Forthcoming: Financial Handbook
Fifth Edition

FINANCIAL MANAGEMENT IN AN INFLATIONARY ECONOMY

by

Moshe Ben-Horim

and

Haim Levy

Working Paper No. 8-80

RODNEY L. WHITE CENTER
FOR FINANCIAL RESEARCH

University of Pennsylvania

The Wharton School

Philadelphia, PA 19104

FINANCIAL MANAGEMENT IN AN INFLATIONARY ENVIRONMENT

CONTENTS

Page

INFLATION EXPERIENCE AND TAX LAW ADJUSTMENTS: AN INTERNATIONAL COMPARISON

One marked consequence of the energy crisis for western economies in recent years has been the high and often accelerating inflation rates. In the United States, the Consumer Price Index (CPI) rose by 13.3% in 1979, the highest increase in almost four decades. Furthermore, contrary to the traditional view, the rapid inflation was not accompanied by low unemployment and the period was characterized by simultaneous high inflation and high unemployment, a condition termed stagflation. Fig. 1 presents the annual inflation rates for the years 1961-79 in a number of countries. In the United States the average inflation rate was 3.1% p.a. in 1961-72, rising to 8.5% in 1972-79. The inflation rate was also higher in the second period in all the other countries except Brazil, which experienced high rates in the 1960s as well.

Inflation normally reduces investment profitability and often slows down investment. This is what happened in the 1970s, the result being stagflation. In an attempt to reactivate the economy and offset inflation losses to firms, some governments introduced investment incentives. For example, in the United States, firms may elect to use the LIFO method of inventory accounting, which relieves them of some of the tax on inflationary profits. Other incentives are accelerated depreciation, introduced by Eisenhower's administration, and the reduced assets lives system for tax purposes, introduced by the Kennedy and Nixon administrations. The investment tax credit introduced in 1962 is another important incentive. With the high inflation rates experienced in the last few years all of these combined do not always compensate the firm for the inflation loss.

In the United Kingdom, a 100% first-year depreciation of plant and equipment has been permitted since 1972. (See: David Hale, "Inflation

Accounting and Public Policy Around the World", Financial Analysts Journal, November/December 1978, pp. 28-40.) Another incentive was introduced in 1975 whereby the difference in the inventory value between the first and last days of the fiscal year is a deductible expense. Canada grants a relatively small tax relief. Firms are not permitted to adopt LIFO recording but an amount of 3% of the opening value of their inventory is a deductible expense. The LIFO method is also not permitted in Australia, where the depreciation code offers other significant investment incentives. The trading stock valuation adjustment (TSVA) allows as a deductible expense an amount equal to 50% of the difference between the opening value of the inventory and that value multiplied by the goods component of the Consumer Price Index. Brazil experienced an average inflation rate of 39.3% in 1961-79. Following the 1964 revolution, the government introduced indexation which applies to companies accounts, government bonds, bank deposits, rents, loans, etc. Firms' assets and depreciation are revalued each year using the wholesale price index.

While in most countries the governments have adopted tax laws amendments to compensate firms for inflation loss, it is safe to say that the incentives included in tax laws are generally insufficient when the price level changes as rapidly as it has been changing in the last few years in some western countries.

INFLATION AND THE FIRM'S FINANCIAL POSITION

In view of high and persistent inflation rates in recent years in the United States and elsewhere, it has become increasingly important to understand the implications of the changes in price levels for the relationships between the financial position of a firm as reflected in its financial statements and the firm's real financial position.

Perhaps a reasonable point of departure for making this distinction is the measurement of income. A firm's economic income is defined as the income that it can distribute during the period, so that at the end of the period it is left with sufficient physical assets to carry on the same level of activity as at the beginning of the period.

Corporate income as reported under generally accepted accounting practices (GAAP) usually deviates from economic income. In the absence of inflation, however, the two measures of income are quite closely related and income reported under GAAP gives a fair idea of both the trend of a firm's economic income and the way it compares with the economic income of other firms in the industry. The same holds for related measures such as earnings per share and the price-earnings ratio. Under inflation, however, the relationships between reported and economic measures are substantially distorted. In addition, because assets are recorded at historical cost, but revenues and expenses are recorded in current dollars, some of the financial ratios traditionally used to analyze a firm's financial position are affected by inflation and must consequently be very carefully analyzed[3] at periods of rapid price increase.

