

THE IMPACT OF INFLATION ON CAPITAL BUDGETING AND WORKING CAPITAL

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INTRODUCTION

A major impact on both financial theory and the practice of financial decision making has been the economic instability, especially in prices, evidenced in the U.S. economy since the mid 1960's. Inflation in the past few years has not been a major macro economic problem, but its spectere, as demonstrated by the Fed's recent increases in interest rates, is never for the agendas of financial decision makers. Macro economic instability has necessitated that expectations about the future rate of inflation be taken into consideration in making decision(s) about which capital projects will be undertaken by a firm. Nominal cash flows determine its degree of profitability. However, in making the capital budgeting decision both real and nominal concepts must be considered. The purpose of this paper is to continue the discussion of the role of inflation in capital budgeting, and to focus on the individual components of the process to draw specific conclusions with respect to the interaction between the cost of capital, inflation, and the cash flow variables within a DCF - IRR framework.

Much research has been published examining the impact of inflation on the capital budgeting decision making process, and, although inflation is not currently a serious problem, bitter lessons from the 1975-1985 period of rapid price increases, coupled with the potential of future inflation, argue for continued research in this field. In a famous article, Rappaport and Taggart [14] examined various methods for incorporating the effect of inflation into capital budgeting. They provided an analysis which showed the differential impact of using a gross profit per unit approach, a nominal cash flow approach (where individual forecasts are incorporated into each component of cash flow) and a real cash flow approach in which a general price deflator is used to deflate nominal cash flows.

In another early article dealing with the subject, Van Horne [16] showed that to be consistent, inflation in forecasting cash flows must also be reflected in a discount rate containing inflation; that is, a bias was introduced if nominal cash flows were discounted at the real and not nominal cost of capital. Cooley, Roenfeldt and Chew revealed the mechanics by which inflation adjustments can be incorporated into the capital budgeting process [6]. At the same time, Nelson [12] demonstrated the theoretical impact of inflation on capital budgeting and showed how inflation would shift the entire NPV schedule of a capital budget downward for a set or projects. Bailey and Jensen [1] have analyzed how price level adjustments affect the process in detail and specifically how various price level adjustments might change the ranking of projects.

Rappaport and Taggart attempt to combine the simplicity of a gross profit per unit methodology of adjusting for inflation with the more realistic nominal case flow and real cash flow approaches. A gross profit per unit focus on Revenues - Cost of Sales divided by units, and can treat inflation by simply inflating this gross profit per unit as opposed to measuring inflation for both revenues and cost of sales. This is done by making the simplifying assumption that gross margin as a percent of sales is constant over time, [14, p. 12] which they point out is the same as assuming that EBIT is a constant percentage of sales over time, or that revenues and costs increase at the same rate.

In this paper we examine a number of issues raised by Rappaport and Taggart in the area of inflation and capital spending. Specifically, we will analyze the following areas:

1. What is the relationship between the cost of capital and inflation?
2. What is the relationship between inflation in the aggregate and the price a firm places on its specific product

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that results from a capital budgeting decision? Assuming costs rise at the aggregate or average rate of inflation, what can we say about expectations of the price of output of the firm?

3. What role do depreciable and non-depreciable assets play in the interaction of the variables? How does the presence of plant and equipment as a depreciable asset and the presence of net working capital as a non-depreciable asset impact on the role of inflation in the capital budgeting process?

THE COST OF CAPITAL AND INFLATION

Towards the end of their article, Bailey and Jensen¹ state: "It has been argued that the market rate of interest already embodies the price level effect and that the rate will be *unique* (emphasis theirs). But it is far from clear that extant techniques provide a unique measure of that rate. In any case, this paper does not require the resolution of these issues. It merely argues that the presence of general price level changes impacts on the evaluation of investment proposals." [1, pp. 30-31].

This statement in itself is unusual, since the argument that nominal rates of interest, and hence the nominal cost of capital, contain an inflation premium dates back to the Fisher Effect and is generally accepted. As Van Horne has shown, nominal cash flows must be treated with nominal costs of capital or else a bias is introduced into the procedure. Since the discount rate is a major determinant of the investment decision, its relationship to inflation is of more than just passing interest in determining the overall impact of inflation on capital spending.

