THE IMPACT OF INFLATION UPON CORPORATE TAXATION

by

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Comments Welcome

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I. Introduction.

The negative relationship between stock returns and inflation in the U.S. is a well-documented empirical finding, a result which seems to be mostly a consequence of the negative relationship between inflation and changes in stock prices, or alternatively between changes in the level of inflationary expectations and changes in stock prices.[1,2] The apparent depressant effect of inflation upon stock values is in turn thought to reflect a similar depressant effect upon true after-tax economic profits, and it is in this connection that the tax argument arises. It has been held by Feldstein and others that the impact of inflation upon economic profits is primarily a consequence of increased taxation arising from non-indexation in the tax system.[3] This study seeks to further examine the validity of this tax-effects hypothesis by using simulation techniques to study the corporate tax burden at various rates of inflation.

The motivation for employing a simulation approach to the tax-effect problem arises as a consequence of the limitations of earlier studies, the bulk of which are empirical. Such studies generally seek to measure the true economic profits of the firm, and use this measure either to identify taxes paid on incorrectly measured income (an inflation tax penalty) or else to compute an effective tax rate as the ratio of taxes paid to true income.

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[1] See Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1977) and Friend and Hasbrouck (1980).

[2] Changes in the level of expected inflation were first introduced into market return analyses by Fama and Schwert (1977). Friend and Hasbrouck (1980) perform a somewhat more comprehensive analysis which controls for economic activity, a time trend, and in addition attempts to differentiate between long-run and short-run inflationary expectations.

[3] See Feldstein (1980, 1980a), Feldstein and Summers (1978, 1979), Feldstein, Green and Sheshinski (1978).

Although the tax payments are usually known with little error, however, the true economic income is subject to vagaries of definition and measurement, and these difficulties affect to no small degree the generality of the conclusions. A representative study in this vein is provided by Feldstein and Summers (1979) who use National Income and Product Account (NIPA) data to study the tax rate across time and SEC-mandated replacement cost data to perform a cross-sectional analysis for 1976.[1] Feldstein and Summers compute the implied additional tax burden resulting from non-indexation of the tax system and find that from 1954 through 1977 this burden is positive with the largest magnitudes being observed in the 1970's.[2]

Concerning the effective tax rate, on the other hand, no clear result is obtained. It appears that the additional tax burden stemming from increased inflation has been approximately offset by the trend toward liberalized depreciation computations. Gonedes (1980) reaches this conclusion on the basis of a time-series study in which he regresses the effective tax rate against contemporaneous inflation and other variables, and finds no statistically significant impact.

There remain, however, inherent limitations in this sort of time-series analysis. Foremost among these is the question of transitional versus steady-state effects. Although some components of the effective tax burden, such as those related to the inventory valuation adjustment and the gain on net

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[1]Times-series analyses have also been performed by Cagan and Lipsey (1978) and Shoven and Bulow (1976), although these studies are not as primarily concerned with taxation issues. Cross-sectional analyses have also been presented by Davidson and Weill (1976) and Tideman and Tucker (1976).

[2]Feldstein and Summers extend their analysis by integrating taxes assessed at the corporate level with those paid by holders of corporate securities. The present paper is directed solely at the analysis of corporate tax effects.

monetary liabilities, react very rapidly to changes in inflation, others react relatively slowly. The real value of the depreciation deduction, for example, depends in a complicated fashion on past inflation and investment patterns.

A further problem is introduced by the non-neutrality of inflation. From 1968 to 1977, for example, the implicit price deflator for manufacturing equipment and structures rose at a rate greater than the GNP deflator, a fact which causes the replacement-value depreciation in this period to overstate that which would obtain in a neutral inflation. Similar distortions may have been introduced over this period by relative price shifts in energy and raw materials. Even apart from considerations of relative price shifts net over the entire period, noise will be introduced due to the heightened volatility of relative inflation rates over the past decade.

Finally, it must be emphasized that a linear time-series model is only an approximation to what is, on the basis of a priori considerations, a considerably more complicated function. Given the level of noise in the series and the confounding of transitional effects, it would not be surprising if a linear model were found to be descriptively adequate, but this historical adequacy does not justify extension of the conclusions to other periods in which linearity may be a poor approximation.