Inflation accounting has been debated for a number of years now, and, in its Statement No. 33, the Financial Accounting Standards Board (FASB) has recently taken action to compel large public companies (specifically, those with $1 billion of assets or $125 million of inventories and gross property) to report the effects of inflation on their financial statements.

The Board has decided to retain historical cost recording in the primary financial statements, but Statement No. 33 specifies requirements for supplementary information in annual reports which will reveal the effects of the changing price level. The new requirements are effective for accounting years ending after December 24, 1979, but companies may postpone disclosure of the current cost information for 1979 until their 1980 annual report. The Board requires companies to report the effect of inflation in two different ways: (a) using constant dollar accounting, and (b) on a current cost basis, a method that employs specific price changes for each asset.

Inflation accounting is at its experimental stage, and the bulk of financial reporting is still on a historical cost basis. Let us then examine the main problems and some consequences of the GAAP rules at times of inflation.

Inventory

The accounting treatment of inventories can affect the firm's reported earnings, tax bill, and cash position. The magnitude of the effect depends particularly on whether the firm uses the first-in-first-out (FIFO) or the last-in-first-out (LIFO) formula. To demonstrate this point in detail, consider a firm which has a revenue of $200 million and for simplicity assume that there are no costs or expenses except the cost of goods sold. Additional information about the firm is:

	Units (millions)	Cost per unit ($)
Inventory at the beginning of the year	100	1.0
Inventory bought during the year	100	1.5
Sales during the year	100	
Inventory at the end of the year	100	

The cost of goods sold is equal to

inventory at the beginning of the year + new purchase during the year - inventory at the end of the year;

it is therefore clear that the method by which we evaluate the end-of-year inventory affects the cost of goods sold. The tax and profit will be affected as follows:

	Millions of $	
	FIFO	LIFO
Revenue	200	200
Cost of goods sold	100	150
Net profit before tax	100	50
Tax (50%)[1]	50	25
Net profit after tax	50	25

Under FIFO, the units sold during the year are the ones bought by the firm at $1.0 each. Thus, the end-of-year inventory is $150 million (i.e. 100 million units at $1.5 each). Under LIFO, the units sold are those bought during the year at $1.5 so that the end of year inventory is $100 million (i.e. 100 million units at $1.0).

What are the implications for a firm of switching from FIFO to LIFO? As shown, the FIFO method allows the firm to show a higher profit than that shown by using LIFO ($50 million versus $25 million in our example). Thus switching will reduce reported earnings. Nonetheless, economic analysis reveals that switching from FIFO to LIFO is advantageous to the

---

[1] This tax rate is used for purposes of illustration. In practice it would be different.

firm. Recalling that the cash outlay for the materials purchased during the year was $150 million, the total cash flow under the two alternative methods is:

FIRM'S CASH FLOW

(in millions of dollars)

	FIFO	LIFO
Revenue	+200	+200
New purchases	-150	-150
Tax	- 50	- 25
Net cash flow	0	+ 25

Evidently, then, switching from FIFO to LIFO increases the net cash flow of the firm by $25 million because of the lower tax burden. Since the replacement cost of the 100 million inventory units sold during the year is $150 million, the firm's true pertax profit is $50 million no matter how the firm records the inventory. The LIFO procedure results in a tax bill of $25 million, or a 50% tax on real earnings, but, in this illustration, FIFO results in a tax bill of $50 million, or an effective tax rate of %100 (i.e., as a percentage of economic income). Despite the advantage of LIFO over FIFO in terms of its effect on economic profit, only about one third of the companies in the United States use LIFO.

The main reason for this is probably the fact that firms must use the same method for both tax purposes and financial reporting. Along with a lower tax rate and a higher real profit, switching from FIFO to LIFO would reduce reported profit. Many financial managers hold the view that the performance of a firm is evaluated and judged largely on the basis of

---

[1a] LIFO method reveals the true economic profit when inflation is neutral. However, with non-neutral inflation, neither LIFO nor FIFO measures precisely the true economic profit.

reported earnings per share, even if they are partly illusory, which accounts for the willingness to pay more tax than called for under LIFO, merely to keep the level of reported profit high. In particular, financial managers hesitate to switch to LIFO because the firm might report a lower profit than other firms in the same industry.

