Adjusting Depreciation for Price Changes

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TABLE OF CONTENTS

		Page
I.	Introduction	1
II.	Measuring Depreciation, Capital Gains and Income	4
III.	Accounting for Inflation	8
IV.	Taxation of Capital Gains	15
V.	Conclusion	23

Adjusting Depreciation for Price Changes *

I. Introduction

It is commonly known that the real value of depreciation may be understated when there are inflationary increases in the value of assets and depreciation is measured on an historic cost basis. Yet considerable debate has arisen over the proper method, if any, of adjusting for inflation, both for income accounting and for tax accounting purposes. Under one proposed method of adjustment, assets would be depreciated on the basis of their current cost of replacement. Under another method, adjustments would be made only for overall changes in general purchasing power rather than changes in specific asset prices. Opinions as to the proper method of accounting for inflation vary widely, as can be witnessed by a tax law which allows for no adjustments from historical cost depreciation; a Securities and Exchange Commission rule 1/ which requires certain large firms to

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1/ Under Accounting Release 190 (March, 1976) the Securities and Exchange Commission requires certain large firms to report replacement cost information on depreciation, inventories, etc.

disclose replacement cost information on depreciation and inventories; and a proposed, but not adopted, statement of the Financial Accounting Standards Board 2/ to require certain large firms to disclose supplemental information on depreciation on either a replacement cost or historical cost/constant dollar (general purchasing power) basis.

This paper argues that the issue of adjusting depreciation for inflation should be treated as part of the broader issue of how to measure all income from capital and, in particular, all income from holding a depreciable asset. Thus, the income of a firm is influenced not only by depreciation, but by other changes in the value of assets. Because replacement cost depreciation provides for depreciation deductions based on current costs, the real value of depreciation can best be measured using a replacement cost basis. However, the fact that the real value of depreciation might be best measured by replacement cost depreciation does not mean that the real income from holding an asset can best be measured by allowing replacement

2/ Financial Accounting Standards Board, Financial Reporting and Changing Prices, Proposed Statement of Financial Accounting Standards, Exposure Draft, December 28, 1978. The statement was in proposal form only at the time when this paper was published.

cost depreciation. In fact, in absence of accrual accounting for all changes in value of assets, it will be found that depreciation based upon replacement cost leads to a worse measure of income than does depreciation adjusted for overall changes in the price level.

If consistent rules are used to measure income for a firm, the choice of a price adjusted basis for measuring depreciation involves a simultaneous choice of the basis for calculating gains on sales of assets which are depreciated. If the basis for calculating capital gains on non-depreciable assets is not indexed, the paper concludes that under tax accounting rules -- but not income accounting rules -- the basis value for calculating realized capital gains on sales of depreciated assets should be different from the basis value for calculating depreciation; that is, capital gains basis should not be indexed.

In Section II the measurement of depreciation is related to the measures of income and capital gains. Section III examines the effect of inflation on these measures and, in particular, demonstrates how two methods of adjusting depreciation for changes in prices -- replacement cost depreciation and inflation adjusted depreciation -- differ in their ability to reflect the change in value of an asset. Section IV details various methods of calculating gains on

the sale of a depreciable asset in a world of price adjusted depreciation and discusses some of the problems and distortions created by each method. Finally, Section V concludes with a note on the difficulties created by indexing only some measures of income or changes in value of capital assets.

II. Measuring Depreciation, Capital Gains and Income

For a firm, an analogue to the Haig-Simon definition of income is that

$$Y = D + \Delta NW \quad , \tag{1}$$

where Y = income, D = dividends, and Δ NW = change in net worth. The expression assumes that wages can be adequately separated from the income to capital and that there are no new capital contributions. 3/

In order to measure the change in net worth over the accounting period, the change in value of the assets of the firm must be determined. That change in value (V), in turn,

3/ Alternatively, one could assume that capital contributions are negative dividends equal in amount to the change in net worth.

can be defined as the change in price (P) times quantity (Q) of assets held, or

$$\Delta V = \Delta(P \cdot Q) \quad . \tag{2}$$

Expanding (2) yields:

$$\Delta V = \Delta P \cdot Q + P \cdot \Delta Q + \Delta P \cdot \Delta Q \quad . \tag{3}$$