The limitations inherent in historical analysis motivate the development of simulation models as an alternative approach to the problem. This modeling involves derivation of the functional relationships between inflation and the taxation on the firm, and coupling these derivations with realistic parameter values in order to obtain implied inflation effects. Heretofore this type of simulation analysis has been used only on a very limited basis. Tideman and Tucker (1977) present some depreciation algorithms, as does Auerbach in the appendix to Feldstein, Green and Sheshinski (1978). But little appears to have been done in the way of further refining these estimates and computing the net corporate tax burden.[1]

The simulations presented here model a representative firm characterized by a number of realistic assumptions. The income adjustment related to cost-of-goods-sold reflects usage of LIFO, FIFO and average cost inventory valuation methods. The depreciation adjustment is computed at a detailed level of equipment and structure type, and reflects a range of current accounting practices. Finally, the firm's monetary position is described with respect to both interest-bearing and non-interest-bearing assets and liabilities.[2] This will lead to a distinction between the total inflation effect and the inflation tax effect.

The balance sheet and income statement for a representative firm are presented in Table 1, where balance sheet classifications have been made to facilitate exposition of the income adjustment. On the income statement, NOI is obtained in the usual fashion. Interest income is computed as the product of interest-bearing assets and a nominal rate written as a linear function of inflation: $r = b_0 + b_1\pi$. This becomes the usual Fisher equation if b_1 is equal to unity, in which case the intercept is the expected real rate of return, on a before-personal-tax basis. Of course, if the Fisher equation were to hold on an after-personal-tax basis, the coefficient b_1 would be

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[1]Although the article by Felstein et. al. integrates the Auerbach depreciation computation with a leverage effect, a linearized approximation to this correction is used. Among other things, this paper will demonstrate that linearity is a very poor approximation even at low to moderate rates of inflation.

[2]In an earlier simulation, Feldstein (1980) allowed for the possibility of non-interest-bearing monetary assets such as cash. He does not allow for non-interest-bearing liabilities, however, such as accounts payable or deferred taxes, and these will be seen to constitute a significant portion of the typical firm's financing.

expected to be greater than unity, holding the expected real return constant. The bulk of the available evidence suggests, however, that b_1 is unity or less, and unity will be assumed in the subsequent simulations.[1] This form will be assumed to apply to nominal returns of all securities held and issued by the firm.

To obtain true economic income, adjustments are made to book income to reflect true cost-of-goods-sold, true economic depreciation and holding gains and losses on monetary assets and liabilities. With a perfectly-anticipated, sustained homogeneous inflation rate, the adjustments are all-inclusive. If the inflation is nonhomogeneous, or if there are transitional effects, adjustments must also be made to reflect real capital gains and losses on physical assets and long-term securities.

The final expression for the true economic income may be rearranged to isolate the inflation and tax effects.

$$(1) \qquad y = y^b + (c^b - c) + (d^b - d) - (a+a')\pi + (l+l')\pi$$

$$= [s - c^b - d^b - (b_0 + b_1\pi)(l' - a')](1-t)$$
$$+ (c^b - c) + (d^b - d) - (a+a')\pi + (l+l')\pi$$

$$= s(1-t) - c - d - b_0(l' - a')(1-t)$$
$$+ t[c^b + d^b + (l' - a')b_1\pi] + [(l' - a')(1 - b_1) + (l - a)]\pi$$

where

[1] See Fama (1975), Fama and Schwert (1977), Gibson (1970, 1972) and Levi and Makin (1979).

y^b	Book income.
c^b	Cost-of-goods-sold for tax purposes.
c	True cost-of-goods-sold.
d^b	Depreciation for tax purposes.
d	True depreciation.
a	Non-interest-bearing monetary assets.
a'	Interest-bearing monetary assets.
l	Non-interest-bearing monetary liabilities.
l'	Interest-bearing monetary liabilities.
π	Inflation.
t	Tax rate.

Written in this fashion, we may identify two key components in (1).

$$(2) \qquad T = t\left[c^b + d^b + (l'-a')b_1\pi\right]$$

represents the inflation-tax interaction term. Inflation enters explicitly as shown, and also implicitly, via the effect on computation of cost-of-goods-sold and book depreciation. The second important term is

$$(3) \qquad R = \left[(l'-a')(1-b_1) + (l-a)\right]\pi$$

This term represents the holding gains on net non-interest-bearing monetary liabilities, and reduces to $(l-a)\pi$ if $b_1=1$. Since there is no tax effect on these non-interest-bearing entities, this component will be ignored in the tax analysis. The combination of the effects encompasses the net inflation impact on the firm:

$$(4) \qquad S = T + R$$
$$= t\left[c^b + d^b + (1'-a')b_1\pi\right] + \left[(1'-a')(1-b_1) + (1-a)\right]\pi$$

For the present purpose, the main feature of consequence in the tax term T, or the net inflation term S, is nonlinearity in inflation. As inflation increases, the real value of the tax deductions from historical cost depreciation and historical cost-of-goods-sold reach limiting points at zero. The gain arising from the deductibility of nominal interest payments, on the other hand, is linear in inflation. As will become apparent in the numerical simulations based on current (prior to 10-5-3 schemes) depreciation rules, the loss due to decreased value of c^b and d^b outweighs the leverage gain, at low levels of inflation, but as inflation increases, the latter meets and surpasses the former.