Depreciation

If a firm invests \$100 million in depreciable assets with a ten-year lifetime, straight-line depreciation comes to \$10 million p.a. Now, if the inflation rate is 20%, the first year's depreciation (i.e., one year after purchasing the assets) should be \$12 million on the basis of purchasing power. However, the federal income tax code admits only historical-cost depreciation; it does not permit replacement-cost depreciation nor does it permit adjustment for the price level. Thus although the \$12 million represents the first year's depreciation in current dollars, the tax code only recognizes \$10 million of this for tax purposes. Clearly, if inflation persists, depreciation adjusted for purchasing power will continue to increase while the amount recognized for tax purposes will remain constant. In the tenth year adjusted depreciation will come to \$61.9 million [$= 10(1.2)^{10}$], but it will still only be \$10 million at historical cost. It is in this way that historical-cost depreciation creates illusory profits and the consequently high effective tax rates and low cash flow. A number of investment incentives have been introduced over the years to rectify this situation, among them accelerated depreciation and investment tax credit. These incentives are discussed below when we deal with the effectiveness of investment incentives. As will be seen, these incentives are often insufficient to fully compensate firms for their inflation losses.

The Treatment of Inventory and Depreciation and its Effect on Earnings and Taxes

In 1978, U.S. business earned a total of $202 billion before tax and $118 billion after tax, the before-tax earnings being 16% above those of 1977 and 68% over the 1975 figure. One should not, however, interpret this as an increase in real profit. About one third of the 1978 earnings reflects the nominal effect of inflation and if we adjust the earnings by extracting inflationary inventory gains and valuing depreciation at replacement cost, the 1978 after-tax income would be lower by $42 billion.

If inventory and depreciation are adjusted for inflation, the tax bill would be $17 billion less. This would reduce the tax rate considerably below the figure computed on the basis of reported earnings. In 1978 cash dividends amounted to $49 billion, or 42% of reported net income. However, on the basis of adjusted net income, the cash dividends come to as much as 65%. Fig. 2 summarizes relevant data for nonfinancial corporations in the United States for the years 1973-77; the inflation-adjusted after-tax income was obtained after adjusting the inventory and depreciation to reflect changes in the price level. The figure shows a considerable gap between reported and inflation-adjusted after-tax income throughout the period.

The dividend pay-out ratio is fairly stable when based on reported net income, but on the basis of inflation-adjusted net income, it is much higher and fluctuates more. The greatest difference between reported and inflation-adjusted net income occurred in 1974, when the effective pay-out ratio reached a high of 151.2%. It seems that firms found it hard to cut back on cash dividends, because of the increasing stream of reported profits.

Inflationary Holding Gains on Assets

Unlevered firm. An increase in the price level creates holding gains on assets by increasing the nominal value of the assets. Consider the effect of such holding gains on the earnings per share (EPS) of a no-growth and unlevered firm. Suppose the price level is stable up to time 0, when a fully anticipated neutral inflation starts at a rate h. For simplicity assume that the price level becomes stable again a year later, at time 1. Since the inflation is neutral, it increases revenues, costs, expenses, asset values, etc., in the same proportion. Denote before-tax income at time 0 by X, the corporate tax rate by T, and the number of common shares outstanding by n; then the EPS at time 0, EPS_0, is:

$$EPS_0 = \frac{(1 - T)X}{n} .$$

One period later, i.e. at time 1, the nominal EPS is

$$EPS_1 = \frac{(1 - T)X(1 + h)}{n} = EPS_0(1 + h) .$$

EPS in constant dollars at time 1, EPS_1^C, is obtained by discounting EPS_1 at rate h;

$$EPS_1^C = \frac{EPS_1}{1 + h} = \frac{EPS_0(1 + h)}{1 + h} = EPS_0 \ .$$

Denote the value of the firm's assets at time 0 by V, the firm gets an amount hV of holding gains on these assets, and it is assumed that these gains are spread over all the firm's assets in equal proportions. This assumption is made for simplicity, but does not impair the generality of the discussion. The holding gains, hV, however, do not represent real gain since in order to keep the profitability in real terms unchanged, the value of assets at time 1 must be $V(1 + h)$. As Hicks puts it (John R. Hicks, Value and Capital, 2nd edition, Clarendon Press, Oxford, 1957, p. 174), "income ... must be defined as the maximum amount of money which the individual can spend this week, and still expect to be able to spend the same amount *in real terms* in each ensuing week." Thus holding gains should not be added to income for the EPS calculations.

