NBER WORKING PAPER SERIES

INFLATION AND THE TAX TREATMENT OF FIRM BEHAVIOR

Alan J. Auerbach

Working Paper No. 547

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

September 1980

The research reported here is part of the NBER's research program in Taxation and project in Capital Formation. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper #547
September, 1980

Inflation and the Tax Treatment of Firm Behavior

ABSTRACT

Because the tax system in the U.S. is not price-level indexed, the tax treatment of the corporation depends on the inflation rate. These effects of inflation are particularly complicated because corporate and personal income are taxed independently, and there are different ways of transferring income from the corporation to the individual.

This paper analyzes the influence of inflation on the corporation's choice of asset durability, asset holding period, debt-equity ratio and investment scale, under a simplified version of the current U.S. tax law.

Alan J. Auerbach
National Bureau of Economic Research
1050 Massachusetts Avenue
Cambridge, Massachusetts

(617) 868-3927

In the past decade, economists have begun to realize that inflation, even when fully anticipated, constitutes a great deal more than a tax on money balances. The primary reason for inflation's wider impact is the existence of a tax system designed with stable prices in mind. This paper offers a brief summary of the effects of inflation on the tax treatment of the firm, focusing on four important decisions the firm makes: the scale of investment, the method of finance, the durability of assets used in production, and the holding period of these assets.

There are a number of interesting and related issues which cannot be covered in a paper of this length. As we will be considering inflation that is both uniform and fully anticipated, questions concerning the behavior of the firm in response to uncertainty about inflation, or to a concommitant change in relative prices, will not arise.

I. The Model

We consider a simple model of a corporation which uses a single type of capital good in producing one type of output.

The firm seeks to maximize the wealth of its shareholders, who discount after-tax cash flows at rate e and are subject to personal taxes on dividends at rate θ, and capital gains, at an accrual-equivalent rate c. The firm pays taxes at rate τ on corporate profits, which are calculated by deducting interest payments and depreciation allowances from gross cash flows. The nominal interest rate is i, and b is the fraction of capital structure that the firm chooses to devote to debt.

All capital goods are assumed to have service patterns which decline exponentially; the rate of decay, δ, is indicative of how durable the asset is. The price, relative to that of output sold concurrently, of a unit of capital of type δ yielding a certain standard level of capital services is $q(\delta)$. All prices inflate at rate π. As the purpose of this paper is to focus on the specific impact of inflation, we shall consider the simple case in which depreciation allowances accorded assets would reflect actual economic depreciation in the absence of inflation, but are based on historic cost. This implies that the nominal depreciation allowance received by an asset of age t and type δ is $\delta e^{-\delta t}$ times its original purchase price. We also omit the investment tax credit in the interest of simplicity.

Firms not only choose the durability of the assets used, but the length of time, T, that they are held before being sold and replaced. Upon such resale, firms are taxed at rate $\gamma<\tau$ on the difference between sale price and basis (the nominal value of remaining depreciation deductions).

As shown in the appendix, the firm's optimal behavior may be viewed as a two-stage process. In the first stage, it chooses the decay rate, δ, the holding period T, and the debt-value ratio, b, to minimize the "user cost" of capital, which is the shadow rental price of capital goods. In the second stage, the firm invests until the marginal product of capital goods equals this minimized cost. For given values of δ, T and b, the user cost is

$$(1) \qquad C = \frac{q(\delta)(\rho+\delta)}{(1-\tau)}\left[(1-\tau z) + (\gamma-\tau z)(1-e^{-\pi T})\left(\frac{e^{-(\rho+\delta)T}}{1-e^{-(\rho+\delta)T}}\right)\right]$$

where

$$(2) \qquad \rho = \frac{bi(1-\tau)(1-\theta)+(1-b)e}{b(1-\theta)+(1-b)(1-c)} - \pi$$

may be interpreted as the real after-tax cost of funds to the firm and

$$(3) \qquad z = \int_0^{\infty} e^{-(\rho+\pi)t} \, \delta e^{-\delta t} dt = \frac{\delta}{\rho+\pi+\delta}$$

is the present value of depreciation allowances accruing to an initial investment of one dollar which is never resold (discounted at the nominal discount rate $\rho+\pi$ because allowances are in nominal terms). To get an intuitive sense of what ρ represents, note that when $b=1$, $\rho=i(1-\tau)-\pi$, the interest rate net of tax deductions and inflation; when $b=0$, $\rho = \frac{e}{1-c} - \pi$.