The specific relationship between inflation and the cost of capital is still in the process of being firmly established, and in the absence of a full model to explain this relationship, this section will focus on the interconnections between changes in inflation and subsequent changes in interest rates. Specifically, we will deal with the distinction between nominal and real interest rates, the relationship between inflation and movements of interest rates and the relationship between the rate of interest and the cost of capital.

In a non-inflationary world, funds loaned at a rate of interest return at a rate equal to the stated or nominal rate of interest. If inflation is introduced into the system, the return as nominally stated will be different from the real return, as the future cash flows have a lower purchasing power. It is debatable whether or not the interest rate will rise exactly in an amount necessary to offset inflation, and arguments on each side have been summarized by Bernstein [2], but what is clear that introducing inflation places upward pressure on interest rates. The reasons for this are that (1) borrowers will increase their demand for funds during the inflation to provide for higher transaction costs and to move from financial assets to non-financial assets as a hedge against inflation, and (2) regulatory authorities will move to reduce the rate of growth of the supply of funds as an inflation fighting policy tool.

The difference between the nominal rate and the real rate has been dubbed an "inflation premium" and while many texts present the premium as an addition to the real rate of interest, [9, pp. 76-77] for example, such as:

Equation 1

$$i = k + p$$

where:

i = the current stated, or nominal rate of interest

k = the real rate of interest

p = the rate of inflation

The actual relationship is multiplicative and not additive. This can be shown if we take a given cash flow and inflate it to some period "t" in the future:

Equation 2

$$C^* = C(1 + p)^t$$

where:

C^* = the nominal or inflated cash flow

t = the time period relative to the base year

and then compute the present value of C^* using the nominal rate of interest from equation (1), we have the following:

Equation 3

$$PV = C^*/(1 + i)^t$$

We could accomplish the same effect by deflating C^* using the price index, and then discounting using the real rate of interest: This would give:

Equation 4

$$PV = (C^*/(1 + p)^t)/(1 + k)^t$$

Since equations (3) and (4) both furnish the same results, they can be set equal to one another thus:

Equation 5

$$\frac{C^*/(1 + p)^t}{(1 + k)^t} = \frac{C^*}{(1 + i)^t}$$

which requires that:

Equation 6

$$(1 + p)^t(1 + k)^t = (1 + i)^t$$

and thus the multiplicative relationship. The additive formulation is a reasonable first approximation, but should not be used in actual capital budgeting cases as it would introduce upward bias.

The relationship between the rate of interest and inflation in the real world is much more difficult to explain than the theoretical relationship described above. Experience shows that deflating any series of interest rates over time by any popular price index does not yield relatively constant real rates of interest. However, this should not be interpreted as telling us that the current rate of interest is properly adjusted for the actual rate of inflation, but only that it will contain some expected rate of inflation. Furthermore, the ability of accurately forecast the rate of inflation is very rare.

Table 1 shows the nominal and real rates of interest on long term corporate AAA securities.

TABLE 1
The Real Rate Of Interest As Deflated By The CPI

Year	AAA Rate	CPI Change	Real Rate	Year	AAA Rate	CPI Change	Real Rate
1976	8.42	3.7	4.72	1985	11.37	3.8	7.57
1977	8.02	6.9	1.12	1986	9.02	1.1	7.92
1978	8.73	9.0	-.27	1987	9.38	4.4	4.98
1979	9.63	13.3	-3.67	1988	9.71	4.4	5.31
1980	11.94	12.5	-.56	1989	9.26	4.6	4.66
1981	14.71	8.9	5.81	1990	9.32	6.1	3.22
1982	13.79	3.8	9.99	1991	8.77	3.1	5.67
1983	12.04	3.8	8.24	1992	8.14	2.9	5.24
1984	12.71	3.9	8.81	1993	7.22	2.7	4.52

Source: "Economic Indicators" Joint Economic Committee, July, 1982, pp. 13, 24; May 1990 pp. 24, 30; March 1994 pp. 26, 30.