Levered firm. Consider now a levered firm. With no inflation, the situation is quite simple. Denote the market value of the debt by D and the interest rate paid on the firm's debt by r; the EPS is then

$$EPS_0 = \frac{(1 - T)(X - rD)}{n} \ .$$

For the case of inflation, it is assumed that the market value of the debt is not affected by it but the interest rate rises from r to $(1 + r)(1 + h) - 1 = r + h(1 + r)$. In other words we assume that bondholders are compensated for inflation by the increase in their interest to a level equal to the sum of the no-inflation interest (rD) *plus* compensation for the decrease in the value of the principal (hD) *plus* compensation for the decrease in the value of the no-inflation interest (hrD).[2] All the interest is assumed to be tax deductible for the firm. Nominal EPS at time 1 excluding holding gains is

$$EPS_1 = \frac{(1 - T)[X(1 + h) - rD - h(1 + r)]}{n}$$

$$= \frac{(1 - T)[(X - rD)(1 + h) - hD]}{n} = EPS_0(1 + h) - \frac{(1 - T)hD}{n},$$

and EPS at time 1 in constant dollars is

$$EPS_1^C = \frac{EPS_1}{1 + h} = EPS_0 - \frac{(1 - T)hD}{n(1 + h)}.$$

In this case, inflation appears to have reduced the EPS. However, this is not so, since we have so far ignored the holding gains on the levered firm's assets: in this case, unlike with the pure equity firm, a part of the holding gain is a real income for the stockholders.

When calculating EPS_1^C we did not consider holding gains, although, just as with the unlevered firm, there is a gain of hV. Since the holding gain 'belongs' only to the equity, it is in excess of what is needed in order to create future income for stockholders which is equal

---

[2] Interest on long-term bonds does not actually adjust fully to current inflation rates since it is largely a function of bonholders' long-term inflation expectations. Also note that we ignore personal tax in this analysis.

in real terms to their past income. To see this, start with the identity $V = E + D$ (where E denotes equity); which implies that $hV = hE + hD$. Thus, so long as D is positive, the (nominal) holding gains exceed hE, i.e., there are excess holding gains in the amount hD.

Suppose that the excess holding gains are distributed (the firm liquidates some of the fixed assets) and are subject to the tax rate T. In this case, the after-tax income (including the excess holding gains) available to stockholders is

$$(1 - T)[(X - rd)(1 + h) - hD + hD] \ ,$$

so that

$$EPS_1 = \frac{(1 - T)[(X - rD)(1 + h)]}{n} = EPS_0(1 + h) \ .$$

This implies that EPS should be adjusted for the excess holding gains and for inflation in order to obtain the *real* value of EPS at time 1, EPS_1^R:

$$EPS_1^R = \frac{EPS_0(1 + h)}{1 + h} = EPS_0 \ .$$

Note the distinction between constant and real EPS: EPS^C is the deflated value of the unadjusted nominal EPS, whereas EPS^R is the deflated EPS, adjusted for excess holding gains.

It has so far been assumed that the excess holding gains on the equity are distributed to stockholders. If this amount, hD, is distributed by liquidating assets worth hD, the firm's debt-equity ratio will change and the EPS in the year after the inflation year will not be the same (in real terms) as in the year before inflation. However, this would happen whatever the reason for the alteration in the capital structure since in general, the EPS varies with it. Denoting the pre-inflation debt-equity ratio by D/E, the post-inflation ratio is $D/[E(1+h)+hD]$ before the distribution of holding gains and $D/[E(1+h)] < D/E$ after it. Since the debt-equity ratio has declined, we expect a lower EPS.

It will now be shown that if the debt-equity ratio in the post-inflation year at time 2 is restored to its original level by issuing additional debt, hD, the EPS in real terms will revert to its original level.

The nominal value of the assets is $V(1+h) = (E+D)(1+h)$ and earnings before interest and tax (EBIT) is $X(1+h)$. The interest rate is back at r since by assumption there is no inflation in the post-inflation years; after additional debt of hD has been issued, total outstanding debt is $D(1+h)$, and total interest is then $rD(1+h)$. Therefore nominal EPS is given by:

$$EPS_2 = \frac{(1-T)X(1+h) - rD(1+h)}{n} = EPS_0(1+h) \ .$$

However, the earning per share in constant pre-inflation dollars is given by:

$$EPS_2^C = \frac{EPS_2}{1+h} = \frac{EPS_0(1+h)}{1+h} = EPS_0 \ .$$

That is, the distribution of excess holding gains at the end of the inflation year leaves the real EPS in the following year the same as before inflation.

