS5	4.5	5.0	5.5	5.8	3.0	3.5	3.9	4.3
AACR12	5.0	5.9	6.5	6.9	3.5	4.3	5.0	5.3
SLGV	5.1	5.1	5.1	5.1	3.6	3.6	3.6	3.6

^{a/} SLHC: Straight-Line Historical-Cost
DDB: Double-Declining-Balance
ACRS5: Accelerated Cost Recovery System (ACRS), 5-Year Recovery
AACRS5: Alternate ACRS, 5-Year Recovery
AACR12: Alternate ACRS, 12-Year Recovery
SLGV: Straight-Line General-Value

^{b/} Not applicable.

CONCLUDING REMARKS

This paper discusses some firm-level effects of inflation on the present value of depreciation deductions and the required real after-tax rate of return on investment when alternative depreciation methods are used.

The results show that the present value of depreciation deductions for five methods based on historical-cost are inversely related to the rate of inflation. By contrast, the present value of depreciation deductions when historical-cost is indexed is invariant with the rate of inflation.

The results also indicate that the required after-tax rate of return on investment increases with inflation, *ceteris paribus*, when historical-cost depreciation is used. By contrast, when the historical-cost basis is indexed, the required rate of return is invariant with inflation.

In addition, the analysis shows that, in the absence of investment tax credit, rising inflation rates progressively favor long-lived investments. A 10 percent investment tax credit, how-

ever, compensates the impact of inflation leading to a bias towards short-lived assets. The results also demonstrate that an investment tax credit can be a powerful device in stimulating capital investment, regardless of inflation rate and depreciation method, due to its downward pressure on after-tax rates of return.

The analysis supports the conclusion that historical-cost depreciation does not conform with a depreciation policy that attempts to recover the original cost of the investment over its useful life in real terms. Moreover, depreciation methods providing for accelerated rates or rapid recovery, such as double-declining-balance and the methods contained in the Accelerated Cost Recovery System, lead to overdepreciation at low rates of inflation and to rising levels of underdepreciation as inflation increases.

Anticipated inflation along with underdepreciation results in an understatement of true capital costs which leads investors to demand higher real rates of return than would be the case if

the general price level was expected to remain stable. A major impact of persistent inflationary pressures under these conditions is to discourage capital investment, thus inhibiting economic efficiency and growth. These distortions, as suggested by this analysis, can be corrected by indexing the historical-cost basis of depreciation.

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