As can be seen from Table 1, one cannot expect to compute the real rates of interest on an ex post basis by deflating the nominal rate of interest by a price index. However, this does not mean that one cannot use the current rate of interest as an ex ante measure of the real rate plus expected rate of inflation. The ex post analysis will fail because current inflation rates are not necessarily the expected future rate and because monetary policy may well distort interest rates for a short period of time.

Generally accepted economic theory supports the conclusion that the rate of interest should move in the same direction as the expected rate of inflation. A pure quantity theory of money approach would argue for almost exact movement. Under the loanable funds theory, the demand for money should increase because of (1) increased transactions demand and (2) increased precautionary demand while the supply of loanable funds would decrease as surplus spending units reduced their excess balances. Both these actions would force up the cost of money.

Under the liquidity preference theory, the demand for funds would increase for the above reason, and for the reason that investors would expect a fall in bond prices as a result of the inflation and would thus tend to want to hold money balances. Theory would then predict rising interest rates as the expectation of higher inflation occurred. On any type of expectations theory approach, the rate of interest should increase with an increase in the expected rate of inflation.

The empirical evidence with respect to whether or not interest rates would perfectly reflect expected inflation is strong but also controversial. Fama⁶ demonstrates that short term rates accurately reflect the expectations of future rates of inflation [7], but his methodology and conclusions have been disputed by several rebuttals, [5, 8, 13]. Cagan and Goldolfi have achieved similar results for long term rates [4], although they argue the results might not be applicable to short term rates.

Finally, the question arises as to the movement of the cost of capital when inflation occurs. We have shown that it is reasonable to expect that the rate of interest will increase when there are expectations of higher inflation, but there appears to be little evidence on the measurement of the cost of capital under inflationary expectations. This is understandable, given the difficulty in just measuring the cost of capital in a static sense.

Our assumption in the following analysis that the cost of capital on an ex ante basis increases with the same proportion as the expected rate of inflation; that is, the same mechanism which causes interest rates to rise during inflation will also cause the cost of capital to rise. Furthermore, those who provide equity capital are likely to behave in the same manner as those who provide debt capital.

Short term phenomena may prevent the cost of capital from behaving precisely in this fashion. One action may be for business to alter capital structure, moving towards greater amounts of debt and thus lowering the after tax cost of capital. However, these corrections are not long term and in the case of rising debt costs should have little impact on the overall movement of the cost of capital from rising proportionately with expected inflation, but this too should not prevent a long term assumption that cost of capital does increase when the expected rate of inflation increases.

INFLATION AND PRODUCT PRICING IN CAPITAL BUDGETING

At this stage we introduce the problem of inflation into the capital budgeting process to determine specifically its impact on a number of financial variables. Let:

Equation 7

$$R_i = PQ$$

where:

R_i = Revenue in Period i

P = average price per product over the period

q = annual quantity sold of the product

Assume that quantity is constant over time, and that P is the constant price in the absence of any inflation. Our costs are designated as C_i and are cash costs only, so that total costs are $C_i + D_i$, where D_i is the depreciation charge during period i .

In traditional capital budgeting theory, the equilibrium position will be such that the firm will continue to invest up to the point where marginal costs equal marginal revenues, or where:

Equation 8

$$I_0 + WC_0 = \frac{(R_i - C_i)(1-t)}{(1+r)_i} + \frac{D_i t}{(1+r)^i} + \frac{WC_0}{(1+r)^n}$$

where:

- I_0 = the original investment in depreciable plant and equipment
- WC_0 = the net working capital required for the project
- t = the marginal tax rate
- r = the firm's real cost of capital

The term WC_0 is not defined in the traditional sense of net working capital being current assets minus current liabilities. Current liabilities in the accounting sense contain short term debt. For capital budgeting decisions net working capital must be defined as current assets minus nondebt current liabilities, for only in that definition does it represent the amount of financing that must come from traditional sources of debt and equity.

This type of investment in net working capital is important in understanding the dynamics of capital budgeting because it represents a non-depreciable asset. The cost to the firm is the time value of money, and it is salvaged at the end of the period as represented by the last term in equation (8). It is, as we shall see, a vitally important concept when inflation is introduced into the process.

