THE JOURNAL OF FINANCE • VOL. XXXV, NO. 1 • MARCH 1980

A Note on Inflation, Taxation and Investment Returns

STEPHEN M. CROSS*

I. Introduction

TAXES AFFECT CAPITAL BUDGETING under inflation in many ways. This note focuses on two of the most important—depreciation deductions and interest deductions. Because depreciation for tax purposes is based on historical costs rather than current values, investments in depreciable assets become less attractive under inflation. Because debtors can deduct nominal interest payments, not just real interest charges, debt-financed investments become more attractive under inflation. The impact of inflation and taxes on the value of potential investment projects depends on which factor dominates.

In a recent paper in this journal, Gandolfi [1] argued that the existence of a tax on corporate profits will not alter the real rate of return on the firm's marginal investment. In a subsequent paper, Jaffe [2] exposed Gandolfi's error in ignoring the tax subsidy to debt-financed investments. Both authors assumed that the firm's investment takes the form of a non-depreciating machine—a special case, as Jaffe notes, among an infinite number of possible depreciation schedules. An extension of Jaffe's analysis to handle alternative depreciable lives confirms his assertion that investments which would be marginal in a world without taxes can become profitable in a world with taxes. However, the cutoff rate of return exceeds the rate calculated by Jaffe whenever the machines have finite lives. Moreover, in the limiting case of an asset which has a single period life, the required rate of return will be unaffected by a tax on profits.[1]

The section which follows introduces a depreciable asset into Jaffe's analysis; quantitative results of the impact of inflation and taxes on the firm's cutoff rate of return are calculated. Section three summarizes the main conclusions from the analysis.

II. Investment in a Depreciable Asset

Consistent with the work of Gandolfi and Jaffe it will be assumed that in the absence of taxes the firm sets the real rate of return on the marginal investment equal to the real rate of interest, r_b. The relationship is characterized by

$$MP_k/P_k = r_b$$

* Department of Economics, College of the Holy Cross. This paper stems from the author's research as a graduate student at the University of Virginia. The author wishes to thank Roger Sherman, John Pettengill, Tom Glaessner, and an anonymous referee for their helpful comments on earlier drafts. The author remains responsible for all remaining errors.

[1] Ironically, Gandolfi's conclusions hold during inflation in the special case of a single period machine rather than in the other extreme of a non-depreciating machine.

where

MP_k = the marginal real product of capital equipment.

P_k = the real price of the capital equipment.

P_k and r_b are assumed to remain constant over time. The rate of inflation is π per period and is perfectly anticipated by all transactors.[2] As a result, the nominal interest rate, i, can be well approximated as:

$$i = r_b + \pi + r_b\pi.$$

Corporate taxes are levied at the rate of λ on income calculated in accordance with generally accepted accounting principles. For the purpose of this paper, two tax deductions are relevant. Allowances for the depreciation of capital goods are tax deductible based on the acquisition cost of equipment. It is assumed that for tax purposes equipment is depreciated on a straight-line basis. In addition, nominal interest costs are fully tax deductible.

Suppose machinery purchased for one dollar at date 0 is financed entirely by debt. In the steady state, as productive capacity deteriorates at the rate of $1/a$ per period (where $a \geq 1$ represents the depreciable life of capital equipment) the firm will pay $(1/a)(1 + \pi)^t$ dollars for the replacement of machinery worn out during period t. As the firm replaces exhausted capacity in each period, tax depreciation in period t will total

$$(1/a^2) \sum_{i=1}^{a} (1 + \pi)^{t-i}$$

dollars.

In equilibrium, the net contribution of the marginal investment to the value of the firm, dV, must equal zero. Introducing a depreciable asset into the analysis, Jaffe's equation (9′G) therefore becomes

$$dV = \sum_{t=1}^{\infty} \left[\frac{(1-\lambda)(1+\pi)^t\left(\dfrac{MP_k}{P_k}\right) - (1-\lambda)i - \lambda\left(\dfrac{1}{a}(1+\pi)^t - \dfrac{1}{a^2}\left(\sum_{i=1}^{a}(1+\pi)^{t-i}\right)\right)}{(1 + i(1-\lambda))^t} \right] = 0. \quad (1)$$

On the right hand side, each term represents a discounted future cash flow. By assuming (as Jaffe does) that the personal tax rate equals the corporate tax rate of λ, the after-tax discount rate equals $(1 + i(1 - \lambda))$. The first term measures the after-tax return from the investment. The second term represents net interest costs. The third term equals the additional tax burden stemming from the underdepreciation of capital equipment due to historical cost accounting.

