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Taxes and the Fisher Effect: A Clarifying Analysis

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ABSTRACT

Supply and demand functions for loanable funds are postulated for a no-inflation economy and equilibrium levels of saving, investment, and the interest rate are specified. Certainty and nondepreciating assets are assumed. An exogenous inflation rate is imposed upon this same economy and new equilibrium values for these same variables are established. The analysis is performed twice. The first time, a Modigliani-Miller [17] tax structure is assumed while the second analysis assumes a Miller-Scholes [15] tax structure. In both cases, inflation causes the nominal rate to increase by more than the inflation rate. The analysis is repeated assuming that investments live for one period and are then written off against taxable income at historical cost.In both tax structures, the level of saving and investment is a decreasing function of the inflation rate.

THE IMPACT OF INFLATION upon certain economic variables such as aggregate savings and investment and interest rates has been a topic of great interest not only in the recent finance literature but to the general public. Most researchers agree that with perfect markets, inflation should not change any of the *real* economic variables. However, one major imperfection that must be included in the analysis is the existence of taxes. An imperfectly indexed tax system may cause inflation to affect real economic variables. In this paper, a model is constructed to assess the impact of taxes and inflation upon the interest rate, aggregate saving, and aggregate investment.

Feldstein, Green, and Sheshinski [7] analyze the relationship between the inflation rate and rates of return on debt and equity securities assuming a uniform personal tax rate on both interest and dividend income, a uniform tax rate on inflation-induced capital gains, and a corporate tax on after-interest income. They assume that the weighted average cost of capital (WACC) is a convex function of the debt to equity ratio and that firms make their financing decisions to minimize the WACC. These assumptions are not consistent with modern capital structure theory. If debt and dividend income are taxed identically at the personal level, the tax deductibility of interest at the corporate level makes debt the preferred financing tool. In contrast to the work of Feldstein, Green, and Sheshinski [7], a series of articles in this journal by Gandolfi [9], Jaffe [11], and Cross [3] begins by *assuming* a particular relationship between the nominal interest rate and the inflation rate. Specifically, they assume the nominal rate equals the real marginal rate of return on investment in the absence of taxes plus the inflation rate. With this assumption, a tax structure similar to that assumed by Feldstein, Green, and

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Sheshinski [7], and assuming nondepreciating machines, the economy's level of saving and investment is shown to be an increasing function of the inflation rate. The analysis of Gandolfi [9], Jaffee [11], and Cross [3] lacks behavioral content in that their results follow directly from their assumed relationship between the nominal rate and the inflation rate.

The U.S. Tax code is so complex that simplifying assumptions are required to analyze its effects. Two different simplifications of the tax code are common in the corporate finance literature. The Modigliani and Miller [MM] tax system assumes no personal tax biases so that for a given individual, the personal tax rate on equity income and the personal tax rate on interest income are equal. Modigliani and Miller [17] proved that with this personal tax system, the tax deductibility of interest at the corporate level makes debt the preferred method of financing. The Miller and Scholes [MS] tax system assumes that equity income is not taxed at the personal level while interest income is taxed at the recipient's marginal tax rate. Although dividends are ostensibly taxed as ordinary income at the personal level, Miller and Scholes [15] argue that investors can legally avoid tax on dividends and reduce the tax rate on equity income to (almost) zero. Miller [14] has shown that the MS tax system implies that shareholders are indifferent as to the choice between debt and equity finance.[1]

In this paper, supply and demand functions for loanable funds are postulated for a no-inflation economy and equilibrium levels of saving, investment, and the interest rate are specified. Then an exogenous inflation rate is imposed upon this same economy and new equilibrium values for these same variables are established.[2] The analysis is performed assuming both an MM tax structure and an MS tax structure. Although other papers have appeared addressing the interactive effects of taxes and inflation, this paper is distinguished from them because it allows for possibly different tax rates for different individuals and incorporates modern capital structure theory.

