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THE TAX EFFECTS OF INFLATION: DEPRECIATION, DEBT, AND MILLER'S EQUILIBRIUM TAX RATES

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FOR DISCUSSION PURPOSES ONLY

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I. INTRODUCTION

Indexing historical cost accounting to inflation has received considerable attention in the accounting literature. From a tax perspective, it is often argued that with historical cost accounting, inflation increases effective corporate tax rates, ceteris paribus. (See Davidson and Weil [1978], Williams [1979], Bernard [1981], and Gonedes [1981].)[1] A major reason is the failure of historical-cost accounting to index the depreciation tax shield to inflation. "But explicit indexation may not be necessary to achieve all the effects of indexation. The same effects can be attained, at least with respect to *expected* rates of inflation, if nominal interest rates incorporate unbiased forecasts of rates of inflation" (Gonedes [1981] p. 247).[2] Davidson and Weil (1976) note that price-level adjusting the tax system would increase the depreciation tax shield, but it "...would diminish the tax-saving attribute of debt financing in a period of rising prices" (p. 99).

In short, it is generally acknowledged that (1) there is an inverse relation between the use of historical cost depreciation and effective corporate tax rates, and (2) the tax deductibility of nominal interest, when assets are at least partially debt financed, plays a role in offsetting the increase in effective tax rates. Thus, both nominal interest and historical cost depreciation would have to be adjusted to fully take into account the tax effects of inflation on real cash flows. However, we know of no *explicit* model of the combined effects of the rate of inflation, depreciation indexing, and the proportion of assets that are debt financed on real cash flows both to the firm and to equity investors. Our objective here is to provide such a model in a more complete manner than previously exists. Further, by applying Miller's (1977) equilibrium tax rates to the analysis, we provide some results that are surprising in light of conventional wisdom.

Section II lays the foundation for our analysis by modeling the impact of inflation on the effective tax rate to the firm (corporation), given the after-tax real cash flows to the firm. Here we will note the important role of debt financing which, is intuitively recognized in some of the earlier literature, as mentioned above. Our explicit model shows that the role debt financing plays in determining the tax impact of inflation on the real cash flows to the firm depends on the relationship between corporate and lender tax rates. Section III extends the model by introducing the equilibrium relationship between corporate and lender tax rates suggested by Miller (1977). An interesting result of this section is that, contrary to claims made in previous research, debt financing does not offset the negative tax impact of inflation on real cash flows to the firm caused by using historical cost depreciation. Rather, after considering both the increase in nominal interest required by lenders under inflation, and the increased tax advantage to the firm from deducting higher interest under inflation, we show that debt financing exacerbates the "problem" caused from failure to index the tax shield.

Equity values and stockholder wealth depend on the total tax picture, not just the corporate tax effect. Section IV carries the results of the previous sections one step further by modeling the impact of inflation on the after-personal-tax cash flows to the stockholder. An interesting result of this section is that the increase in the stockholder's effective tax rate because of the historical cost depreciation tax shield, is completely independent of the amount of debt financing used by the firm.

In general, we find that indexing the depreciation tax shield would neutralize the effects of inflation on the real depreciation tax shield only in very limited cases, even in our *ceteris paribus* world. Further, if Miller's equilibrium tax rates hold, then depreciation indexing would systematically undercompensate for the effects of inflation on the real depreciation tax shield.

Of course, as with most models in this area, we are limited by our partial equilibrium framework. A more complete model of the tax effects of inflation would incorporate effects of inflation on tax avoidance strategies by taxpayers (e.g., changes in production, consumption, and investment decisions), subsequent changes in the tax law, changes in relative prices, etc. Nevertheless, we believe our results will be useful in their own right.

II. IMPACT OF DEPRECIATION INDEXING ON THE FIRM'S CASH FLOWS

To begin, assume a simple firm which acquires a depreciable asset with a one-year life and no salvage value for cash at the beginning of the year. All cash flows occur at the end of the year and are either paid in operating expenses, interest and principal, taxes, or are paid to the firm's stockholders. Sales and wage contracts are such that all cash transactions take place at year-end in end-of-year dollars. Relative and general price changes are the same;[3] as are actual and expected price changes. This latter assumption allows us to abstract from wealth transfers between borrowers and lenders.[4] Finally, assume that the real interest rate is unaffected by anticipated inflation.[5] As we proceed through the analysis, it will be seen that these assumptions, although seemingly restrictive, do not affect the underlying concept and are employed only to simplify the exposition.