Equation (1) differs from the standard formula for user cost because it explicitly accounts for the tax treatment of the disposal of assets by resale. It reduces to the basic formula when $T = \infty$.

II. The Effects of Inflation

A. Asset Holding Period

In a more general model than that considered here, firms might find it optimal to sell and replace assets of a certain vintage, rather than use them until fully exhausted, even in a world without taxes. In the current model, all assets are identical in productive characteristics, so such behavior could have no real consequences.

However, the introduction of taxes may cause assets identical in productive characteristics to differ in another sense. If depreciation allowances are accelerated, an asset declines in value faster than would be dictated by its decline in productivity alone. This is because it is now really two "assets": one that produces capital services, and one that "produces" depreciation deductions, the second declining in value more rapidly than the first. However, if the asset is sold, under current U.S. law the depreciation allowances that remain are not transferred. Rather, the sale price is used as a new basis for depreciation deductions. Thus, if the depreciation schedule is accelerated, the asset transfer will increase the value of remaining deductions and generate an increase in the value of the asset. This is countered by the fact that the seller must pay a tax at rate γ on the difference between sale price and basis (the nominal value of remaining depreciation allowances). The rate γ simply equals τ for equipment, but for structures is actually a weighted average of the ordinary corporate rate and the lower corporate capital gains rate; the ordinary rate is applied only to the amount by which the asset's basis falls short of that which would have obtained had straight-line tax depreciation been used. (This practice is technically referred to as the "recapture" of "excess" depreciation, though such a designation is rather inappropriate.) Imagining a firm selling the asset to itself, we can see that it must weigh the increased value of depreciation allowances against the tax liability incurred on transfer.

When there is economic depreciation of assets, as we have assumed in our analysis, such a distortion disappears; basis and sale price would be identical and turnover would have no real impact on the firm. However, inflation once again introduces the same divergence caused by accelerated depreciation. Historic cost depreciation implies that turnover provides a step-up in basis, generating both an increase in the value of future depreciation deductions and an immediate tax liability.

This effect is represented by the second term in brackets in the cost of capital expression in equation (1). This term increases or decreases with T according to whether the turnover tax γ is less than or greater than the present value of tax deductions. Since, for structures, γ is approximately equal to τ, currently .46, for small values of T, and approximately equal to the corporate capital gains rate, currently .28, for T large (because the fraction of sale price less basis "recaptured" declines over time), the optimal holding period T, with positive inflation, will be zero, infinite, or somewhere in between according to whether $z \geq 1$, $z \leq .28/.46$ or $1 > z > .28/.46$. The first condition is never met, and the second requires that $\delta < (\rho+\pi)x(.28/.18)$. For a nominal discount rate of .10, this critical value of δ is .156, much higher than the rate of depreciation for any general category of structures. Since $\gamma \equiv \tau$ for equipment, an optimal holding period less than infinity never obtains. Thus, for most assets, inflation will encourage holding assets, despite their inflation-eroded depreciation allowances, rather than replacing them.

B. Debt-Equity Ratio

As the Modigliani-Miller Theorem shows, the choice of debt-equity ratio is of no consequence in a taxless world under a variety of circumstances, and debt dominates equity with a corporate tax but no personal taxes. However, in reality, holders of debt and equity pay taxes, too, and because of the favorable tax treatment of capital gains, the personal tax rate on debt income is higher for any given individual than the tax on equity income. Thus, the choice between debt and equity depends on the relative magnitudes of the corporate tax rate, τ, the capital gains rate, c, and the personal tax rate, θ. As discussed in an earlier paper (author, 1979b), the debt-equity choice is knife-edged if all investors possess the same tax rates, even in the presence of short sale constraints on individuals. However, with progressive taxes, an interior solution is possible in which firms are indifferent between debt and equity and individuals are specialized in clienteles.