For expositional purposes, I will describe this process by identifying three different rates of inflation. The zero-equivalence rate will be computed as that positive rate of inflation at which the tax term T takes on the same value as at zero inflation. I shall also seek to identify the .03-equivalence inflation rate, defined as that rate at which the tax term takes on the same value as at an inflation rate of 3 percent. The motivation for computing the .03-equivalence rate lies in the fact that 3 percent approximates the average inflation in the post-Korean War pre-1967 period of rapid growth in corporate profits and stock prices. Finally, it is also useful to identify that rate of inflation at which the tax burden is maximized: beyond this point inflation will reduce the net tax burden. Of course, all of these inflation rates may be computed with respect to the total inflation impact term S as well.

These determinations are made using relatively refined algorithms for computation of the cost-of-goods-sold and depreciation tax deductions. The cost-of-goods-sold deduction is treated in Section II, and that of depreciation is discussed in Section III. In Section IV, realistic values for certain balance sheet parameters are discussed and final computations are performed. The zero-equivalence inflation rate computed with respect to taxation is somewhat dependent on the depreciation method used for tax computation, but appears to be in the range of 20-25 percent (annually). On the other hand, the tax-maximizing inflation rate is found to be 7-9 percent. This suggests that although current inflation levels are below that which would result in a zero-inflation tax burden, any further increases in the inflation rate into the double-digit range will have the effect of reducing the tax burden. Finally, under the proposed 10-5-3 depreciation rules, the leverage gain is apt to outweigh the losses from historical cost depreciation and inventory valuation at any positive inflation rates. Thus any positive inflation will be beneficial.

II. The Inventory Valuation Adjustment (IVA).

The purpose of this section is the derivation of an algorithm for computation of the IVA at a given rate of inflation. This derivation will be accomplished in the following steps. First theoretical models will be developed for the three most commonly used inventory valuation methods, LIFO, FIFO and average cost. Next, the actual incidence of usage of these methods will be estimated using existing accounting survey data. Despite the tax advantages of LIFO utilization for most firms during inflationary periods, LIFO does not seem to be significantly more widely used than either of the other methods.

The data on choice of inventory valuation method are used to construct utilization weights for each method. The IVA is then obtained as the wieghted average of the IVA's computed under each accounting method. The resulting algorithm is then tested by applying it to manufacturing, wholesaling and retailing firms for the years 1970-1978, and the values predicted in this manner are quite close to those reported in the NIPA data.

The Theory of the IVA.

Formally, the IVA is defined as the difference between cost-of-goods-sold (CGS) at book and true, replacement value CGS: IVA = $c^b - c$. Since determination of c^b is dependent on the inventory valuation method used, so too is the IVA.

The simplest case involves LIFO inventories. Goods sold are assumed to be those most recently added to stocks, so in continuous time at a steady level of sales and production, these goods are the ones just produced. Hence, $IVA_L = 0$. Since in the steady-state the nominal price of the inventories remains constant, the deflated book value of inventories will in time approach zero as the price index rises.

Next in degree of complexity are FIFO inventories, where goods sold are assumed to come from the earliest additions to stocks. If inventory turnover is c/i where c is the rate of sales (and production) valued at real acquisition or production cost and i is the level of inventory similarly measured, then a unit currently being sold was produced with a lag of $l = i/c$. Accordingly, the difference between replacement cost and historical production or aquisition cost is

$$IVA_F = -c\left(1-e^{-\pi l}\right) \tag{5}$$

where π is the inflation rate. The deflated book value of inventories may be shown to be $i_F^b = (c/\pi)\left(1-e^{-\pi l}\right)$, or if $\pi = 0$, $i_F^b = cl$.

The determination of the IVA for average cost inventories is slightly more complex. In this case, the price at which cost-of-goods-sold are valued is the price of goods-available-for-sale, essentially an average between current and past production prices. It may be shown (Hasbrouck, 1981), that the deflated book value of such inventories is $i_A^b = i/(1+\pi l)$, where i is the replacement value. The inventory valuation adjustment when this method is used may be shown to be

$$IVA_A = - c\pi l/(1 + \pi l) \tag{6}$$

Before taking up the question of actual accounting practice, there are several final considerations regarding the above formulas worthy of mention. First, it is apparent that the critical parameter in the IVA for both FIFO and average cost cases is the holding lag l. Column (6) of Table 2 contains estimates of this lag for a number of different industries, where these estimates are formed as the inverse of book inventory turnover using IRS corporate tax return data for 1975. The average value of l is about .19 years, but there is considerable variation among the industries. This variability in l is a potential source of difficulty in estimating an aggregate IVA.