I. The Model

There are N savers ordered according to their personal tax rates. For each individual, saving is a strictly increasing function of the real aftertax rate of return so that

$$S_j = f(r_j) \quad \frac{df}{dr_j} > 0$$

where r_j is the saver's real aftertax rate of return.[3] Total saving for the economy

[1] The empirical evidence on the Miller-Scholes position is mixed. If the tax rate on equity income is zero percent, dividend policy should be irrelevant. If dividends are taxed at a higher rate than capital gains, high-dividend-payout firms must offer a higher pretax return to compensate for their tax disadvantage. The Black and Scholes [1] study indicates that pretax rate of return is not dependent upon payout ratio whereas the Litzenberger and Ramaswamy [12] study concludes that high-payout shares do offer higher pretax returns.

[2] This approach is used to avoid any needless discussions as to the correct definition of "the real interest rate." In this paper, no mention is made of the real rate.

[3] The effect of an increase in the real interest rate is the sum of a substitution and an income effect. The price of future consumption relative to current consumption is lower and wealth (the present value of future income) is also lower. We assume that the substitution effect dominates the income effect implying that savings is an increasing function of the real rate for each consumer.

is denoted by S and

$$S = \sum_{j=1}^{N} S_j$$

Note that S cannot be specified as a function of a single real aftertax rate of return since tax rates vary across savers. All investment proposals are for nondepreciating assets yielding level perpetuities in real terms.[4] Aggregate investment is assumed to be a strictly decreasing function of the required return on investment:

$$I = g(k) \quad \frac{dI}{dk} < 0$$

where I is aggregate investment and k is the hurdle rate. It is assumed that any capital gain on the investment good is untaxed and that no aftertax cash flow is retained by the firm.

II. The Analysis

Case 1: The personal tax rate on dividend income equals the personal tax rate on debt income for each saver.

Let r be the equilibrium corporate bond rate in a no-inflation economy. In the absence of personal tax biases, after-corporate-tax income is valued independently of its classification as debt or equity income so that the corporate bond rate (r) should be used to discount *all* after-corporate-tax cash flows.

Consider an investment of \$1 offering a perpetual return of \$$M$. If this investment were financed with equity capital, its net present value would be

$$NPV = \sum_{t=1}^{\infty} \frac{M(1 - T_c)}{(1 + r)^t} - 1$$

However, in view of the corporate income tax deduction for interest and the lack of tax biases at the personal level, equity financing is always inferior to debt financing and the net present value formulation must be adjusted by adding the present value of the tax deductions on interest payments. There are two widely-recognized methods for adjusting the net present value formulation so that the benefits of debt financing (in an MM tax world) are recognized. The direct approach is to explicitly itemize each annual tax savings from interest payments and then discount these tax savings at the prevailing interest rate.[5] An alternative is to discount the investment opportunity's unlevered cash flow (i.e. the cash flow provided in the absence of debt financing) at the rate $r(1 - T_c)$.[6] Since all projects would be debt financed in the absence of personal tax biases, the net present

[4] The tax implications of existing depreciation tax laws have been developed elsewhere. See Nelson [20].

[5] The direct approach of explicitly specifying the interest tax savings and discounting them at the firm's cost of debt is called the adjusted present value (APV) method and was developed by Myers [18]. A textbook discussion of APV can be found in Brealey and Myers [2].

[6] A proof that discounting the unlevered cash flows at $r(1 - T_c)$ will correctly adjust for the tax advantage of debt financing in the absence of personal tax biases is developed by Myers, Dill, and Bautista [19].

value formulation can be written as

$$NPV = \sum_{t=1}^{\infty} \frac{M(1 - T_c)}{(1 + r(1 - T_c))^t} - 1$$

Let M^0 be the rate of return on the marginal investment when the inflation rate is equal to zero. Then

$$NPV = \sum_{t=1}^{\infty} \frac{M^0(1 - T_c)}{[1 + r(1 - T_c)]^t} - 1 = 0 \tag{1}$$

Solving Equation (1) for M^0 yields

$$M^0 = r \tag{2}$$

so that the marginal pretax return on investment equals the equilibrium corporate bond rate.

