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THE IMPACT OF LEVERAGE AND TAX POLICY ON VALUE UNDER CONDITIONS OF ANTICIPATED INFLATION

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I. Introduction

The recent round of double digit inflation has been accompanied by increased research on the effects of inflation on the value of real and financial assets. Much of this research is empirical in nature, investigating the relationship between realized inflation and realized returns on financial assets (e.g. Bodie [1976], and Fama and Schwert [1977]). In trying to explain the empirical results, some researchers have concentrated on inflation's impact on the real interest rate (e.g. Chen and Boness [1975], Feldstein [1976], and Levi and Makin [1979]), while others have looked into the way in which inflation impacts on a firm's cash flow. It is this last line of research that interests us.

The procedures firms use to evaluate their investments need to be revised under conditions of anticipated inflation. Van Horne [1971] reintroduced some well established adjustments that must be made in the capital budgeting process when facing inflation. Cooley, Roenfeldt, and Chew [1975] investigated in more detail the effect of inflation on capital budgeting procedures. Nelson [1976] established analytically that, under certain assumptions, the magnitude of a given firm's investment in plant and equipment would be reduced in the face of anticipated inflation. Nelson's analysis was performed under the "uniform sensitivity" assumption; that is, the prices of all the real factors of production and of all real output inflate at the same rate. Kim [1979] relaxes the assumption of uniform sensitivity and concludes that the effect of a general inflation on a firm's investment activity depends on the specific sensitivity of that firm's cash flow to the general inflation.

All of these authors writing on inflation and capital budgeting emphasize the importance of the tax treatment of depreciation. Nelson's establishment of an inverse relationship between inflation and capital investment is derived from the fact that depreciation for tax purposes is not indexed to inflation; "...after-tax present values are not neutral with respect to different rates of inflation because depreciation charges are based on historical costs.... One of the strongest arguments for indexing of accounting costs would be the elimination of such distortions."[1] Kim also makes specific reference to decreasing investment under inflation due to historical depreciation charges.[2] The purpose of this paper is to extend the analysis of the relationship between a firm's investment level and inflation to include consideration of the firm's leverage position and of its investors' personal taxes. We find that inflation's effect on a firm's investment level is more complex than has been suggested and that indexing depreciation charges for tax purposes will not remedy the situation. In Section II we introduce the project valuation model that is most convenient for our purposes. Given that model, Section III establishes the investment level-inflation relationship in the absence of personal taxes. Section IV introduces personal taxes, and Section V summarizes our findings.

II. Project Valuation Model

A. General Project Valuation

The basic procedure followed in the most relevant research mentioned above is to investigate the effect that anticipated inflation has on the computed value of a project or portfolio of projects. Value is measured in the usual way by discounting the project's after-tax operating cash flows at the appropriate cost of capital. For example[3]

$$V = \frac{X(1-t_c) + t_c D}{1 + c} \tag{1}$$

where V = value of the project to be compared to the project's cost, C, in order to make the investment decision,

X = increase in the firm's net operating income occasioned by investing in the project,

t_c = corporate tax rate,

D = depreciation writeoff of the project for tax purposes, and

c = appropriate cost of capital.

As is well known, if c is correctly computed, $V - C$ measures the increase in stockholders' wealth which will result from accepting the project. Although this is an operationally convenient approach for measuring wealth effects, there is a more direct approach which will simplify our discussion. In the more direct approach, the change in stockholder wealth is computed by discounting changes in the after-tax (corporate and personal) cash flows to the stockholders at their appropriate after-personal tax-discount rate.

The first step in formulating this model is to define the flow of cash to the stockholders before personal taxes are paid as

$$X(1-t_c) + t_c D - I(1-t_c) - R \tag{2}$$

where I = interest payment on debt that was issued to finance the project, and

R = repayment of debt that was issued to finance the project.