We now define the firm's cash flows in the no-inflation case, as follows:

$$CF = X(1 - t_c) + t_c A - \left[\frac{r}{1 - t_\ell}\right] bA(1 - t_c) - bA \qquad (1)$$

where

CF = Net cash flows to the firm and available for payment to stockholders in the no-inflation case;

X = before-tax cash operating flows. These are the net result of all before-tax, before-interest operating transactions, except depreciation. X is assumed to be taxable.

t_c = corporate tax rate. (We assume a single corporate tax rate.)

A = cost of the asset at the beginning of the period. This entire cost is depreciated for tax purposes. (Hence the term $t_c A$ is the depreciation tax shield.)

r = the lenders' risk-adjusted required after-personal-tax rate, with no inflation.

t_ℓ = the lender's marginal personal-tax rate. (We assume one rate covers the financing of the firm's asset.)

b = the percent of the cost of the asset financed with debt. (Thus bA is the debt principal, which is assumed to be repaid at year-end, and $[\frac{r}{1 - t_\ell}]$ bA is the interest paid on debt at year-end.)

Under our assumptions regarding actual and expected inflation, when the rate of inflation is p, the firm's cash flows become[6]

$$CF_p = X(1 - t_c)(1 + p) + t_c A - [\frac{r(1 + p) + p}{1 - t_\ell}] bA(1 - t_c) - bA. \quad (2)$$

As shown in equation (2), after-tax operating cash flows $[X(1 - t_c)]$ automatically reflect changes in market prices as goods and services are exchanged, but the depreciation tax shield does not. The term $\frac{r(1 + p)}{1 - t_\ell}$ from equation (2), when multiplied by the principal, bA, reflects the lenders' requirement that they be paid an interest payment under inflation that is purchasing-power-equivalent to what they would be paid under no inflation. In addition, lenders require a payment to maintain the purchasing power of the principal loaned, or pbA. Because that payment is taxable to lenders as "interest," they require a before-personal-tax rate of $\frac{p}{1 - t_\ell}$, (<u>not</u> p) in order to maintain the after-tax purchasing power of their principal.

To highlight the impact of inflation on the firm's cash flows, rearrange equation (2) and write it as follows[7]:

$$CF_p = CF(1 + p) - pt_c A - pbA \left[\frac{1 - t_c}{1 - t_\ell} - 1\right]. \tag{3}$$

This shows the difference between complete indexation (i.e., CF(1 + p)) and what actually occurs (i.e., CF_p). The first term in equation (3) holds real cash flows constant, under inflation; the second term, ($pt_c A$), can be thought of as the negative impact on real cash flows from failing to index the depreciation tax shield; and the third term, $pbA \left[\frac{1 - t_c}{1 - t_\ell} - 1\right]$, shows the impact of treating the principal "premium" as tax deductible to the borrower and as taxable income to the lender.

<u>Impact of depreciation indexing.</u>

Under depreciation indexing, the index, $pt_c A$, would be added to the depreciation tax shield in equation (2), so, the shield would become (1 + p) ($t_c A$), causing the second term in equation (3), $pt_c A$, to drop out. The third term would not drop out, however, so depreciation indexing would exactly neutralize the tax effects of inflation in only two cases: (1) when assets are completely equity-financed (so b = 0); and (2) when assets are financed with debt, and the borrower's tax rate, t_c, equals the lender's tax rate, t_ℓ. In short, if we let CF_{pd} = net cash flows to the firm under inflation with depreciation indexing, we have the following relationships:

(i) $t_c > t_\ell \Rightarrow pbA \left[\frac{1 - t_c}{1 - t_\ell} - 1\right] < 0 \Rightarrow CF_{pd} > CF(1 + p)$,

and depreciation indexing <u>over</u>compensates;