Let M^π represent the real return on the last dollar of investment in the same economy when the inflation rate is π, and let i denote the nominal corporate bond rate. Then

$$NPV = \sum_{t=1}^{\infty} \frac{M^\pi(1 - T_c)(1 + \pi)^j}{[1 + i(1 - T_c)]^t} - 1 = 0 \tag{3}$$

or solving for M^π,

$$M^\pi = \frac{i(1 - T_c) - \pi}{(1 + \pi)(1 - T_c)} \tag{4}$$

Equation (4) specifies the real marginal pretax return on investment in the with-inflation economy.

Define the nominal interest rate $i^c(\pi)$ by

$$i^c(\pi) = r + \pi r + \frac{\pi}{1 - T_c} \tag{5}$$

Then it follows from Equation (4) that if $i = i^c(\pi)$,

$$M^\pi = r$$

or, recalling Equation (2),

$$M^\pi = M^0 \tag{6}$$

Equation (6) says that the dollar of investment which was at the investment margin in the no-inflationary economy is still at the investment margin with an exogenous inflation rate of π provided the nominal rate is given by $i^c(\pi)$. Therefore, if $i = i^c(\pi)$, aggregate investment is not altered by the inflation.

The assumption that $i = i^c(\pi)$ will be satisfied only if $i^c(\pi)$ is such that aggregate savings are independent of the rate of inflation. Otherwise, savings will not equal investment when there is inflation.

The aftertax real return for the j^{th} saver when the inflation rate is π is

$$r_j^\pi = \frac{i(1 - \lambda_j) - \pi}{1 + \pi} \tag{7}$$

where λ_j is the saver's personal tax rate. Equation (7) says each saver receives a nominal interest payment of i per dollar invested and this return is fully taxed at the rate of λ_j. Then π dollars is subtracted and set aside to preserve the purchasing power of the original investment of one dollar. The remainder is divided by $1 + \pi$ to convert next years payoff to current dollars.

Assume initially that all savers have the same personal tax rate of λ(i.e. $\lambda_j = \lambda$ for $1 \leq j \leq N$). This assumption has been widely used in the literature and its implications should be scrutinized.[7] Define $i^\lambda(\pi)$ by

$$i^\lambda(\pi) = r + \pi r + \frac{\pi}{1-\lambda} \tag{8}$$

If $i = i^\lambda(\pi)$, it follows from Equations (7) and (8) that

$$r_j^\pi = r(1-\lambda) \ \forall j \tag{9}$$

so that the real aftertax return to savers in the with-inflation economy is the same as their aftertax return in the no-inflation economy. Therefore, the aggregate level of savings remains unchanged with inflation *if* the nominal interest rate varies with inflation according to (8).

The following statements should now be obvious for the special case of a uniform tax rate:

(1) The nominal rate i will be between the values specified in Equations (5) and (8). If $\lambda > T_c$, $i^\lambda(\pi) > i > i^c(\pi)$ while if $\lambda < T_c$, $i^\lambda(\pi) < i < i^c(\pi)$.

Proof: If $\lambda > T_c$ and $i = i^\lambda(\pi)$, then savers would supply the same quantity of funds that they were willing to supply in the no-inflation economy. However, $\lambda > T_c$ implies $i^\lambda(\pi) > i^c(\pi)$ so that $i = i^\lambda(\pi)$ would cause firms to want to invest less than in the no-inflation economy. Remember that $i = i^c(\pi)$ brought the same demand for investment funds as with no-inflation so that $i = i^\lambda(\pi)$ must bring a smaller demand. If $i = i^\lambda(\pi)$, supply of funds exceeds demand and i must fall. If $i = i^c(\pi)$ similar reasoning indicates that i must rise. Therefore, i must be between $i^c(\pi)$ and $i^\lambda(\pi)$. The same kind of argument applies when $\lambda < T_c$.