Ignoring personal taxes, cash flow to the stockholders is the project's after-corporate-tax operating cash flow, $X(1-t_c) + t_c D$, less the after-corporate-tax interest payment on debt, $I(1-t_c)$, and less the repayment of debt capital, R. However, the stockholders must pay taxes on all of this, except for the return of any capital they provided to finance the project. If we let S be the amount of equity used to finance the project, then stockholder taxes would be

$$t_e[X(1-t_c) + t_cD - I(1-t_c) - R - S] \tag{3}$$

where t_e = stockholders' personal tax rate.[4] Combining equations (2) and (3) and discounting at the stockholders' after-personal-tax required rate k', the value of a project to the stockholders becomes

$$V_S = \frac{[X(1-t_c) + t_cD - I(1-t_c) - R][1 - t_e] + t_eS}{1 + k'} \tag{4}$$

For any specific project, the value of equation (4) is computed and compared to S, the stockholders' investment in the project. Although equation (4) may be unfamiliar, intuitively its application is quite straight forward. As can be seen from the example in Table 1, the numerator of equation (4) is simply the after-personal-tax cash flow to the stockholders. Discounting this

Table 1

An Application of Equation 4

Assumptions:	X = \$2,500	R = \$500
	t_c = 0.50	S = \$500
	C = \$1,000	t_e = 0.28
	I = \$50	Project Life = 1 year

Operating Cash Flows	\$2,500
Less Depreciation	-1,000
EBIT	\$1,500
Less Interest	- 50
EBT	\$1,450
Less Taxes	- 725
Net Income	\$ 725
Plus Depreciation	+1,000
After-Corporate-Tax Cash Flow	\$1,725
Less Debt Repayment	- 500
Cash Flow Available to Stockholder	\$1,225
Less Equity Repayment	- 500
Taxable Income to Stockholder	\$ 725
Less Stockholder Taxes	- 203
After-Personal-Tax Income	\$ 522
Plus Equity Repayment	+ 500
After-Personal-Tax Stockholder Cash Flow	\$1,022

Numerator of Equation (4)

$$= [X(1-t_c) + t_cD - I(1-t_c) - R][1-t_e] + t_eS$$

$$= [2,500(1-.5) + .5(1,000) - 50(1-.5) - 500][1-.28] + .28(500)$$

$$= \$1,022$$

amount at the after-personal-tax rate required by stockholders yields the value of the project to the stockholders. Comparing this to their investment, S, determines whether stockholder wealth would increase or decrease by investing in the project.

B. Specifying Required Rates

In order to complete the valuation model, the interest variable needs to be specified more completely so that its level can be formulated under conditions of inflation. If B is the amount of debt issued to finance the project, then I = iB where i is the rate required on debt capital. The level of i is set by the market as a function of risk and personal taxes;

$$i = \frac{i'}{(1-t_i)} \tag{5}$$

where i' = the lenders' after-personal-tax required rate, and

t_i = lenders' personal tax rate.

If the lenders are to receive an after-personal-tax rate commensurate with the risk they are facing, and if that rate is i', then they must charge the borrower at the rate i.

The level of i as specified in equation (5) ignores expected inflation. If the real rate of interest is unaffected by anticipated inflation,[5] then according to the traditional Fisher hypothesis

$$i = \frac{i'}{(1-t_i)}(1+p) \tag{6}$$

where p is the expected annual rate of inflation. In the spirit of Nelson [1976] and of Kim [1979] we can use equation (6),[6] as far as it goes. Unfortunately, equation (6), like most specifications of the Fisher hypothesis, ignores the complete impact of personal taxes.[7] If an amount equal to B is loaned to the firm, then in the face of anticipated inflation equal to p, the lenders will want B(1+p) returned. The pB term compensates for the loss of the purchasing power of B. Given conventional loan contracts in which the repayment of principle is set at B, the lenders must raise their interest rate in order to maintain the principal's purchasing power at B. This is a well-known requirement, and, in order to include it, the Fisher hypothesis is often written as

$$1 + i = \left[1 + \frac{i'}{1 - t_i}\right][1 + p],$$

or as

$$i = \frac{i'}{1 - t_i}(1+p) + p. \tag{7}$$

However, because the maintainence of the purchasing power of B is accomplished by an increase in the interest rate charged by the lenders, and because the resulting interest is taxable to the lenders, they need to charge $pB/(1-t_i)$, not pB. Therefore, a modified Fisher hypothesis, one which includes consideration of personal taxes, is that

$$i = \frac{i'(1+p) + p}{(1-t_i)}. \tag{8}$$

In other words, if a lender of $1,000 wants a three percent real return after personal taxes (i'=0.03), and if the lender faces a 28 percent tax rate (t_i=0.28) and expected inflation of five percent (p=0.05), the borrower must pay an 11.3 percent interest rate (i=.113). Of the $113 interest payment, $31.50 would be paid by the lender in taxes, leaving $81.50. Of this amount, $50 keeps the real value of the $1,000 principle repayment, in the face of five percent inflation, at $1,000. The remaining $31.50 yields the three percent real rate required by the lender.