(ii) $t_c < t_\ell \Rightarrow pbA \left[\frac{1 - t_c}{1 - t_\ell} - 1\right] > 0 \Rightarrow CF_{pd} < CF(1 + p)$,

and depreciation indexing <u>under</u>compensates;

(iii) $t_c = t_\ell \Rightarrow pbA\ [\frac{1 - t_c}{1 - t_\ell} - 1] = 0 \Rightarrow CF_{pd} = CF(1 + p)$,

and depreciation indexing exactly <u>neutralizes</u> the effects of inflation;

(iv) $b = 0 \Rightarrow pbA\ [\frac{1 - t_c}{1 - t_\ell} - 1] = 0 \Rightarrow CF_{pd} = CF(1 + p)$,

and depreciation indexing exactly <u>neutralizes</u> the effects of inflation.[8]

The payment to lenders to maintain the purchasing power of their principal (the principal "premium") is not a tax-free transfer of funds, but rather it is a deductible expense to the firm (the borrower), and a taxable income to the lender. Thus, instead of paying merely a "premium" of pbA to lenders, firms must pay $pbA[\frac{1 - t_c}{1 - t_\ell}]$. When $t_c > t_\ell$, $pbA > pbA\ [\frac{1 - t_c}{1 - t_\ell}]$, so, inflation coupled with the tax treatment of the principal "premium" would work to the firm's advantage. The opposite would be true when $t_c < t_\ell$.[9] (See Feldstein [1976] for similar results at a macro level.)

III. THE EFFECT OF MILLER'S EQUILIBRIUM TAX RATES

In the above analysis, we showed that whether depreciation indexing neutralizes the effect of inflation on purchasing-power after-tax cash flows to the firm depends on the level of debt and the relationship between t_c and t_ℓ. Using Miller's (1977) work on the equilibrium level of debt, given corporate and personal taxes, we can show an equilibrium relationship between t_c, t_ℓ, and t_s, where t_s is the stockholder's personal tax rate on income from equity investments. The story proceeds as follows.

Miller assumes $t_s < t_\ell$,[10] so, $\frac{r}{1 - t_s} < \frac{r}{1 - t_\ell}$ (all rates should be interpreted as risk-adjusted or certainty-equivalent rates). By borrowing rather than raising equity funds, the firm will give up $\frac{r}{1 - t_\ell} - \frac{r}{1 - t_s}$, but gain $t_c\,[\frac{r}{1 - t_\ell}]$, because of the tax shield on interest.

The firm will replace equity funds with debt funds as long as the gain from the corporate tax shield on interest, $t_c[\frac{r}{1 - t_\ell}]$, exceeds the loss, $\frac{r}{1 - t_\ell} - \frac{r}{1 - t_s}$. In equilibrium, we would expect

$$t_c\,[\frac{r}{1 - t_\ell}] = \frac{r}{1 - t_\ell} - \frac{r}{1 - t_s} \qquad (4)$$

and

$$1 - t_\ell = (1 - t_c)(1 - t_s). \qquad (5)$$

Equation (5) can also represent the equilibrium relationship between tax rates under inflation by merely repeating the above argument and replacing each r with r(1 + p) + p.

Now we are able to make a more precise statement about the impact of the principal "premium," pbA $[\frac{1 - t_c}{1 - t_\ell}]$, on the firm's purchasing-power-equivalent-cash flows. Recall from equation (3) that the principal "premium" works to the firm's advantage if $t_c > t_\ell$ and to the firm's disadvantage if $t_c < t_\ell$ since

$$CF_p = CF(1 + p) - pt_cA - pbA[\frac{1 - t_c}{1 - t_\ell} - 1]. \qquad (3)$$

The term $[\frac{1 - t_c}{1 - t_\ell} - 1]$ can be replaced with $\frac{t_s}{1 - t_s}$ in equilibrium so, equation (5), can be restated as

$$CF_p = CF(1 + p) - pt_cA - pbA\;[\frac{t_s}{1 - t_s}]. \qquad (6)$$

As long as shareholder tax rates are greater than zero, the firm loses real cash flows because of the principal "premium." Further, the higher the relative amount of debt used, the more the firm "loses." Indexing the depreciation tax shield would eliminate the second term, pt_cA, from equation (6), but the third term $pbA\ [\frac{t_s}{1 - t_s}]$ would, of course, remain. Thus, depreciation indexing would not completely neutralize the tax effects of inflation on real cash flows assuming Miller's equilibrium tax rates, $t_s > 0$, and some debt financing.