The discussion has assumed a one-year inflation followed by a period of stable prices. However, the same result holds if prices continue to rise. Note also that if the excess holding gains are not realized, they are not taxed, and the real EPS of a levered firm will rise with inflation.

A numerical illustration. To begin with, assume the absence of leverage. Suppose the total value of the firm's assets is $100 at the beginning of the period, the EBIT is $20, the tax rate is 50%, and there are 10 shares outstanding. Fig. 3 presents the data for the current and the next year assuming a 10% (neutral) inflation.

Disregarding depreciation, there is a holding gain of $10 since the value of assets has risen to $110 by the beginning of the second year from $100 at the beginning of the first year. However, the gain is only nominal. The real value of the assets at the beginning of the second year is $110/1.1 = $100. If the firm did not have $110 worth of assets at the beginning of the second year, it could not end up with EBIT of $22. Thus there is no real holding gain and the result is that real EPS has not changed. Looking at it in another way, suppose that the real discount rate is 10%. Then, before inflation, $V = 10/1.1 + 10/(1.1)^2 + \cdots + 10/(1.1)^\infty = \$100$; after the 10% inflation (which occurs only in the first year), the nominal value is $11/1.1 + 11/(1.1)^2 + \cdots + 11/(1.1)^\infty =$ $= \$110$, and its *real* value is $100.

Consider now a levered firm. Assume that the leverage is 50% at the beginning of the first year, and the firm pays 10% interest on its debt.

Assume also that the inflation rate is 10% and the interest rate in the second year is 21%, to compensate bondholders for the inflation. Earnings per share calculations without considering holding gains are simply EPS expressed in constant dollars, EPS^C, as shown in Fig. 4. Thus EPS^C has declined when the stockholders' excess holding gains are not considered. However, the equity value in the example has risen beyond what is needed to keep up with inflation: with 10% inflation, the \$50 of equity has to rise to \$55 to keep up with inflation, but in the example it has risen to \$60, hence there is an excess holding gain, hD, of \$5 (= 0.10 × 50) and stockholders have had a *real* gain. Looked at from the debt side, the value of the debt remains unchanged at \$50, there is a decrease in the real value of the debt which generates \$5 of excess holding gain on the equity. If the \$5 holding gains are subject to 50% tax, the net profit available for stockholders is \$8.25 (= 5.75 + 0.5 × 5) and EPS_1 is \$1.65 (= 8.25/5) or in real terms, EPS_1^R is \$1.5 (= 1.65/1.1). Thus $EPS_1^R = EPS_0 = \$1.5$, since a neutral inflation should not affect the EPS^R so long as the appropriate adjustments are carried out. No such correction should be made for unlevered firms since for them $hD = 0$.

Clearly, if the \$5 excess holding gain is subject to a lower tax rate, the real EPS is even higher. Suppose for example, that the holding gain is not realized. In this case, $EPS_1 = \$2.15$ [= (5.75 + 5.00)/5 = = 10.75/5], and $EPS_1^R = \$1,955$ (= 2.15/1.1).

While the standard EPS calculation, which ignores holding gains, shows a decline in EPS^C as a result of inflation, the correction for holding gains shows that EPS^R increases as a result of inflation. This, of course, has implications for the way EPS growth and the firm's cost of capital are to be measured.[3]

Liquidity

The preceding section demonstrated that the EPS of an unlevered firm will not be affected by inflation whereas the EPS of a levered firm will increase. However, the negative effect of the treatment of inventory and depreciation on the firm's net income was ignored in arriving at these conclusions. When it is taken into consideration the unlevered firm may experience reduced profitability in times of rising prices. The levered firm would incur inflationary losses on its inventory and depreciation, it would, however, benefit from excess holding gains on its debt. Thus the net effect of inflation on a levered firm is unclear. Both unlevered and levered firms, however, are bound to find themselves in a liquidity crunch if the inflation is severe enough.

The reduced economic earnings of the unlevered firm will not necessarily be reflected in reported earnings. Consequently, dividend pay-out ratios computed on the basis of economic earnings will tend to rise. Coupled with the high effective tax rate, the firm is likely to find that its cash flow is insufficient for new investments.