Equation (8) represents the market interest rate on debt, i, as a function of the underlying rate determined by risk, i', the personal tax rate of the lender, t_i, and the expected rate of inflation, p. Since I in equation (4) is set at iB, equation (8) can be substituted into equation (4). There is another required rate in equation (4), k'; however, since k' is already an after-personal-tax rate, no further specification of it is necessary. In other words, k' is to the stockholders what i' is to the lenders--their after-personal-tax required rates.

III. Inflation and Project Value: The No Personal-Tax Case

A. The No Inflation Standard

In this section we want to determine how project value (as measured by the model developed in the previous section) is affected by inflation. In order to accomplish this we first need to specify its value in the absence of inflation as the standard of comparison. In addition to no inflation, we assume in this section that there are no personal taxes; i.e. $t_i = t_e = 0$. This assumption will enable us to most directly compare our results to those of earlier papers since they also ignored personal taxes (e.g. Nelson [1976] and Kim [1979]).

We start by substituting iB into equation (4), where i is set as in equation (8), and B, the debt issued to finance the asset, is set in relation to the project's cost (B=bC). Therefore, the project's value becomes[8]

$$V_s = \frac{X(1-t_c) + t_c D - bC(1+i'(1-t_c))}{1 + k'}. \tag{9}$$

As with Nelson, Kim, and others, our concern is with what happens to V_s as inflation becomes anticipated. We follow the usual assumption that an inflation equal to p sets in <u>after</u> we've invested C dollars in the project. Since our major interest centers on the impact of leverage and personal taxes, we abstract from the differential effects of inflation by imposing the "uniform sensitivity" assumption. Our conclusions could be generalized by additions from Kim's work.

B. Project Value Under Inflation

Under the assumption of uniform sensitivity and an inflation rate of p, the expected operating cash flows after corporate taxes become $X(1+p)(1-t_c)$. Under current accounting rules, the depreciation tax reduction remains at t_cD. The subtraction for principal repayment and interest becomes $bC[1 + (i'(1+p)+p)(1-t_c)]$. Putting these all together with an inflated discount rate of $k'(1+p) + p$, we find that

$$V_s^* = \frac{X(1+p)(1-t_c) + t_cD - bC[1 + (i'(1+p)+p)(1-t_c)]}{1 + k'(1+p) + p} \tag{10}$$

where V_s^* is the value of the project to the stockholders under conditions of a uniformly sensitive expected inflation rate of p percent annually. Simplifying this we find that

$$V_s^* = \frac{[X(1-t_c) + t_cD - bC(1+i'(1-t_c))][1 + p] + pt_c(bC) - pt_cD}{(1+k')(1+p)}$$

$$V_s^* = V_s + \frac{pt_c(bC-D)}{(1+k')(1+p)} . \tag{11}$$

As long as $bC - D \neq 0$, $V_s^* \neq V_s$. Project value, in other words, is indeed affected by inflation as long as $bC - D \neq 0$. The pt_cD term in equation (10) corresponds to Nelson's finding that project value is negatively affected by inflation because of original cost depreciation rules. According to Nelson and others, pt_cD represents the amount of the overpayment of taxes caused by not indexing depreciation charges to inflation. As far as that analysis goes, it is quite correct; however, once the impact of financial leverage is included, there is an at least partial offset equal to $pt_c(bC)$. Before comparing the two terms, let's first explain what $pt_c(bC)$ relates to.