Contrary to claims in the literature, debt financing does not offset the tax effects of inflation on the depreciation tax shield. Rather, the greater the proportion of debt financing, the greater the negative tax effects of inflation. This result, derived from the above equilibrium analysis, requires that $t_\ell > t_c$, which may or may not be true, of course.

This result provides some insight into the impact of inflation on net after-tax cash flows to the firm. Some have argued that various investment tax incentives offset the tax effects of the historical cost depreciation tax shield,[11] regardless of what were the original interests of the law. Our results show that these tax incentives must equal the loss to the firm for <u>both</u> pt_cA and $\left[pbA\ [\frac{t_s}{1 - t_s}]\right]$ to neutralize the effect of inflation on the real depreciation tax shield.

To carry the analysis further, we next analyze the impact of depreciation indexing on after-tax cash flows to equity holders and some of its valuation implications.

IV. IMPACT OF DEPRECIATION INDEXING ON CASH FLOWS TO STOCKHOLDERS

Since the analyses in Sections II and III have implications for after-tax cash flows to stockholders, they must also carry forward to stock price valuations. For expository purposes, assume our firm pays out all of its net cash flow, CF or CF_p, to stockholders. A portion of the payout, (1 - b)A, is a return of capital to stockholders, which is not subject to personal taxes. In this context, t_s reprsents a composite of the stockholders' personal and capital gains tax rate, with (1 - b)A as the basis for computing capital gains.

No inflation case. With no inflation we have

$$CF^s = CF(1 - t_s) + (1 - b)At_s, \qquad (7)$$

where the superscript, s, on CF denotes these as cash flows to stockholders after personal taxes. The second term, $(1 - b)At_s$, is added because a portion of CF paid out to stockholders is a return of their capital investment which is shielded from personal taxes.

Inflation case: Without Miller's equilibrium conditions. Recall from Section II that the firm's real cash flows decreased with inflation if the depreciation tax shield was not indexed, and that the firm's nominal net cash flows went up by more than p when $t_c > t_\ell$ and by less than p when $t_c < t_\ell$. Stockholders will also "suffer" under inflation if the tax shield on their return of capital is not indexed. That is, the same amount of taxes will be shielded under inflation as under no inflation, viz., $(1 - b)At_s$, which means the stockholder's real cash flows will be lowered under inflation.[12] This is shown in the third term in equation (8).

$$CF_p^s = CF^s(1 + p) - pAt_c(1 - t_s)$$

$$- pbA\left[\frac{1 - t_c}{1 - t_\ell} - 1\right](1 - t_s) - p(1 - b)At_s \qquad (8)$$

where CF_p^s refers to after-personal-tax cash flows to stockholders under inflation.

Depreciation indexing would eliminate the second term, $pAt_c(1 - t_s)$, from equation (8). Moreover, if the firm's asset was completely equity-financed ($b = 0$), or if $t_c = t_\ell$, the third term would go to zero. The fourth term, $p(1 - b)At_s$, would remain since it is a measure of the loss to the stockholder under inflation if the tax shield on equity capital repaid was not indexed. This loss occurs as long as $b < 1$ (i.e., the firm's asset is not completely debt-financed). Thus, while indexing the depreciation tax shield would exactly neutralize the impact of inflation on the real cash flows to the firm if assets are completely equity-financed, ceteris paribus, that result does not hold for cash flows to stockholders, unless the tax shield on equity capital repaid was indexed.

The net impact of inflation on cash flows to stockholders in equation (8) is ambiguous until we specify equilibrium conditions for the relationship between t_c and t_ℓ, as in the next section.