(2) If $\lambda > T_c$, the level of savings and investment is smaller in the with-inflation economy than in the no-inflation economy.[8]

Proof: From above, since $\lambda > T_c$, $i^\lambda(\pi) > i > i^c(\pi)$. Since $i^\lambda(\pi) > i$, we have less saving and $i > i^c(\pi)$ means less investment.

(3) If $\lambda < T_c$, the level of savings and investment is larger in the with-inflation economy than in the no-inflation economy.

Proof: Similar to Statement 2 above.

(4) If $\lambda = T_c$, the level of savings in the no-inflation economy is the same as the level of savings in the with-inflation economy.

Proof: Obvious.

[7] Gandolfi [9], Jaffe [11], and Cross [3] published a sequence of articles in this journal assuming this same tax scenario. However, their results are contraindicated by the analysis provided here.

[8] This result refutes Jaffe's claim that inflation stimulates debt-financed investment due to the tax-deductibility of the entire nominal interest payment. See Jaffe [11]. Cross [9] builds upon Jaffe's work.

For the more general case, assume $\lambda_i \leq \lambda_j$ for $i < j$. As shown previously, Equation (7) specifies the real aftertax return for the j^{th} saver. Suppose the nominal rate is as shown in Equation (5). This value for the nominal rate maintains investment in the with-inflation economy at the same level as in the no-inflation economy. Substituting the right-hand side of (5) for i in Equation (7) yields

$$r_j^{\pi} = r(1 - \lambda_j) + \left(\frac{\pi}{1 + \pi}\right)\left(\frac{T_c - \lambda_j}{1 - T_c}\right) \tag{10}$$

Equation (10) shows that a single corporate bond rate cannot provide each saver with the same real aftertax return in the with-inflation economy as in the no-inflation economy when the personal tax rates are nonuniform. For investors with personal tax rates higher than T_c, the nominal interest rate $i^c(\pi)$ leads to a lower real aftertax return than these investors would receive in the no-inflation economy. Therefore, investors having $\lambda_j > T_c$ would reduce their aggregate saving. Similarly, investors having $\lambda_j < T_c$ would be willing to save more given the nominal rate $i^c(\pi)$. If the reduction in savings by the one group is *exactly* offset by the increased savings of the other group, then $i^c(\pi)$is the equilibrating rate and the level of savings and investment is the same in the with-inflation economy as in the no-inflation economy. Any deviation of actual nominal rates from $i^c(\pi)$ depends upon the quantifiable issues relating to the elasticities of the supply and demand functions for loanable funds and is best left to empirical analysis.

Case 2: The j^{th} saver pays tax at the rate of λ_j on interest income but pays no tax on equity income.

Given the tax deductibility of corporate interest payments, the net present value of a perpetual bond issue of one dollar in the no-inflation economy is

$$NPV = 1 - \frac{r_b(1 - T_c)}{r_e}$$

where r_b is now the bond rate and r_e is the discount rate applicable to equity cash flows. The aftertax interest payments are discounted at r_e since they would have accrued to the shareholders *tax-free*. With personal tax biases, debt-related cash flows are valued differently from equity-related cash flows.

For debt and equity to be equally attractive alternatives, the NPV of debt issues must be zero. Setting the above NPV specification equal to zero implies

$$r_e = r_b(1 - T_c) \tag{11}$$

This equilibrium relationship for the tax scenario in Case 2 was first derived by Miller [13]. In the with-inflation economy,

$$i_e = i_b(1 - T_c) \tag{12}$$

where i_e is the nominal pretax return on equity and i_b is the nominal pretax return on debt.

In Case 2 where certainty is assumed, each saver with a tax rate less than T_c will invest in bonds while savers with tax rates greater than T_c will invest in equity. Given the equilibrium relationship shown above between r_e and r_b, the choice between investing in equity and debt is similar to the choice between municipal and corporate debt.