If we introduce inflation here, and assume that the cost of capital perfectly reflects the inflation assumption, as do revenues and costs, equation (8) becomes as follows:

Equation 9

$$I_0 + WC_0 = \frac{(R_i - C_i)(1+f)^{i-1}(1-t)}{(1+r)^i(1+f)^{i-1}} + \frac{D_i t}{(1+r)^i(1+f)^{i-1}} + \frac{WC_1}{(1+r)^i(1+f)^{i-1}} + \frac{WC_0 + WC_i}{(1+r)^n(1+f)^{n-1}}$$

The appearance of the new term in equation (9), WC_i , represents the increase in net working capital each year as a result of the inflation. If current assets of a company are \$10 million, and current liabilities excluding debt are \$5 million, then a 10% increase in these prices will increase both current assets and current liabilities by 10%. Current assets would rise by \$1 million, but current liabilities would rise by only \$500,000, leaving, in this case, \$500,000 financed. This additional financing requirement must be included in the capital budgeting decision making process, or else the net cash flow and net present value are overstated. The additions to net working capital and the initial net working capital is recovered at the end of the projects, as shown in the last term.

An important result of comparing equation (9) with equation (8) is that with respect to the right hand side of equation (9), which represents the present value of the cash inflows after inflation, those values are less than the right side of equation (8). This is to say, inflation reduces the present value of the cash inflows from any given project. There are two reasons why this reduction in value takes place. The first is that the cash flow from depreciation is reduced on a present value basis, since the nominal cash flow from depreciation is unchanged while the discount rate rises due to the inflation. The second reason for the decline in the present value of the cash flows is the appearance of net working capital and its increased requirements during the life of the project. Although these outflows are recovered, the time value of money reduces the present value of the entire stream.

In effect, the introduction of inflation into equation (8) negates the analysis of Rappaport and Taggart in their conclusion in which they state that:

“a rule of thumb that may help to combine the administrative simplicity of the gross profit approach with the theoretical advantages of the nominal cash flow approach is to make the simplifying assumption, when appropriate, of a constant ratio of $R_i - C_i$ to R_i over time ... This is equivalent to assuming that revenues and costs increase at the same rate over time [14, p.12]

The impact of inflation as shown in equation (9) says that this is not likely to happen. Managers could only accept equal increases if they were willing to lower the amount of profit acceptable from a capital project. And at the margin, the introduction of inflation would cause the project to be rejected. Rappaport and Taggart do state that there is no requirement that this rate be the economy wide inflation rate, but for most firms one would expect that the rate to be reasonable approximation of the case for the cost side of the equation. Thus inflation of revenues must tend to be larger than inflation of costs if the NPV is to remain the same.

At this point consider the following example. In Table 2, data is given for two nearly identical projects, A and B, whose only difference is in the type of investment required. A requires \$200,000 and B requires \$200,000 but A's investment is in net working capital while B's is in depreciable plant and equipment.

TABLE 2
Summary Of Project Data

	Project A	Project B
Years	5	5
Tax Rate	.45	.45
Quantity	1000 units	1000 units
Cost Per Unit	\$250	\$250
Discount Rate	3%	3%
Inflation Rate	0	0
Investment In Net Working Capital	\$200,000	0
Investment In Plant & Equipment	0	\$200,000

If equation (8) is used to solve for the missing variable, the price of the project necessary to justify the undertaking of the investment, that is the price at which the NPV is zero, then for case A and B the price is as follows:

Case A: \$260.91

Case B: \$296.67

The higher price in Case B is the result of the fact that only 45% of investment costs are recovered through the tax shield from depreciation, whereas 100% of the net working capital is recovered. It is true that the depreciation is recovered faster, but at a low discount rate this faster recovery is not sufficient to overcome the loss of 55% of the initial investment on a cash basis.