Inflation case: With Miller's equilibrium conditions. Relying on Miller's equilibrium conditions, the term $\left[\frac{1 - t_c}{1 - t_\ell} - 1\right]$ becomes $\frac{t_s}{1 - t_s}$, so equation (8) can be rewritten as

$$CF_p^s = CF^s(1 + p) - pAt_c(1 - t_s)$$
$$- pbAt_s - p(1 - b)At_s. \qquad (9)$$

Under these conditions, stockholders lose $pbAt_s$ because of inflation and the tax treatment of the principal "premium." If the depreciation tax shield were indexed, we would have:

$$CF_{pd}^s = CF^s(1 + p) - pbAt_s - p(1 - b)At_s$$
$$= CF_{pd}^s(1 + p) - pAt_s \qquad (10)$$

Thus, contrary to claims in the literature, depreciation indexing under equilibrium conditions leads to no role for the level of debt in the remaining shortfall to the stockholder, pAt_s. Hence, even with depreciation indexing, inflation would have negative tax effects on real cash flows in our *ceteris paribus* model, their level being a function of (1) the rate of inflation and (2) the stockholder's personal tax rate on equity income.

Neutralizing the tax effects of inflation on shareholders' wealth would also require that pA also be deductible from the stockholder's equity income to neutralize the statutory tax effect of inflation on stockholders.[13] It is interesting to note that neutralizing the effect on stockholders would require deducting pA, *even if the asset is completely debt-financed*.

V. SUMMARY

Much research supports the notion that inflation is not neutral with respect to the tax rate, but causes instead an increase in the effective tax rate. One cause of this is the reluctance of tax authorities to allow depreciation charges to be indexed to inflation. Some researchers have argued, however, that the results of indexing are accomplished automatically because the tax deductible interest under inflation will include a premium to maintain the purchasing power of the principal. Hence the more debt a firm utilizes during inflation, the lower the tax penalty.

In this paper, we analyzed the relationship between inflation, depreciation indexing, the use of debt financing, and the effective tax rate. Our model showed that the impact of inflation on the effective tax rate, with indexing and debt financing, depends on the relationship between corporate and personal tax rates. Using Miller's equilibrium tax rates, we found some surprising results, as summarized in Exhibit 1 below. First, the use of debt financing does not offset the positive relationship between inflation and the effective tax rate caused by the failure to index. Second, at the firm level, the use of debt financing actually intensifies the positive relationship between inflation and the effective corporate tax rate.

Exhibit 1

Rate of Increase In After-tax Cash Flow
Allowing For Inflation, Indexing, and Miller's
Equilibrium Tax Rates

	Positive Stockholders' Tax Rate		Zero Stockholders' Tax Rate
	No Debt	With Debt	
Rate of Increase in After-tax Cash Flow to Firm Is	Equal to Inflation Rate	Less than Inflation Rate	Equal to Inflation Rate
Rate of Increase in After-tax Cash Flow to Stockholders Is	Less than Inflation Rate	Less than Inflation Rate	Equal to Inflation Rate

As Exhibit 1 shows, the after-tax cash flows to the firm increase by exactly the rate of inflation only if depreciation indexing is allowed and no debt financing is used. Otherwise, after-tax cash flows to the firm increase by less than the rate of inflation, implying an increase in the effective tax rate. Third, cash flows to stockholders increase by less than the rate of inflation even with depreciation indexing. That shortfall is independent of the level of debt financing. Finally, firm and stockholder cash flows increase by exactly the rate of inflation if depreciation indexing is allowed and stockholders' tax rate is zero. In this case also, the level of debt financing plays no direct role in maintaining the effective tax rate.

A complete program for neutralizing inflation's effect on firms and shareholders would require (1) indexing the depreciation shield and the capital invested by shareholders, and 2) indexing the principal paid by lenders to finance assets, so that the inflation premium is neither a tax deduction nor a taxable income.

FOOTNOTES

1 See also a report by Peat, Marwick, Mitchell & Co. in "Living Off Capital," Forbes (November 10, 1980), p. 234, which lists a number of large U.S. companies having an effective tax rate on current cost income greater than the statutory rate maximum of 48 percent that was then in effect.