The net present value of an equity-financed investment of $1 in the no-inflation economy is

$$NPV = \sum_{t=1}^{\infty} \frac{(M)(1 - T_c)}{(1 + r_e)^t} - 1 \tag{13}$$

whereas if all-debt financing is employed

$$NPV = \sum_{t=1}^{\infty} \frac{(M)(1 - T_c)}{[1 + r_b(1 - T_c)]^t} - 1 \tag{14}$$

Since r_e equals $r_b(1 - T_c)$, net present value is the same with all-debt financing as with all-equity financing.

For the marginal one dollar investment in the no-inflation economy,

$$NPV = \sum_{t=1}^{\infty} \frac{M^0(1 - T_c)}{(1 + r_b(1 - T_c))^t} - 1 = 0$$

or

$$M^0 = r_b \tag{15}$$

no matter how the investment is financed. The use of $r_b(1 - T_c)$ as a discount factor here need not imply all-debt financing. Since $r_b(1 - T_c) = r_e$ (see Equation (11), either $r_b(1 - T_c)$, r_e, or some weighted average of the two could be used to compute present values regardless of the desired financing plan.

In the with-inflation economy, the marginal one dollar of investment satisfies

$$NPV = \sum_{t=1}^{\infty} \frac{M^\pi(1 - T_c)(1 + \pi)^t}{[1 + i_b(1 - T_c)]^t} - 1 = 0$$

or

$$M^\pi = \frac{i_b(1 - T_c) - \pi}{(1 - T_c)(1 + \pi)} \tag{16}$$

Here, discounting is performed at the aftertax nominal corporate bond rate of $i_b(1 - T_c)$. The nominal required rate of return on equity is $i_b(1 - T_c)$. Just as in Case 1, the nominal rate which keeps investment in the with-inflation economy at the same level as in the no-inflation economy can be specified as

$$i^c(\pi) = r_b + \pi r_b + \frac{\pi}{(1 - T_c)} \tag{17}$$

If $i_b = i^c(\pi)$, savers with tax rates greater than T_c have the same real aftertax return in the with-inflation economy as in the no-inflation economy. To see this, note that these savers will prefer to invest in equity (which is tax-free) so that their real after-tax return is

$$r_j^\pi = \frac{i_e - \pi}{1 + \pi}$$

Equation (12) says $i_e = i_b(1 - T_c)$ and substituting this value for i_e in the proceeding equation yields

$$r_j^\pi = \frac{i_b(1 - T_c) - \pi}{(1 + \pi)}$$

If $i_b = i^c(\pi)$, then substitution of the right-hand side of (17) for i_b above yields

$$r_j^\pi = r_b(1 - T_c) \tag{18}$$

Equation (18) shows that the real (aftertax) return on equity in the with-inflation economy is the same as in the no-inflation economy. Therefore, each saver with a tax rate greater than T_c is willing to supply the same quanity of savings in the with-inflation economy as in the no-inflation economy provided the nominal rate is $i^c(\pi)$.

The rate specified in (17) maintains the same level of investment in the with-inflation economy as in the no-inflation economy. That rate also causes equity investors to supply the same quantity of savings in both economies. If the rate in (17) causes the "low-tax-rate" bondholders to supply the same quantity of funds in both economies, then it is the equilibrating rate. It should be obvious, however, that the rate in (17) causes bondholders to supply more funds in the with-inflation economy than in the no-inflation economy.

If $\lambda_j < T_c$, the j^{th} saver's real after-tax return is

$$r_j^\pi = \frac{i_b(1 - \lambda_j) - \pi}{1 + \pi}$$

or, substituting the right-hand side of (17) for i_b,

$$r_j^\pi = r_b(1 - \lambda_j) + \left(\frac{\pi}{1 + \pi}\right)\left[\frac{T_c - \lambda_j}{1 - T_c}\right] \tag{19}$$

Equation (19) shows that bondholders (i.e. savers with a tax rate less than T_c) will find their real aftertax return increased if $i_b = i^c(\pi)$. These bondholders will want to supply *more* savings in the with-inflation economy than they were willing to supply in the no-inflation economy. Since equity savers supply the same quantity of funds and firms demand the same quantity of funds, supply exceeds demand and the rate specified in (17) is "too high."