In the case of both depreciable and non-depreciable assets, the income term on the left-hand side of equation (3) is seldom measured for tax or income accounting purposes. In the case of depreciation, what is usually measured is some variant of the second term on the right-hand side of the equation (i.e., $P \cdot \Delta Q$); that is, some rate of supposed wear and tear is applied to a given asset price. In the case of capital gains, (for both depreciable and non-depreciable assets), what is usually measured is some variant of the first term on the right side (i.e., $\Delta P \cdot Q$); in this case, the asset quantity is held constant and only the change in its price is measured. Thus, for a non-depreciable asset, capital gains = ΔV; while for depreciable assets, capital gains roughly equals that portion of ΔV not accounted for by

depreciation. Yet some authors have also defined the change in net worth as depreciation, 4/ and some have defined it as capital gains. 5/ In both cases, the authors essentially are defining depreciation or gains as equal to the more comprehensive income variable, Δ V.

What adds to the confusion is the treatment of depreciation for purposes of taxation. The tax code 6/ allows as a depreciation deduction an allowance for "exhaustion" and "wear and tear;" thus, the deduction is conditioned on "physical" changes in the assets. Land may not be depreciated, but buildings may be depreciated even if they increase in value in real terms. Since the basis for tax depreciation cannot be adjusted upward or downward for changes in overall price levels, one might conclude that tax depreciation is a measure of "physical" depreciation based on historic cost. However, an asset is depreciated to zero (or

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4/ As an example, Coen defines economic depreciation as "change in value of capital goods over the accounting period." See [4], p. 59.

5/ For instance, Break and Pechman speak of investors who "increase their wealth by the full amount of any accrued capital gains," roughly equating change in wealth with capital gains. See [3], p. 45.

6/ Code Section 167(a).

salvage value) over the course of its life or the life of a related "class" 7/ of assets, and the tax code further defines the depreciation deduction parenthetically to include an allowance for obsolescence. Because "life ends" or obsolescence occurs when either price or quantity equals zero, the allowable life of most assets is dependent upon changes in prices as well as physical changes in the assets. For instance, technological advances may lower the price of an asset to zero even though the asset, when combined with certain other inputs such as labor, may still be capable of producing output. The life of an asset is then affected by the change in its relative price as well as its actual physical deterioration. Since the rate of depreciation is dependent upon the life of the asset, it too is affected by changes in price as well as physical depreciation.

To simplify our analysis, equation (3) will be rewritten as:

$$\text{Change in Net Worth} = \text{Capital Gains} + \text{Depreciation} + \text{Residual}, \qquad (3')$$

7/ Under the class life asset depreciation range (ADR) system, lives of individual assets are based on average lives for a class of assets.

where changes in value due to changes in price are referred to as capital gains and changes in value due to changes in the units of capital, or quantity, are referred to as depreciation. 8/ In effect, for present purposes depreciation is confined to changes in value caused by wear and tear. However, the result of the following analysis will hold as long as all changes in value of depreciable assets are not recognized currently in the calculation of depreciation or income; capital gains in that sense may be thought of as the change in value of the asset not recognized in the calculation of depreciation.

III. Accounting for Inflation

We have already made clear that the income from holding a depreciable asset is related to change in value and, therefore, not only to depreciation, but to changes in the price of capital assets as well. This is true regardless of whether or not there is inflation in the economy. The total change in value of a depreciable asset can be affected by a variety of factors besides physical depreciation, including

8/ Since the literature on depreciation is inconsistent in its definition, this distinction between depreciation and other changes in value of assets cannot be consistent with all definitions.

change in demand for the output of the capital, changes in capital/labor ratios, technological change, and change in the scarcity value of the primary inputs from which the asset is made.