The results above are for a world with zero inflation. If we introduce inflationary expectation of a steady rate, say 12% into the system, the results would be to increase both costs and the discount rate. If we assume that the relationship between inflation and the discount rate is as previously described, 12% inflation would produce a 15.36% discount rate. If we increase the product price by the amount of the expected rate of inflation, and test for NPV we find the following results:

NPV	
Case A	(\$101,637)
Case B	(\$ 33,302)

The substantially lower NPV for Case A reflects the problems caused by the presence of net working capital during periods of inflation. In this case the inflation causes an addition to the net working capital each year, and the additions are cash outflows which are not recovered until the end of the project. The cash opportunity cost is high, because the discount

rate is high which is elevated due to high inflation. In case 2, the only effect was to reduce the tax flow from the depreciation shield. Thus if prices only kept pace with inflation, both projects are unacceptable, but the project with the higher net working capital is more unacceptable.

The degree to which prices must increase to bring the investment back to an acceptable level can be computed. For each case the results are as follows:

	Case A	Case B
Price Increase Necessary To Product "0" Under 12% Inflation	22.3%	15.9%

Case A, with its net working capital, requires almost a doubling of the rate of cost inflation in order to keep the company's project profitability unchanged, while Case B requires only a slightly higher than inflation price increase.

IMPLICATION FOR CORPORATE PRICING AND INVESTMENT BEHAVIOR

The above analysis has significant implications for corporations, and these implications go beyond the capital budgeting decision. Certainly the capital budgeting decision itself is significantly affected by the existence of inflation and higher inflationary expectations, and of critical importance is that the capital budgeting decision is not neutral even if prices of output are expected to rise at the same rate as costs and the cost of capital. Specifically, the implications of an increase in the expected rate of inflation on the capital budgeting process and decision making is as follows:

1. Assuming the firm could not raise output prices above the general rate of inflation, the firm would have to accept lower NPV and hence lower profitability as measured by NPV. At the margin, the firm would have to forego investment projects unless output prices could be raised at a rate greater than the general expected rate of inflation. The exact amount which prices would have to be raised is dependent upon the degree of net working capital required relative to the overall level of investment.
2. A firm does have a number of ways in which it can respond to the problems created by inflation. There are three major areas that could be addressed in an attempt to offset the negative impact of rising price levels. One action would be to raise output prices above the level of inflation, but the ability of the firm to do so will be limited to the extent that the market will withstand the higher prices. Market structure will play an important role here, with the more oligopolistic firms enjoying greater success than the more competitive firms. However, in the long run, this will lead to high inflation and thus may be self-defeating. Unless other adjustments are made, the investment sector of the economy could under allocate resources to new investment projects.
3. Two internal adjustments that can be made are with respect to net working capital and the capital structure. As the previous analysis has shown, during inflation firms will be under pressure to reduce the amount of net working capital employed by decreasing inventory and receivables and extending payables. This reduces the exposure of capital requirements increasing during the inflation.

With respect to the discount rate, the major adjustment that a company can make is in its capital structure. The inflationary increase in the discount rate can be offset to some degree by increasing debt in the capital structure and lowering the weighted cost of capital. This action, however, is not available to all firms, only to those who begin the inflationary period with a relatively low amount of debt in the capital structure.

Due to the above, one would expect that the degree of leverage employed by firms increases during inflationary periods. Moreover, to the extent that this is "unplanned" debt, it is more likely a firm would finance this debt from short term rather than long term borrowings. As the inflation eased, the firm would find it much easier to return to a more normal capital structure by replacing short term debt with retained earnings. This would suggest that the demand for short term funds would rise rapidly during the periods of inflation, and this has certainly been the case in the most recent inflationary periods of 1973-74 and 1978-81.

SUMMARY AND CONCLUSIONS

This paper has explored the question of the impact of inflation on the capital budgeting process. It has shown that it is reasonable to expect that the cost of capital will increase at the same rate as the rate of inflation on an ex ante basis, and that this increase will be a multiplicative relationship.

In addition, the paper has shown that the capital budgeting process is not neutral with respect to inflation, even if output prices rise at the same rate as costs. Of critical importance is the degree of net working capital as a proportion of the overall financing required, the higher the net working capital the greater being the impact of inflation on capital spending.

Finally, it would appear that corporate financial behavior is influenced by inflation. Inflation will cause the firm to reduce its capital budget, to attempt to reduce net working capital, and to alter the debt/asset ratio using short term debt, thus driving up short term rates relative to long term rates.

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