Secondly, the IVA expressions exhibit nonlinearity in inflation. As the inflation rate increases, both IVA_F and IVA_A reach limiting values at $-c$. Nevertheless, for moderate rates of inflation, the departure from linearity is apt to be insignificant. For example, if we approximate IVA_F by a second-order Taylor expansion about a zero level of inflation, taking a holding lag of $l = .2$, then at a 10% level of inflation, the quadratic term accounts for only one percent of the total size of the adjustment.

Finally, the above inventory valuation formulas (IVA_F and IVA_A) are technically valid only for the no-growth case. Expressions for the adjustment in the presence of real growth are derived in Hasbrouck (1981), but for subsequent simulations, the no-growth approximations will be used. This will introduce error of insignificant magnitude, since at reasonable rates of growth and inventory turnover only a trivial fraction of production is diverted to building inventories.

Inventory Valuation Practice.

For the present purposes, it would be most useful to possess a measure of method usage relative to inventories or cost-of-goods-sold. Such data are not available, however, so in consequence, we are forced to rely on cruder survey data. Each year, Accounting Trends and Techniques conducts a survey of the accounting practices of 600 large manufacturing and trade firms, and among the practices surveyed is inventory valuation method. Table 3 reports inventory valuation method usage among these 600 companies for LIFO, FIFO, average cost and "other" — mostly retail method, specific good, etc. Note that since a firm may employ more than one method, the total of responses is somewhat larger than the number of companies. Table 3 also reports valuation method usage relative to the total number of responses. It is apparent that throughout the 1970's, usage of LIFO inventory valuation has increased, with the largest jump occurring in 1974. Nevertheless, in 1979, after nearly a decade of moderate-to-high inflation and every indication that these rates will persist, LIFO usage is far from predominant.

IVA Computation Procedure.

The computational form for the IVA used in the subsequent simulations was formed as the weighted sum of the IVA's computed under each valuation method.

$$IVA_t = w_{L,t}(0) + w_{F,t} IVA_{F,t} + w_{A,t} IVA_{A,t} \qquad (7)$$

where the w's are usage weights computed from the Accounting Trends and

Techniques data. $IVA_{L,t}$ was taken as zero, and $IVA_{F,t}$ and $IVA_{A,t}$ were computed using formulas (5) and (6), respectively.

This algorithm was tested by using it to estimate the IVA for manufacturing, wholesaling and retailing concerns for 1970-1978, and then comparing these estimates with the figures reported in the NIPA data. In the computations, the holding lags were estimated as the inverses of the book inventory turnover figures from Table 2: .187, .116 and .171 years for manufacturing, wholesale trade and retail trade, respectively. Inventories (i_t) were estimated as constant dollar average inventory figures for the year (NIPA). The real values for the NIPA IVA's were obtained by deflating the reported figures by the implicit price deflator for the type of inventory in question (manufacturing, wholesaling or retailing), and inflation was estimated as the rate of change in this index. The resulting computations are presented in Table 4. Agreement between actual and predicted values is quite good. The bias in the predicted total IVA is about 1% over the period, although the error is somewhat larger in the individual components. On the basis of this test, this algorithm was judged quite adequate for the subsequent simulations.

III. Tax Depreciation Effects.

The purpose of this section is the development of expressions for the value of the depreciation tax deduction--d^b in the analysis of Section I--for use in subsequent simulations. This quantity will be seen to be critically dependent on, besides the inflation rate, the gross investment rate of the firm (and by implication, the true economic depreciation and growth rates), and also the method used to compute the tax deduction. In regard to the former, it will be assumed that true economic usefulness declines exponentially over time. As to the latter, alternative results will be presented for four methods of tax depreciation computation: declining balance, straight line, double declining balance, and sum of the years digits. Although the first of these is not extensively used in the U.S., it is employed in certain foreign countries, and in addition has been used by other researchers in addressing the U.S. data.[1]

Next, to make these expressions operational, parameter values are discussed. Because the types of capital comprising the stock differ widely as to service lifetimes, the computational algorithm is executed at a fine level of detail: 20 classes of machinery and equipment and 11 classes of structures are considered. The resulting algorithm is used as input in the subsequent analysis. For present purposes, the most important feature of the depreciation tax deduction is its nonlinearity in inflation, a feature which holds for all methods of tax computation. As inflation rises, the real value of this deduction approaches zero. Furthermore, in contrast with the IVA discussed in the last section, the nonlinearity of the depreciation tax deduction is significant at relatively low to moderate levels of inflation. Finally, although the present analysis is oriented toward the description of the system in the steady-state, since the depreciation deduction is apt to be the effect limiting speed of adjustment, a brief analysis of the transitional properties is presented.