If inflation is added to the system at the rate "i," then the real change in value ($\Delta\overline{V}$) can be measured as:

$$\Delta\overline{V} = \Delta P \cdot Q + P \cdot \Delta Q + \Delta P \cdot \Delta Q - i \cdot P \cdot Q \ , \qquad (4)$$

where $i \cdot P \cdot Q$ equals the inflation rate times the value of the asset at the beginning of the time period. With inflation, the value of depreciation may be understated due to the increased price of the asset. To remedy this understatement, replacement cost depreciation (RCD) is often proposed as an alternative measure of depreciation, where:

$$RCD = (P + \Delta P) \cdot \Delta Q \qquad . \qquad (5)$$

Under this accounting technique, also called current cost accounting, the physical depreciation or decline of the asset is applied to an adjusted price or the "replacement cost" of the asset. However, comparing equation (3) with equation (4), replacement cost depreciation can be seen to equal the nominal change in net worth less nominal capital gains:

$$RCD = \Delta V - \Delta P \cdot Q \qquad . \qquad (6)$$

Similarly, combining equations (4) and (5), replacement cost depreciation can be seen to equal the real change in net worth less real capital gains:

$$RCD = \Delta\overline{V} - [\ \Delta P - (i \cdot P)] \cdot Q \qquad . \qquad (7)$$

Thus, replacement cost depreciation can be viewed as subtracting from total change in net worth not only the inflationary component of capital gains, but the real component as well.

Suppose that it was decided to adjust the measure of depreciation for the effects of inflation. Would replacement cost depreciation be the correct way of allowing for such as adjustment? Consider the difficulties that would arise. Businesses would be required annually to measure and report the change in prices of numerous assets. These estimates would need to take into account technological change and other hard-to-measure variables on prices of assets. The prices of the assets, if new, could not be checked in the market place since most of the assets would change in form and characteristics over time.

However, these administrative difficulties of replacement cost depreciation are only practical reasons for objecting to its adoption. <u>The major theoretical objection</u>

to replacement cost depreciation from both an income and a tax accounting standpoint is that it could result in the depreciation of real capital gains that were never recognized as income or realized for tax purposes.

Suppose, for instance, that a widget-making plant is capable of producing 10 widgets when new but only 9 widgets after a year. Suppose also that the plant must be made out of silver, and that, while there was no inflation, the original cost of such a plant rose from $100 to $200 as the price of silver rose. 9/ In a world of replacement cost depreciation, but not of accural accounting of gains and losses, replacement cost depreciation would allow a depreciation of $20 after one year. One-half of that $20 would be depreciation of the $100 of unrealized gains. Moreover, if there were no further price changes, replacement cost depreciation eventually would allow $200 of depreciation to be recognized on an investment of $100.

Similarly, if there were real capital losses, replacement cost depreciation would reduce the basis for depreciation by the amount of these non-realized losses and

9/ Alternatively, the potential profit from selling widgets might be assumed to double.

could actually prevent the initial investment from ever being fully depreciated. Assume the same circumstances for the widget-making plant described in the preceding paragraph, except let the plant be made out of copper which falls in price from $100 to $50. In this case, allowed depreciation under replacement cost depreciation is only $5 after one year, and, with no further price changes, total allowed depreciation over the life of the asset will only be $50 even though the initial investment equaled $100.

Only if gains and losses simultaneously were realized on an accrual basis would an allowance for replacement cost depreciation lead to a correct measure of income. An easy coversion of equations (6) and (7) reveals that if capital gains (real or nominal) are added to replacement cost depreciation, the sum equals the change in value of the asset (real or nominal). This is more or less a corollary to the Samuelson requirement for tax deductibility of economic depreciation. Interpreted in the language of this paper, Samuelson shows that, if valuations of assets are to be independent of individuals' tax rates, then accrued capital gains from changes in relative price should offset declines in value due to wear and tear; the net tax deduction should equal the change in market value of the asset 10/ (Samuelson did not deal with price changes due to inflation).

10/ See [10] and the comments in [1], pp. 10-11.

Here we note that, if capital gains are counted in income as accrued, then the correct measure of depreciation is obtained through replacement cost accounting. Correspondingly, in absence of accrual accounting for gains and losses, replacement cost depreciation by itself would not correctly measure the change in value of the asset.