The term bC represents the amount of debt issued to finance the project. Multiplying that amount by p gives us that part of the interest payment

: represents the lenders' attempt to maintain the real value of the principal the loan. If bC is lent and the inflation is p, then bC + p(bC) must be ɔovered. The bC amount is recovered through the principal repayment, and bC) is recovered through an increase in the interest rate (see equation (8) ith t_i=0). In this sense p(bC) can be referred to as the inflated principal epayment. Because the lender receives the inflated principal repayment as part of the interest payment, an additional part (relative to the no inflation case) of the firm's cash flow is shielded from corporate taxes. In fact, $t_c p(bC)$ represents the corporate tax reduction caused by the increase in the interest payment due to the inflated principal repayment.

Given these interpretations, we can now return to equation (11) to compare V_s^* to V_s. Inflation causes a decrease in project value ($V_s^* < V_s$) as long as the increased tax shield from the inflated principal repayment is less than the overpayment of taxes caused by original cost depreciation rules. Because of our assumption of a one year project life, D = C. Therefore, in general $V_s^* \leq V$ as $b \leq 1.0$. Thus Nelson's negative relation between inflation and project value remains intact unless the project is completely debt financed. On the other hand, the magnitude of the reduction in project value caused by inflation is not as great as Nelson and others have suggested, unless no debt is used to finance the project (b=0).

Perhaps more important is the fact that, contrary to some claims, indexing depreciation costs to inflation will not result in $V_s^* = V_s$. In order to see this, replace $t_c D$ in equation (10) with $t_c D(1+p)$, the replacement cost depreciation tax shield. Carrying this through to equation (11) results in

$$V_s^* = V_s + \frac{pt_c(bC)}{(1+k')(1+p)} \tag{11a}$$

In other words, unless only equity is used to finance the project, value would increase with expected inflation ($V_s^* > V_s$) if we followed the common recommendation of indexing depreciation charges to inflation.

In the presence of financial leverage and the absence of personal taxes, the impact of inflation on project value is not as perverse as has been previously indicated, and inflation would have a positive impact if replacement cost depreciation was adopted for tax purposes. In the next section, we extend our analysis to include personal taxes.

IV. Inflation and Project Value: With Personal Taxes

A. The No Inflation Standard

As in the case with no personal taxes, the first step in our analysis is to establish project value in the absence of expected inflation. This then serves as the standard of comparison. The process is identical to that in the previous section, except that now we let t_e and t_i be greater than zero. Substitute iB into equation (4), the general model of project value. Set i according to the adjusted Fisher equation, equation (8), and let B equal bC. The result, after some rearranging, is

$$V_s = \frac{X(1-t_c)(1-t_e) + t_c D(1-t_e) + t_e S - bC(1+i'(1-t_c)/(1-t_i))(1-t_e)}{(1+k')} \quad (12)$$

Although this formulation of value looks quite complex, it has a rather straight forward interpretation. The first term in the numerator represents the project's operating cash flow after corporate taxes and after personal taxes. The second term is the after-personal-tax value of the depreciation corporate-tax shield. The third term represents the "equity capital repayment" personal-tax shield. The final term subtracts the after-personal-tax value of the debt repayment and the after-corporate-tax interest payment. The sum of these four terms, all discounted at the stockholders' after-personal-tax discount rate represents the value of the project when there is no expected inflation.

B. Project Value Under Inflation

Under the assumptions of an expected inflation rate of p and uniform sensitivity, the expected operating cash flow after all taxes is $X(1+p)(1-t_c)(1-t_e)$. Under current accounting rules, the after-personal-tax value of the depreciation corporate-tax shield remains at $t_c D(1-t_e)$. Even with expected inflation, the "equity capital repayment" personal-tax shield also stays at its no inflation value, $t_e S$. However, using equation (8) for setting i results in a new value of the last term in equation (12) when there is expected inflation. It becomes $-bC[1 + (i'(1+p)+p)(1-t_c)/(1-t_i)][1-t_e]$. Finally the discount rate under conditions of inflation becomes $k'(1+p) + p$. After putting all these formulations together and rearranging, we find that, when including the impact of personal taxes

$$V_s^* = V_s + \frac{p(bC)(1-t_e)(t_c-t_i)/(1-t_i) - pDt_c(1-t_e) - pSt_e}{(1+k')(1+p)} . \qquad (13)$$

The impact of expected inflation on project value depends on the sign of the numerator in the second term. If it's positive, expected inflation increases value; if it's negative, expected inflation decreases value. Before investigating the sign of this set of terms, we should understand what each of terms represents.