Gross Investment Assumption.

Computation of the value of the book depreciation deduction will be seen to depend rather critically on the gross investment rate. This rate consists of two components, the larger of which is replacement of worn-out capital, and the smaller of which represents net additions to capital stock. In the steady

[1]See Auerbach (1981) and Auerbach's appendix to Feldstein, Green and Sheshinski, op. cit.

state, net additions to capital stock will be made at the economy's growth rate, g, so we may assume that the net real capital stock follows exponential growth: $k_t = k_0e^{gt}$. The real net investment will then be $N_t = k_tg$.

Determination of stock-replacement investment is much more difficult. The analysis hinges on determination of the flow of capital services from a piece of equipment throughout its lifetime, and this problem has long plagued researchers attempting to compute capital stock estimates. Although no simple functional form accurately depicts this true economic depreciation for all types of capital, this study will adopt the approximation that true economic usefulness declines exponentially, with the decay factor being that of the double declining balance computation using .85 Bulletin F service lives.[1]

Using this assumption, the real gross investment at time t will be $G_t = k_t(\delta + g)$ where δ is the true economic decay factor. Define $D_t(s)$ as the real depreciation expense at time t arising from one unit of capital acquired at time s. Then the real depreciation expense at time t on the firm's total capital stock may be written as

$$d_t^b = \int_{-\infty}^{t} D_t(s)G_s ds. \tag{8}$$

The function form used for $D_t(s)$ will of course depend on the depreciation computation method used for tax purposes.

<u>Declining Balance Computation Method</u>

This method and the double declining balance method are the easiest to analyze because the functional form used for tax purposes is the same as the form used for determination of economic depreciation. Suppose a piece of

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[1]See Terborgh (1954) and Kendrick (1976).

equipment has a service life for tax purposes of λ. Then according to the declining balance method of computation, the depreciation expense is $1/\lambda$ times the net value of the equipment. At time t, the nominal book net value of a unit of capital acquired at time s is $P_s e^{(s-t)/\lambda}$, where P_s is the price level. If inflation is at a constant rate π, then the real value of the depreciation tax deduction on this unit is

$$D_t(s) = (1/\lambda)e^{(\pi+1/\lambda)(s-t)} \tag{9}$$

The real value of the depreciation tax deduction from all previously acquired assets may be obtained by substituting (9) in (8):

$$d_t^b = \frac{k_t(g + \delta)}{\lambda(g + \pi + 1/\lambda)}$$

Straight Line Computation Method

The straight line method is, for book purposes, the most commonly used depreciation computation method. If the service lifetime for tax purposes is λ, then each year, $1/\lambda$ of the asset's initial cost is expensed. Thus, the real tax deduction at time t for a unit of capital acquired at time s is

$$D_t(s) = \begin{cases} (P_s/P_t)(1/\lambda) & \text{if } t < s + \lambda \\ 0 & \text{otherwise.} \end{cases}$$

If inflation is at a constant rate π, then

$$D_t(s) = \begin{cases} e^{\pi(s-t)}/\lambda & \text{if } t < s + \lambda \\ 0 & \text{otherwise.} \end{cases}$$

The total real value of the depreciation tax deduction for all previously acquired investments will then be

$$d_t^b = \frac{k_t(g + \delta)}{(g + \pi)\lambda}\left[1 - e^{-(\pi+g)\lambda}\right]$$

Double Declining Balance Computation Method

This computation is formally identical to the declining balance case discussed above, except that the decay rate is doubled. If the service lifetime for tax purposes is λ, then $2/\lambda$ of the asset's net value may be expensed for depreciation. Accordingly, it may be shown that

$$d_t^b = \frac{2k_t(g + \delta)}{\lambda(g + \pi + 2/\lambda)}$$

Sum of the Years Digits Computation Method

For the sum of the years digits computation, it may be shown that the real depreciation expense at time t for one unit of capital with a tax-service lifetime of λ acquired at time s is

$$D_t(s) = \begin{cases} \frac{P_s}{P_t}\left(\frac{2}{\lambda^2}(\lambda - (t-s))\right) & \text{for } t < \lambda + s \\ 0 & \text{otherwise.} \end{cases}$$

Thus,

$$d_t^b = k_t\left(\frac{2(g+\delta)}{\lambda^2(\pi+g)}\left(\lambda - \frac{1-e^{-(\pi+g)\lambda}}{\pi+g}\right)\right)$$