If inflation adjustments are to be made for depreciation, an alternative (and simpler) method to replacement cost depreciation would be to allow an adjustment only for some average rate of inflation. 11/ In this case, allowable depreciation would still be based primarily on physical depreciation, only the price variable (or basis) would be adjusted by the rate of inflation over time. In effect, both original cost and past depreciation would be restated in the current period's prices to determine the basis for current depreciation. Thus, if IAD equals inflation adjusted depreciation,

$$IAD = (1 + i)\ P \cdot \Delta Q \quad . \qquad (8)$$

11/ Here we ignore the question of which is the appropriate price index to choose.

It should be made clear, however, that <u>IAD does not correctly measure the current value of depreciation or wear and tear.</u> IAD allows the value of all past depreciation allowances plus value of the original purchase price of the asset to be measured in constant dollars based on the current year's prices. In other words, basis for depreciation becomes indexed for inflation.

As long as capital gains and losses on depreciable assets are not recognized as accrued, inflation adjusted depreciation comes closer to a measure of the total income from change in value of the asset than does replacement cost depreciation. This may at first appear to be a contradiction, since it has just been demonstrated that replacement cost depreciation is a better measure of real depreciation. However, when real gains (or losses) are not realized, inflation adjusted depreciation partially offsets that misstatement of income by not allowing depreciation of those gains (or losses). Thus,

$$\Delta\overline{V} = RCD + (\Delta P - iP)Q, \text{ and} \qquad (7')$$

$$\Delta\overline{V} = IAD + (\Delta P - iP)(Q + \Delta Q) \quad . \qquad (9)$$

For a depreciating asset,

$$Q + \quad Q < Q,$$

Therefore,

$$[\Delta\overline{V} - RCD] > [\Delta\overline{V} - IAD] \quad . \tag{10}$$

Inflation adjusted depreciation is thus a better measure of the total real change in value of a depreciable asset. 12/

IV. Taxation of Capital Gains

Many discussions of inflation adjustment for depreciation or of replacement cost depreciation assume that once "real" depreciation is correctly calculated, the problem of inflation accounting for depreciable assets has been solved. In actual fact, equation (3') forewarns us that

12/ Lischer ([9], p. 574) and others state that replacement cost depreciation is based on the theory that "depreciation is the source of replacement funds," while inflation adjusted depreciation is "a device to determine net income more accurately." I argue that replacement cost depreciation and inflation adjustment depreciation should be compared on an income basis alone. Replacement cost depreciation better measures the depreciation component of income, but inflation adjusted depreciation better measures income due to total change in value when real gains and losses are not realized on an accrual basis.

other variables -- in particular, capital gains -- interact with the measure of depreciation. If the basis for depreciation is adjusted for price changes, then the basis for calculating capital gains may also be changed. In this section we will discuss some of the possible bases for calculation of capital gains and some of the problems posed for capital gains taxation by price adjustments for depreciation. All price changes are assumed to take place at the rate of inflation, so that price adjusted depreciation equals both inflation adjusted depreciation and replacement cost depreciation.

In order to measure price adjusted depreciation, it is also necessary to determine the basis of the asset from one period to the next. In the context of the equations in section II,

$$\text{Basis}_t = P_t \cdot Q_t \quad . \tag{11}$$

Of course, basis undergoes changes from year to year, so that adjustments must be made to the basis in year "t" to arrive at basis in year "t+1". Following equation (11),

$$\begin{aligned}\text{Basis}_{t+1} &= P_{t+1} \cdot Q_{t+1} \\ &= (P_t + \Delta P)\ (Q_t + \Delta Q) \\ &= P_t Q_t + (P_t + \Delta P_t)\ \Delta Q_t + \Delta P \cdot Q_t \\ &= \text{Basis}_t + \text{Price Adjusted Depreciation} \\ &\quad + \text{Capital Gains} \quad .\end{aligned} \tag{12}$$

Thus, normal accounting methods of adding negative depreciation to old basis to determine new basis would be incorrect in the case of price adjusted depreciation; capital gains must also be added in order to calculate correctly the basis for depreciation in following years.