The first term is rather complex. However, one clue to its interpretation is that it becomes zero when no debt is used to finance the project (i.e. when b=0). Another clue is that when $t_i = t_e = 0$, it becomes $pt_c(bC)$, which we've already interpreted. It follows that the first term in the numerator of equation (13) represents the after-personal-tax value of the corporate tax reduction caused by the increase in the interest payment due to the inflated principal repayment.

The $pDt_c(1-t_e)$ term in equation (13) represents the after-personal-tax value of the overpayment of corporate taxes caused by the use of original cost depreciation. This is the after-personal-tax version of negative impact on value isolated by Nelson.

The pSt_e term in equation (13) is the overpayment of personal taxes due to the tax provision that protects from personal taxes a capital repayment to equity of only the amount contributed, S, even if an additional pS needs to be returned in order to maintain the real value of S.

Is V_s^* less than or greater than V_s? For a given value of V_s, the no-inflation project value increases as more leverage is used.[9] However, even with all debt financing (i.e. b=1.0 and S=0), equation (13) reduces to show that $V_s^* < V_s$ as long as $t_c < 1.0$. So Nelson's claim that expected inflation reduces project value remains intact, even with the advantages of leverage, as long as consideration is given to personal taxes. However, the magnitude of reduction in project value depends on how much leverage is used to finance the project.

Another way to show that the nature of inflation's effect on project values is more complex than it was previously thought to be is to investigate $V_s^* - V_s$ under the assumption that depreciation is indexed to inflation. If this much recommended procedure were implemented, V_s^* would become

$$V_s^* = V_s + \frac{p(bC)(1-t_e)(t_c-t_i)/(1-t_i) - pSt_e}{(1+k')(1+p)} . \tag{13a}$$

In such a case, it is clear that inflation decreases value (i.e. indexing depreciation charges does not neutralize inflation's effect on value) if the project is all equity financed. In other words, $V_s^* < V_s$ if b = 0 and S = C. Just as clearly, however, inflation increases value (i.e. indexing depreciation charges overcompensates for inflation's effect on value) if the project is all debt financed. In other words, $V_s^* > V_s$ if b = 1.0 and S = 0. Replacement cost depreciation, or the indexing of depreciation charges to inflation, neutralizes the impact of inflation on project value only by accident.

V. Summary

In this paper we have investigated the relationship between changes in the expected level of inflation and changes in the value of the portfolio of capital expenditures a firm faces. Our research is an extension of previous research on this question in that we specifically allow for the impact of financial leverage and personal taxes. We do not consider the case of differential inflation effects.

Previous research has shown that because depreciation charges are based on original costs, inflation reduces the value of a given project. Initially we ignored personal taxes, and concluded that the use of financial leverage reduces the negative impact inflation has on project value. This is because of an additional tax shield provided by debt under conditions of expected inflation. We also showed that allowing depreciation charges to be based on replacement costs would actually result in inflation increasing project value.

Finally, we allowed personal taxes and the results are mixed. Under our current tax system, inflation does indeed reduce project value, but not by as much as previously thought. However, a switch to replacement cost depreciation would neutralize the impact of inflation on project value only as a special case.

Footnotes

1. Nelson [1976], p. 923 and p. 931.

2. Kim [1979], p. 941.

3. Nelson [1976] and Kim [1979] both concentrated on models which assumed the project had a one year life. This simplifies the model development without loss of insight. We will follow that approach in this paper.

4. In this paper we are abstracting from any differences between normal income tax rates and capital gain tax rates.

5. We follow the assumption in most of this literature by abstracting from shifts in the real rate.

6. In other words for purposes of our analysis, we, like Nelson [1976] and Kim [1979] are willing to assume that real rates are unaffected by expected inflation. For an excellent discussion of the possible effect of uncertain inflation on the real rate, see Levi and Makin [1979].

7. For a more detailed presentation, which supports our position, see Feldstein [1976].

8. Remember that $t_i = t_e = 0$, $p = 0$, and that $R = B = bC$ (because of the assumption that the project has a one year life).

9. The first term in the numerator of equation (13) increases with leverage and the last term decreases.

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