Parameter Estimates

Table 5 gives NIPA estimates of the replacement value of capital stock by different classes of assets (column (1)). Also reported are the IRS .85 Bulletin F service lives for these classes and the double declining balance decay factors. The latter average .159 for machinery and equipment and .067 for structures. The depreciation tax deduction used in subsequent simulations was computed as a weighted average of the individual tax deductions. Denoting the depreciation tax deduction for the ith class of equipment as d_{it}^b and letting w_i be the relative weight (column (3) in Table 5), then the total tax deduction will be

$$d_t^b = k_t \, \Sigma \, w_i d_{it}^b$$

Note that the net values in Table 5, and therefore the weights used in the above algorithm, reflect an assumption of straight-line depreciation on a replacement cost basis. This is not quite optimal for the present purpose, as ideally we would want the weights to reflect double declining balance depreciation, regarded as economically more realistic. This approximation will introduce some error into the computation, exaggerating the importance of long-lived assets.

Some additional error may also be introduced because the above algorithm does not reflect usage of Class Life Asset Depreciation Range (CLADR) tax accounting. This practice was sanctioned but not required by the IRS in 1971 and permits computation of the depreciation deduction using tax lives based on broad asset classes. The tax lifetimes associated with these classes are generally lower than the Bulletin F lifetimes, and in consequence the depreciation deductions computed here are slightly lower than the maximum permissible under current law. The CLADR scheme modifies tax lifetimes only; depreciation computation methods remain the same.

Before continuing the discussion of the simulations, I note here some key features of the depreciation tax deduction. First, as is the case with the

IVA, the tax depreciation deducations manifest nonlinearity in inflation, but in contrast with the IVA, the departure from linearity may be significant even at moderate levels of inflation. For example, if we assume a tax lifetime of $\lambda = 15$ years (approximately correct for machinery and equipment) and a real growth rate of 2% per year, the second-order Taylor expansion of the depreciation tax deduction using the declining balance method is

$$d_t^b = \left[k_t(g+\delta)/\lambda\right] \left[(1/.087) - (1/.087)^2\pi + (1/.087)^3\pi^2\right]$$

and at an inflation rate of 10% per year, the quadratic term will account for over a third of the total adjustment.

Although this note is primarily concerned with the steady-state properties of the model, it is worthwhile to briefly note some of its transitional properties. Among the three inflation effects considered in this analysis--inventory valuation, leverage and depreciation--the first two reach their limiting values relatively rapidly following a shift in inflation rates. The depreciation effect, on the other hand, changes only as the capital stock turns over, a relatively slow process. Thus, examination of the transitional behavior of the depreciation deduction yields insight into the time required for the system to approach the steady-state.

Suppose that until time t^*, inflation has been steady at rate π_1, and that at time t^* it jumps to and remains at π_2. It may be shown that for the declining balance method of computation,

$$d_t^b = k_t \left[\frac{\delta+g}{\lambda}\right] \left[\frac{1}{\pi_1+g+1/\lambda} e^{-\left(\pi_2+g+\frac{1}{\lambda}\right)(t-t^*)} + \frac{1}{\pi_2+g+1/\lambda} \left(1 - e^{-\left(\pi_2+g+1/\lambda\right)(t-t^*)}\right) \right]$$

Figure 1 depicts the transitional effects for a representative level of capital, assumed to have a tax lifetime of 15 years and an economic decay factor of 2/15. The firm is assumed to hold \$100 worth of this capital at time zero and this is assumed to grow at a real rate of 2% annually. The bottom line in Figure 1 depicts the time path of the real value of the annual depreciation deduction assuming inflation is 10% at all times. The top line depicts the time path of the deduction assuming that inflation was 3% until time zero, and 10% thereafter. This transitional path does not close to within 10% of the steady-state path until approximately ten years have elapsed.

Thus, convergence here takes place over relatively long periods of time, and of course, convergence would be even slower if the service life estimate were to be revised upward to reflect the inclusion of structures. Due to the slow convergence, it is not feasible to compare the depreciation deductions predicted by these steady-state formulas with the macro data, as was done with the IVA. The historical variability of inflation rates and gross investment is sufficient to limit the usefulness of these convenient formulas outside of the steady-state framework.

IV. Simulation Results.

The tax-related and total inflation terms S and T of Section I are composed of adjustments for historical-cost depreciation, inventory valuation and gain on net monetary liabilities. In the preceding sections, computational formulas have been developed for the first two of these, formulas which depended on the stocks of inventories and physical capital. Computation of the third component is trivial when the levels of monetary assets and liabilities have been ascertained. Therefore, the initial part of this section will be devoted to a discussion of realistic values for these balance sheet entries. On the basis of these parameters, computations of the tax and inflation burdens may then be made.