If basis value of a depreciable asset is to be adjusted by capital gains, then the question arises of how to calculate realized capital gains if the asset is ever sold. From an income accounting standpoint, the gains themselves ought to be adjusted for inflation, and, if real income is to be correctly calculated, the basis for calculating gains should equal the price-adjusted basis for depreciation. However, if non-depreciable assets are not similarly indexed, such a procedure would result in a distinction between the tax treatment of depreciable assets and non-depreciable assets. Were such a distinction to arise in the tax law, it would lead to a broad and wholesale effort of property owners to convert their assets to depreciable form, 13/ an effort not unlike the current effort of many property owners to

13/ A similar, but reverse argument, can be made against proposals to allow price adjustments for non-depreciable assets, but not for depreciable assets. In that case, property owners would be encouraged to convert depreciable assets to non-depreciable form, e.g., issuing stock for depreciable assets, and buying and selling the stock on a regular basis.

convert ordinary income into capital gain income. For want of better terms, this will be called the "Problem of Gold-Plated Machinery." 14/

An alternative is to calculate basis differently for purposes of capital gains than for purposes of depreciation. Under one approach, basis for capital gains might be calculated as under current tax law by adjusting old basis for the amount of depreciation claimed each year, i.e.,

$$\begin{aligned} \text{Basis}_{t+1} &= \text{Basis}_t + D_t \\ &= \text{Basis}_0 + \sum_{j=1}^{t} D_j \qquad \text{, where} \end{aligned} \tag{13}$$

D_j equals depreciation claimed in time period j and Basis_0 equals original basis value of the asset.

To simplify calculations, let us assume that both the rate of physical depreciation and rate of capital gains are constants over time, or

$$\begin{aligned} \Delta Q/Q &= d \qquad \text{(d is negative); and} \\ \Delta P/P &= i \qquad \text{(i is positive).} \end{aligned} \tag{14}$$

14/ Credit or blame for coining this expression must be shared with Mr. Hudson Milner of the Office of Tax Analysis, Department of the Treasury.

Then,

$$
\begin{aligned}
\text{Basis}_{t+1} &= P_oQ_o \\
&\quad + P_o(1+i)dQ_o \\
&\quad + P_o(1+i)^2(1+d)dQ_o \\
&\quad + \ldots \\
&\quad + P_o(1+i)^{t+1}(1+d)^t dQ_o \\
&= P_oQ_o + P_oQ_od(1+i)\sum_{j=1}^{t}(1+i)^j(1+d)^j \\
&= P_oQ_o + P_oQ_od(1+i)\cdot\left[\frac{1-(1+i)^t(1+d)^t}{1-(1+i)(1+d)}\right] .
\end{aligned}
\tag{15}
$$

Let us treat two cases. If the rate of price increase "i" is greater than the negative of the rate of depreciation "d," 15/ then as time approaches infinity, the basis of the asset actually approaches negative infinity. In the other case, the absolute value of the rate of depreciation is greater than the rate of price increase, and equation (15) collapses to the following expression as time approaches infinity:

$$
\text{Basis} = P_oQ_o\left[1 - \frac{d(1+i)}{d(1+i)+i}\right] . \tag{16}
$$

15/ This is an approximation. The strict case is defined by $i > -d - di$.

As might be expected, expression (16) is negative as long as the rate of price increase is greater than zero. Only if the rate of price increase equals zero do we reach the familiar result that long-run basis equals zero after the asset is fully depreciated.

If gains are calculated in this manner, that is, if basis value for purposes of capital gains is not also indexed for price increases, but only adjusted by depreciation claimed each year, then there arises a tremendous lock-in effect on the holding of depreciable assets. Although there may be some lock-in effect under current law, it is not nearly as binding a force since basis is never reduced below zero. However, when basis for calculation of gains is reduced by the value of price adjusted depreciation, each asset will actually reach a point of depreciation where the tax on the gains from selling the asset is greater than the value of the asset. Assets which are no longer useful to a firm would be given away rather than sold for salvage value.