To examine the effect of inflation on the debt-equity decision, we rewrite equation (2) by replacing i and e with the real, after-tax returns to holders of equity and debt, $e_N = e-\pi$, and $i_N = i(1-\theta')-\pi$, where θ' is the personal tax rate of those who hold debt, and not necessarily equal to θ. Equation (2) becomes:

$$(4) \quad \rho = [b(1-\theta)+(1-b)(1-c)]^{-1}\{[bi_N(1-\tau)(\frac{1-\theta}{1-\theta'})+(1-b)e_N]+\pi[b(\frac{1-\theta}{1-\theta'})(\theta'-\tau)+(1-b)c]\}$$

For given underlying real rates of return e_N and i_N, inflation influences the real cost of funds ρ in three ways, depicted in the term multiplying π in (4). First, corporations can deduct at rate τ the inflation premium component of the nominal interest rate; second, bondholders must pay tax at rate θ' on the same amount. Thus, for i_N given, debt becomes cheaper to the firm as inflation increases if $\tau>\theta'$, and more expensive if $\tau<\theta'$. Although τ is directly observable, θ' is not, because individual tax rates differ; estimates of θ' vary considerably. From a comparison of returns on tax-exempt and taxable long-term debt, Roger Gordon and Burton Malkiel estimate θ' to have been approximately 22.5 percent in 1978. Using flow of funds data to identify holders of debt and calculate θ' directly, Martin Feldstein and Lawrence Summers arrive at a value of 42 percent for 1977. It is thus unclear to what extent inflation reduces the effective tax rate on debt, if at all, though it seems likely that no appreciable additional tax burden is introduced.

The final influence of inflation on ρ is through the taxation of nominal rather than real capital gains. Here, there is no question about the direction of the effect; for e_N given, equity becomes more expensive. Estimates of c, like those of θ', are not very accurate, though c may very well be under 10 percent, as suggested by Martin Bailey. (Remember that c is the accrual-equivalent of the tax rate on realizations.) Thus, for given values of e_N and i_N, the likely effect of inflation is to make debt a cheaper source of finance, and equity more expensive, encouraging greater use of the former. Of course, the general equilibrium effect of inflation on b is more complicated, for it must also depend on the behavior of e_N and i_N.

C. Choice of Asset Life

Assuming the choice of asset durability to be among values of δ in the "normal" range where the optimal holding period T is infinite, the cost of capital for given b and δ may be written more simply as

$$(5) \qquad c = \frac{q(\delta)(\rho+\delta)}{(1-\tau)} (1-\tau z) = q(\delta) \left[\frac{\rho}{1-\tau} + \delta + \frac{\tau\pi z}{1-\tau}\right]$$

Expression (5) shows that the user cost per dollar of capital consists of three terms: the gross of tax real firm discount rate, the rate of asset decay, and the rate of decline due to inflation in the value of the nominally denominated "asset" representing the present value of the stream of depreciation allowances.

Perhaps a commonly-held belief is that this "inflation tax" on depreciation allowances weighs more heavily on longer-lived assets which have to wait longer to collect their depreciation allowances. This view is incorrect (author, 1979a). For any given value of ρ, the required internal rate of return before taxes on an asset of type δ is

$$(6) \qquad \nu(\delta) = \frac{c(\delta)}{q(\delta)} - \delta = (\rho+\tau\pi z) \; / \; (1-\tau)$$

It is evident that while inflation raises this rate for all values of δ, the rate of change increases monotonically with δ; the size of the inflation tax declines with asset durability.

It is important to realize that just as the increase in the tax burden on equity relative to debt does not <u>necessarily</u> imply that inflation will lead to increased leverage in a full general equilibrium model, the heavier rate of tax on short-lived assets needn't imply that a smaller value of δ will result from inflation. The ultimate answer depends on the behavior of the real after-tax return ρ. If ρ is fixed, there are two offsetting effects which determine the optimal δ. The relatively higher tax rate on short-lived assets will favor the choice of a small value of δ. However, the general increase in all tax rates, with the resulting higher before-tax rate of return, favors the choice of short-lived assets with large values of δ. As has been pointed out by Richard Kopcke, the total effect on the choice of δ is ambiguous, as can be seen from considering the effect of π on the cost of capital. On the other hand, if ρ decreases with the increase in inflation, as Patric Hendershott has suggested, this second effect favoring short-lived investment is lessened.

D. Investment Scale

The scale of investment depends on the cost of capital. If we hold constant the underlying rates of return to investors, e_N and i_N, and the other decision variables of the firm, b, δ and T, then the likely effect of inflation, as discussed by Feldstein and Summers, will be an increase in user cost and a drag on investment. The effect on ρ will be ambiguous but small relative to the increase in the inflation tax on depreciation allowances. For example, for representative values of the relevant parameters (θ=.4, θ'=.3, τ=.46, c=.1, T=∞, b=.3, δ=.1, ρ=.04 and π=.06) an increase in the rate of inflation of $\Delta\pi$ raises ρ by .036$\Delta\pi$, while $\tau\pi z$ increases by .161$\Delta\pi$.