Table 6 reports the aggregate balance sheet for U.S. nonfinancial corporations as estimated by the Flow-of-Funds Section of the Board of Governors of the Federal Reserve System. Tangible assets are reported in current dollar replacement values, monetary items are carried at book values and equity is computed as a residual. For the present purpose, it is necessary to rework this data in several respects. Monetary items must be classed as interest-bearing or non-interest-bearing, and some restatement of plant and equipment is required. The reworked balance sheet figures are reported in Table 7.

The net plant and equipment value in Table 6 is the BEA estimate of domestic equipment and structures computed on a straight-line replacement cost basis assuming .85 Bulletin F service lives. From the discussion of the previous section, however, it is more realistic to assume that the true economic value of the capital is that computed on a double-declining balance replacement cost basis. Accordingly, the values for net structures and net machinery and equipment reported in Table 7 are estimates of the double-declining balance net stocks based on BEA estimates.

Classification of monetary items into interest-bearing and non-interest-bearing groups is sometimes problematic. Non-interest-bearing monetary assets were considered to include time deposits, U.S. and other government obligations, commercial paper and security repos. Concerning consumer and trade credit, it is noted that interest is customarily assessed on the former, and it is also usual to build in an interest payment on the latter by the use of time-dependent payment terms. Accordingly, these items were allocated to interest-bearing monetary assets.

On the liability side, non-interest-bearing monetary liabilities are computed as taxes payable plus miscellaneous liabilities, and interest-bearing liabilities were computed as the sum of commercial paper, acceptances, finance company loans, U.S. government loans, tax-exempt bonds, corporate bonds, bank loans not elsewhere classified and, to be consistent with the asset side, trade debt. Some error is introduced at this stage because although book values are probably quite close to replacement values for short-term monetary items, this may not be the case with respect to long-term items, such as bonds. Interest rates have generally risen over the period during which most long-term debt was issued, and the replacement value of this debt may therefore be lower than the book value. This bias in the long-term debt estimates will cause an overestimate of leverage and a consequent underestimation of the zero-equivalence, .03-equivalence and tax-maximizing rates of inflation. Such bias is likely to be smaller than might be expected, however, since the dollar-weighted average maturity of corporate debt is much smaller than the unweighted figure.

From Section I, the inflation tax term was found to be

$$T = t\left[c^b + d^b + (1'-a')b_1\pi\right]$$

where all variable were defined in Section I and b_1 is taken as unity. For computational purposes, it is somewhat easier to work with the expression

$$\begin{aligned} T' &= t\left[\left(c^b - c\right) + d^b + \left(1'-a'\right)b_1\pi\right] \\ &= t\left[IVA + d^b + \left(1'-a'\right)b_1\pi\right] \end{aligned}$$

since the formulas developed in Section II are for the inventory valuation adjustment rather than cost-of-goods-sold. Since T' differs from T by the constant tc, the maximizing and equivalence values for T' and T will be identical. The IVA and d^b terms were evaluated using the formulas derived in sections II and III and using the balance sheet weights for inventories and physical capital from Table 7. The parameters 1' and a' were also taken from Table 7, and a real annual growth rate of 2 percent was assumed.

Since IVA and d_b in the above are generally complex nonlinear functions of π, it is not generally possible to rearrange the expression for T' in order to isolate π. In consequence, the functions were studied using numerical analysis. To determine the zero-equivalence rate of inflation, for example, a grid-refinement procedure was employed to minimize the absolute value of the difference between T' and T' evaluated at zero inflation.

Values are presented in the top half of Table 8 for the zero-equivalence rate, .03-equivalence rate and that rate of inflation at which T' is maximized, under four alternative depreciation assumptions. Under all depreciation schemes, the zero-equivalence rate is well above the average rate of the past decade. Indeed, it would seem that the recent U.S. inflation is in the vicinity of the maximizing rates, which range from 7-9 percent.

Analysis was also made of the total inflation impact term

$$\begin{aligned} S &= t\left[c^b + d^b + (1'-a')b_1\pi\right] \\ &\quad + \left[(1'-a')(a-b_1) + (1-a)\right]\pi \\ &= t\left[c^b + d^b\right] \\ &\quad + (1'-a')\left[1 - (1-t)b_1\right]\pi + (1-a)\pi \end{aligned}$$

A tax rate of 46% was assumed for this computation, and b_1 was assumed to be unity. As with the tax computations above, the balance sheet weights were taken from Table 7.