One might think of a compromise approach that would prevent basis for purpose of depreciation from differing from basis for purpose of capital gains and would prevent basis value from being adjusted below zero. For instance, one could increase depreciation annually by the rate of

inflation, but require basis value to be calculated in the normal way, i.e.,

$$D_t = Basis_{t-1} \cdot d \cdot (1+i) \quad , \qquad (17)$$

but $Basis_{t+1} = Basis_t - D_t$.

There is another name for this -- accelerated depreciation. The only difference between equation (18) and other familiar expressions for accelerated depreciation is that the annual adjustment for acceleration is (1+i) rather than some constant like 120 percent. In effect, without a price adjustment for the basis of depreciation, this approach yields little difference from historical cost depreciation.

A final approach -- and perhaps the most practical one in a tax world in which indexing is only allowed for depreciation -- is to calculate basis and adjustments to basis differently for capital gains than for depreciation. Thus, the basis for capital gains would not equal the basis for depreciation; neither would capital gains basis be adjusted by the amount of inflation adjusted depreciation taken each year. For instance, an asset might be allowed inflation adjusted depreciation as defined in the previous section, while, at the same time, the capital gains basis would be calculated by subtracting a measure of depreciation

which was not inflation adjusted, e.g., straight-line depreciation on historical cost. This would lessen the incentive to convert all assets into depreciable form (as would occur with inflation adjustment for capital gains basis of depreciable assets) and avoid a perverse lock-in effect (as would occur if historical basis for purposes of capital gains were adjusted by inflation adjusted depreciation taken each year).

This final alternative seems the only practical one in a tax world in which the prices of non-depreciable assets are not indexed for inflation. Still, there are a number of problems. Inflation adjusted depreciation with a non-indexed basis for capital gains would create distortions in investment behavior. Depreciable assets clearly would be favored over non-depreciable ones. Inflationary capital gains on depreciable assets would escape taxation by being depreciated to zero, while for non-depreciable assets, such gains would be taxed if the asset was ever sold or otherwise realized through the flow of income. If we again assume that change in price equals the rate of inflation, then inflation adjusted depreciation would cause income subject to tax to equal real income from the depreciable asset (see equation 9). For a non-depreciable asset, however, income subject to tax would still include an inflationary component.

V Conclusion

We have come full circle on the question of price adjusted depreciation. Replacement cost depreciation correctly measures the depreciation component of real income. However, income to a firm arises from all changes in value of its assets, not just those caused by depreciation, physical or otherwise. Thus, changes in prices of depreciable assets may reflect real capital gains and losses on those assets as well as inflationary gains. In absence of recognition or realization of all changes in value as they accrue, adoption of a rule allowing for replacement cost depreciation would lead to a worse calculation of real income than would inflation adjusted depreciation.

Even if basis increases only reflected inflation, there remains the question of how to calculate capital gains in a world of price adjusted depreciation. If basis value of assets for purposes of capital gains is the same as basis value for purposes of depreciation, then it would not merely be depreciation that was indexed, but capital gains on depreciable assets as well. Yet, if gains on depreciable assets were to be indexed for inflation, and not gains on other assets, then firms and individuals would make substantial efforts to convert non-depreciable assets into

depreciable form. In some cases, these shifts would be somewhat superficial in nature. In a sense, machinery would become "gold-plated."

Yet if gains on depreciable assets were not indexed for inflation, and historical capital gains basis were adjusted by the full value of claimed depreciation, then basis value of these assets would fall below zero, and eventually the tax on the nominal gains would be greater than the value of the assets themselves. Firms would become further "locked-into" their assets.

The final alternative seems to be to adjust basis for depreciation by an inflation factor, but to adjust capital gains basis only by some rate of historical cost depreciation. While probably the only practical way to allow for price adjusted depreciation in absence of indexing of all income from capital, this solution still leads to distortions, especially the favoring of depreciable over non-depreciable assets.

In summary, if indexing is to apply only to depreciable assets -- and there are strong, practical reasons not to extend indexing to other assets, interest payments and receipts -- price adjustments for depreciation, if adopted, should not be based upon replacement cost but rather on

restatement of historic cost and past depreciation in the current period's prices. Basis for capital gains, however, must remain on historic cost terms.

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