2 Also see Tideman and Tucker (1976) and Feldstein and Summers (1979) for extensive discussions of the way debt financing can offset the tax disadvantages of the historical cost depreciation tax shield under inflation.

3 To focus on the issue of depreciation indexing, we have assumed that all inflows and outflows inflate at the same rate, p. In other words, we are examining the impact of inflation on the cash flows of the "average" firm in the economy. Of course, a particular firm's experience with inflation will also be influenced by the differential effects of inflation on its cash inflows and outflows and by assumed inventory flows for tax purposes.

4 In another paper (Maher and Nantell [1982]), we relax this assumption to show the well known inflation-induced wealth transfer from lenders to borrowers that occurs whenever lenders underestimate inflation rates, and vice versa. Allowing expected and actual inflation to be unequal affects the dollar amount of cash flows available to the firm and its stockholders, but it does not affect our findings about the conditions under which depreciation indexing systematically undercompensates or overcompensates for the effect of inflation on the real depreciation tax shield.

5 To demonstrate our results, we, like Nelson (1976) and Kim (1979), assume that real rates are unaffected by expected inflation. For an excellent discussion of the possible effect of uncertain inflation on the real rate, see Levi and Makin (1979). For evidence that inflation raises the nominal interest rate while leaving the real rate unchanged, see Fama (1981).

6 Development of equation (2) requires application of the Fisher (1930) hypothesis. For a detailed development, see Maher and Nantell (1982).

7 The terms pt_cA and $pbA\,[\frac{1 - t_c}{1 - t_\ell} - 1]$ in equation (3) are derived by multiplying equation (1) by (1 + p) and subtracting equation (2) from the result. That is,

$$CF\,(1 + p) - CF_p$$

$$= X(1 - t_c)(1 + p) + t_cA\,(1 + p) - [\frac{r}{1 - t_\ell}]\,(1 + p)\,bA\,(1 - t_c)$$

$$- bA\,(1 + p) - \{X(1 - t_c)(1 + p) + t_cA - [\frac{r(1 + p) + p}{1 - t_\ell}]bA\,(1 - t_c) - bA\},$$ which simplifies to:

$$pt_cA + pbA\,[\frac{1 - t_c}{1 - t_\ell} - 1].$$

[8] We suspect that the literature proposing depreciation indexing as a means of neutralizing the impact of inflation implicitly assumes scenario (iv) in which assets are totally equity financed. (See Nelson [1976], Bailey [1976], and Kim [1979], for example.)

[9] Results like these are sometimes confused with the argument that there is a wealth transfer from lenders to borrowers when inflation is underestimated. Our analysis assumes lenders correctly anticipate inflation, so the effects of debt financing are purely through the tax treatment of the principal premium.

[10] Miller (1977) argues that t_s is quite small, given that high dividend paying stocks will be preferred by tax exempt organizations and low income investors; whereas stocks yielding more of their return in the form of capital gains will be preferred by taxpayers in the upper brackets. While taxes on gains are certainly greater than zero, holders generally pay no taxes on their gains until realized and only a small fraction of such gains are realized and taxed in any year.

[11] Parker and Zieha (1976) measure the extent to which various statutory incentives (e.g., accelerated depreciation, asset depreciation range, and the investment tax credit) included in The Tax Reduction Act of 1975 offset the impact of inflation on the real depreciation tax shield. (They ignored the impact of debt financing.) Using simulation, they showed that generally the negative impact of inflation on the real depreciation tax shield more than offsets the statutory investment incentives when inflation was greater than 8%.

[12] This failure to shield the return of equity capital is analogous to the argument that inflation reduces earnings to the stockholder by imposing a tax on nominal capital gains. (See Feldstein, 1980, p. 841.) Our analysis goes beyond this to show the role of debt and to consider the impact of Miller's equilibrium tax rates on the stockholder's earnings.

[13] Making pA deductible to stockholders is equivalent to changing the tax law such that the principal "premium," pbA, is neither taxable to lenders nor deductible to borrowers, and indexing the tax shield on capital repaid to equity investors, p(1 - b)A.

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