Computational results are presented in the lower half of Table 8. The zero-equivalence, .03 equivalence and maximizing rates appear to be substantially higher than the corresponding rates for the tax term discussed above. This reflects the fact that nonfinancial corporations are net lenders of non-interest-bearing monetary items. This is illustrated by the computation, in Table 7, of two leverage terms. "Effective tax leverage" is defined as $t(1'-a')$, a measure related to the computation of the T and required return T' terms above. "Effective total leverage" is defined as $t(1'-a')+(1-a)$, and is related to the computation of S. The effective tax leverage is larger than the effective total leverage, and therefore the offsetting leverage benefit from the gain on net nominal liabilities is smaller when both interest-bearing and non-interest-bearing items are considered. Both leverage measures reflect, of course, U.S. practice. In an economy such as Japan's where leverage is more extensive, the equivalent inflation rates would be lower.

That the recently proposed depreciation liberalization may ameliorate the situation is suggested by the computations presented in Table 9. For these computations, the lifetimes allowable for tax purposes were taken as ten, five and three years for structures, equipment and motor vehicles, respectively. All other parameters of the computations were left unchanged. It appears that for three of the depreciation computation methods, any positive inflation is unambiguously favorable in consideration of taxes. Even when the total inflation term is considered, the computed equivalence inflation rates are generally much lower than those computed under the current depreciation allowances.

It should be noted that these computations may be subject to several distortionary influences. Two of these, stemming from use of a class life asset depreciation range scheme and error in the measurement of the replacement value of long-term debt, have already been noted. In addition, distortions may be introduced due to error in classification of monetary items, a non-constant real interest rate, or non-constancy in the balance sheet weights.

Concerning the first of these, it should be noted that leverage, as measured by either $t(1'-a')$ or $t(1'-a')+(1-a)$, is a highly critical variable. Furthermore, both of the leverage measures will be affected by classification of monetary items into interest-bearing and non-interest-bearing groups. For example, if the proportion of non-interest-bearing monetary liabilities in the balance sheet of Table 7 is increased by .01 and the proportion of interest-bearing liabilities is decreased by .01, then under a double-declining-balance depreciation assumption the tax-maximizing inflation rate goes from .077 to .085, while the inflation rate that maximizes the total inflation burden drops from .126 to .111.

Since a large measure of the leverage benefit stems from deductibility of nominal interest payments, it is worthwhile to comment on how these results might be affected if the nominal rate does not rise point for point with expected inflation, i.e. if b_1 is other than unity. It may be recalled that the Fisher equation for the nominal rate is $r = b_0 + b_1\pi$, and if this is to hold on an after-personal-tax basis, with a constant real rate, then $b_1 = 1/(1-t_p) > 1$, where t_p is the marginal personal tax rate.[1] If corporate bonds and tax-free bonds are considered close substitutes, then the marginal tax rate would be that rate at which an investor is indifferent between holding either. The leverage benefit in the tax term T will then be

$$t(1'-a')b_1\pi = t(1'-a')\pi/(1-t_p)$$

which is larger than if $b_1 = 1$. The tax deduction will be larger and the zero-equivalence rate of inflation will be lower in consequence. The leverage component of the net inflation impact term S, however, is

$$\begin{aligned}&(1'-a')[1 - (1-t)b_1]\pi + (1-a)\pi \\ &\qquad = (1'-a')[1 - (1-t)/(1-t_p)]\pi + (1-a)\pi\end{aligned}$$

This term will be smaller than if b_1 is unity, thereby raising the zero-equivalence inflation rate. Furthermore, if personal and corporate tax rates are equal, the leverage effect associated with interest-bearing items will wash, although the leverage effect associated with non-interest-bearing items will remain. This analysis applies in the opposite direction if b_1 is less than unity, as appears possible on the basis of the empirical evidence cited in Section I.

Finally, it must be noted that these results may change if the balance sheet weights do not remain invariant to the rate of inflation. To take an obvious example, it is likely that the cash holdings of an optimizing firm will drop as the inflation rate rises. Of course, this reduction will entail

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[1]The consequences of an after-tax Fisher effect were initially discussed by Darby (1975).

additional cash management costs, but the additional costs will be less than the cost that would be incurred if the firm were to hold real balances constant. The balance sheet weights used in these simulations are from the end of 1979. Over this year, inflation as measured by the rate of change in the GNP deflator was .090, and over the five preceding years the average rate was .071. If inflation were to increase substantially beyond this neighborhood, it is likely that some compensatory reaction would ensue. As the simulations ignore this possibility, there will be an overestimate of the zero-equivalence, .03-equivalence and maximizing inflation rates.

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