The lower bound to i_b is

$$i^L(\pi) = r_b + \pi r_b + \pi \tag{20}$$

Clearly, the rate specified in (20) is too low. With $i_b = i^L(\pi)$, investment is higher and savings (for every saver with a positive personal tax rate) will be lower in the with-inflation economy than in the no-inflation economy. Consequently,

$$i^L(\pi) < i_b < i^c(\pi)$$

where $i^c(\pi)$ and $i^L(\pi)$ are the rates specified in (17) and (20) respectively.

III. The Analysis Assuming Single Period Investments and Historical Cost Depreciation

A crucial element in both cases is that the capital investment yields a perpetuity and is never subject to depreciation. Here, we consider the polar case of a capital good which lives for one period and is then fully written off against taxable income at historical cost. Let M^0 be the return on the last dollar invested in the no-inflation economy. The end-of-period cash flow from that investment is $1 + M^0$ before taxes and

$$NPV = \frac{(1 + M^0)(1 - T_c) + T_c}{1 + r_b(1 - T_c)} - 1 = 0$$

Solving for M^0 yields

$$M^0 = r_b$$

In the with-inflation economy, the last dollar of investment satisfies

$$NPV = \frac{(1 + M^\pi)(1 + \pi)(1 - T_c) + T_c}{1 + i_b(1 - T_c)} - 1 = 0$$

or, solving for M^π,

$$M^\pi = \frac{i_b - \pi}{1 + \pi} \tag{21}$$

Suppose for the moment that

$$i_b = r_b + \pi r_b + \pi \tag{22}$$

Then M^π equals M^0 and the nominal rate in Equation (22) will cause the level of investment in the with-inflation economy to equal the level of investment in the no-inflation economy. The rate specified in Equation (22) will provide every investor with a lower aftertax real return than was available in the no-inflation economy so it cannot be the equilibrium rate. Desired investment exceeds savings implying the rate specified by (22) is a lower bound. The upper bound in an MM tax system is

$$i_b = r_b^{NI} + \pi r_b^{NI} + \frac{\pi}{1 - \lambda_N}$$

where λ_N is the highest personal tax rate in the economy and the upper bound in an MS tax system is

$$i_b = r_b^{NI} + \pi r_b^{NI} + \frac{\pi}{1 - T_c}$$

In either tax system, the level of investment is diminished by inflation when historical cost depreciation is assumed.

IV. Summary

This paper analyzes the interaction of taxes and inflation in both a Modigliani-Miller world and a Miller-Scholes world. Both tax structures permit nonuniform personal tax rates. The special case of an MM tax system and a uniform personal tax rate was examined here only to clarify previous articles appearing in the *Journal of Finance*. Specifically, Jaffe [11] concluded that a uniform personal tax rate and an MM tax structure imply that the economy's level of investment is an increasing function of the inflation rate. Cross [3] builds upon Jaffe's work.

However, the analysis in this paper shows that investment is an increasing function of the inflation rate only when the (uniform) personal tax rate is less than the corporate tax rate. It is shown here that if the personal tax rate exceeds the corporate tax rate, then investment is a *decreasing* function of the inflation rate. This paper generalizes previous work dealing with the interaction of taxes and inflation by permitting a nonuniform personal tax structure. For the nonuniform personal tax system, the relationship between the level of investment and the inflation rate cannot be determined, a priori, assuming an MM tax structure.

The analysis employing the Miller-Scholes tax structure permitted both debt and equity finance. Here, the results were unambiguous when abstracting from the impact of depreciation tax laws. Investment is shown to be an increasing function of the inflation rate. When we assume capital goods live for one period and are then fully written off against taxable income at historical cost, investment is shown to be a decreasing function of the inflation rate under both tax structures. Clearly, the tax systems employed in this paper lie at the extremes with respect to the issue of personal tax biases and improvements in "tax-system-modeling" should be the goal of future research in this area.

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