However two important qualifications are necessary. First, if the real after-tax rates of return e_N and i_N fall as a result of inflation, as some theory and evidence suggests, ρ will increase less (or decrease more) and so will user cost, than has been proposed. Moreover, to the extent that firms can alter their debt-equity ratio and choice of asset durability, this must also diminish the increase in user cost. The answer to how inflation affects the scale of investment thus depends in part on a number of empirical magnitudes about which more information should be acquired.

Appendix - The Firm's Optimizing Behavior

We assume the firm produces output with the concave production function F(K), where K is the capital stock on hand. The firm seeks to maximize the wealth of its owners as represented by the present value of net cash flows, discounted at the equity rate e. As demonstrated in an earlier paper (author, 1979b), this is equivalent to choosing b to minimize ρ (as presented in equation (2) in the text), and then maximizing the present value, calculated with discount rate $\rho+\pi$, of flows to the firm before interest payments and debt issues. Letting I_t be the physical investment in capital at time t, this present value is:

$$\text{(A1)}\quad v = \int_o^\infty e^{-(\rho+\pi)t}\,[(1-\tau)e^{\pi t}F\,(\int_{-\infty}^t I_s e^{-\delta(t-s)}ds) - e^{\pi t}q(\delta)I_t(1-x)]dt$$

where x is the present value of depreciation allowances times τ plus turnover tax payments per dollar of investment. If each asset is turned over every T years, the present value of depreciation deductions it receives per initial dollar is

$$\text{(A2)}\quad \int_o^T e^{-(\rho+\pi)t}\delta e^{-\delta t}dt + e^{-\rho T}\int_T^{2T} e^{-(\rho+\pi)(t-T)}\delta e^{-\delta t}dt + \ldots = z\left(\frac{1-e^{-(\rho+\pi+\delta)T}}{1-e^{-(\rho+\delta)T}}\right)$$

which exceeds z because of the step-up in basis every T years. The present value of turnover tax payments is

$$\text{(A3)}\quad \gamma[e^{-\rho T}e^{-\delta T}(1-e^{-\pi T}) + e^{-2\rho T}e^{-2\delta T}(1-e^{-\pi T}) + \ldots] = \gamma\left(\frac{e^{-(\rho+\delta)T}}{1-e^{-(\rho+\delta)T}}\right)(1-e^{-\pi T})$$

Combining (A2) and (A3) yields

$$\text{(A4)}\quad x = \tau z + (\tau z-\gamma)(1-e^{-\pi T})\left(\frac{e-(\rho+\delta)T}{1-e^{-(\rho+\delta)T}}\right)$$

Insertion of this value of x into (A1) and differentiating v with respect to I_t yields the requirement that the marginal product of capital F' equals c, as represented in equation (1) in the text. Differentiation of v with respect to δ and T yields the conditions that $\frac{\partial c}{\partial \delta}$ and $\frac{\partial c}{\partial T}$ should equal zero.

REFERENCES

Alan J. Auerbach, "Inflation and the Choice of Asset Life," J. Polit. Econ., June 1979, 87, 621-638.

___________, "Wealth Maximization and the Cost of Capital," Quart. J. Econ, August 1979, 93, 434-446.

Martin J. Bailey, "Capital Gains and Income Taxation," in A.C. Harberger and M.J. Bailey, eds., The Taxation of Income from Capital, Washington 1969, 11-49.

Martin Feldstein and Lawrence Summers, "Inflation and the Taxation of Capital Income in the Corporate Sector," Nat. Tax J., December 1979, 32, 445-470.

Roger H. Gordon and Burton G. Malkiel, "Taxation and Corporation Finance," Princeton U. Financial Research Center Memorandum no. 31, Princeton 1980.

Patric H. Hendershott, "The Decline in Aggregate Share Values: Inflation, Taxation, Risk and Profitability," paper presented at NBER Conference on Taxation, November 1979.

Richard W. Kopcke, "Inflation, Corporate Income Taxation, and the Demand for Capital Assets," J. Polit. Econ., forthcoming.