Simplifying equation (1),[3]

[2] The price of all goods rise at the uniform rate of π per period. Relative price changes are also ruled out.

[3] $\sum_{i=1}^{a} (1 + \pi)^{-i}$ is a convergent geometric series and equals $\left[\dfrac{1 - \left(\dfrac{1}{1+\pi}\right)^a}{1 - \dfrac{1}{1+\pi}}\right]$

$$dV = \frac{(1-\lambda)(1+\pi)\left(\dfrac{MP_k}{P_k}\right)}{i(1-\lambda)-\pi} - 1 \qquad - \frac{\dfrac{\lambda}{a^2}(1+\pi)\left[a - \dfrac{1}{1+\pi}\left[\dfrac{1-\left(\dfrac{1}{1+\pi}\right)^a}{1-\left(\dfrac{1}{1+\pi}\right)}\right]\right]}{i(1-\lambda)-\pi} = 0. \quad (2)$$

Solving for the return on the marginal dollar of investment,

$$\frac{MP_k}{P_k} = \frac{1}{1+\pi}\left[\left(i - \frac{\pi}{1-\lambda}\right) + \frac{\lambda}{a^2(1-\lambda)}\left(\frac{1+(a\pi-1)(1+\pi)^a}{\pi(1+\pi)^{a-1}}\right)\right]. \quad (3)$$

If machinery has a useful life of only one year, $a = 1$. In that case, (3) reduces to

$$\frac{MP_k}{P_k} = \frac{1}{1+\pi}(i-\pi) = r_b$$

indicating that the real return on the firm's marginal investment will equal r_b even in the presence of corporate taxes—a result radically different from Jaffe's but readily explained. The tax subsidy on interest deductions which Jaffe recognized is exactly offset by underdepreciation of machinery which he ignored. In the limit, as $a \to \infty$, the second term on the right hand side of (3) approaches zero and (3) reduces to

$$\frac{MP_k}{P_k} = \frac{1}{1+\pi}\left(i - \frac{\pi}{1-\lambda}\right), \quad (4)$$

which is Jaffe's result for a non-depreciating asset.

In the normal case, $a > 1$ but finite. In such a case, (3) exceeds (4) because[4]

$$\frac{1+(a\pi-1)(1+\pi)^a}{\pi(1+\pi)^{a-1}} > 0.$$

In other words, the cutoff rate of return is greater if machinery is depreciable than when it is not. The understatement of true depreciation only partially offsets the overstatement of interest costs.

Although the current tax system does subsidize debt-financed investments during periods of inflation, the effect is mitigated, at least in part, by depreciation deductions insufficient to replace worn out capital equipment.

III. Conclusion

The limited objective of this paper is to broaden the scope of Jaffe's conclusions about the effect of inflation and taxes on the real rate of return from a firm's

[4] $\dfrac{1+(a\pi-1)(1+\pi)^a}{\pi(1+\pi)^{a-1}} = a(1+\pi) - \sum_{j=0}^{a-1}(1+\pi)^{-j}$ which is positive at positive rates of inflation.

marginal investment, where the marginal dollar of investment is financed by debt. It has been found that in the special case of assets which last only one production period, the cutoff rate of return is unaffected by inflation and taxes. When machinery lasts more than one period, the rate of return required from the marginal dollar of investment declines. In general, however, the magnitude of this decrease is less than that calculated by Jaffe for the special case of a non-depreciating machine.

REFERENCES

1. A. E. Gandolfi. "Taxation and the 'Fisher Effect.'" *Journal of Finance* (December, 1976).
2. J. J. Jaffe. "A Note on Taxation and Investment." *Journal of Finance* (December, 1978).