Levered firms will find themselves in a similar situation. Although the levered firm's excess holding gains improve its profitability, they

---

[3] Modigliani and Cohn (Franco Modigliani and Richard A. Cohn, "Inflation, Rational Valuation and the Market," Financial Analysts Journal, March/April 1979 , pp. 24-44), have also described the effect of inflation on earnings. However, in their model the stockholders' gain originates in the decline in the market value of the debt.

must be realized if they are to provide liquidity relief. The liquidity problem is illustrated in Fig. 4 above, where a 10% anticipated inflation reduces net income from $7.5 in the first year to $5.75 in the second. The levered firm gets a $5 excess holding gain, but since it is not realized, it does not affect the firm's cash flow or its liquidity. To overcome the liquidity problem the firm can either liquidate some of its assets, or, more likely, raise additional debt. Note that the illustration of the unlevered firm under inflation (Fig. 3) shows no decrease in the firm's net income.

Most firms cope with the liquidity problem by issuing more debt. For example, in 1975 Du Pont tripled its outstanding debt to $793 million, and in late 1979 IBM issued $1 billion of notes and debentures for financing investments and growth, the largest single debt issue by an industrial company in the United States. Kepcke (R.W. Kepcke, "Current Accounting Practices and Proposals for Reform", New England Economic Review, Federal Reserve Bank of Boston, September/October 1976, p. 23), shows that the debt-equity ratio of U.S. nonfinancial corporations rose from 0.97 to 1.34 in the period 1965-75. However, on the basis of current-value (rather than conventional) reporting, the ratio hardly changed during the period: it was 0.91 in 1965 and 0.92 in 1975.

CREDIT TERMS AND INFLATION

Sales terms specify the period for which credit is extended and the discount, if any, given for early payment. If for example, the terms are '2/10 net 30', a 2% discount is granted if payment is made within 10 days, and the full sales price is due within 30 days from the invoice date if the discount is not taken. The percentage <u>opportunity cost</u> if the discount not taken is easily calculated, the textbook calculation being[4]

$$\begin{array}{c}\text{annual}\\\text{percentage}\\\text{cost (APC)}\end{array} = \frac{\text{discount \%}}{100 - \text{discount \%}} \times \frac{360}{\begin{array}{c}\text{days credit}\\\text{outstanding}\end{array} - \begin{array}{c}\text{discount}\\\text{period}\end{array}} .$$

For '2/10 net 30' the APC is thus

$$\text{APC} = \frac{2}{100 - 2} \times \frac{360}{30 - 10} = 0.367 ,$$

i.e., 36.7%. This is an opportunity cost. It can also be derived as follows. Suppose the XYZ Corporation has annual purchases of \$367.2 million. If the 2% discount is taken, the daily purchases are 367.2 × (1/1.02)(1/360) = \$1 million. Since each bill will be paid on the 10th day, accounts payable will be \$10 million.[5] If the discount is not taken, the bills will be paid on the thirtieth day and payables will amount to \$30 million, an increase of \$20 million. A 2% discount

---

[4] See for example Brigham (Eugene F. Brigham, Financial Management, The Dryden Press, 1977, p. 387). The effective annual rate is in fact even higher, since the formula given here disregards compound interest during the year. Putting λ = 360/(days credit outstanding - discount period), the rate which takes this effect into account is APC = $[1 + (\text{disount \%})/(100 - \text{discount \%})]^{\lambda} - 1$, and for '2/10 net 30' this comes to 0.438 = $= (1 + 0.0204)^{18} - 1$, or 43.8%.

[5] Most accountants record payables net of discount, then report the higher payments that result from not taking discounts as an additional expense (see, Brigham, *op cit*).

on the annual sales then amounts to \$7.344 million which is 36.7% of the \$20 million.

Under inflation, the discount becomes less advantageous, since the real difference between the discounted price and the full price paid at the end of the period is reduced by the decline in the purchasing power of the dollar during the credit period.

To see how the gain from the discount changes with inflation, consider a firm which purchases P dollars worth of materials per day. Consider now the credit policy 'α/t_1 net t', and assume a daily inflation rate h. If the discount is taken, the purchases are paid for after t_1 days and the purchase price in real terms is $(1 - \alpha)P/(1 + h)^{t_1}$; if the discount is not taken, the bill will be paid after t days, the real purchase price is $P/(1 + h)^t$, and the real benefit from the discount is thus

$$\text{real benefit} = \frac{P}{(1 + h)^t} - \frac{(1 - \alpha)P}{(1 + h)^{t_1}} .$$

Expressing the benefit as a proportion γ of the real purchase price if the discount is taken, we obtain:

$$\gamma = \frac{\dfrac{P}{(1 + h)^t} - \dfrac{(1 - \alpha)P}{(1 + h)^{t_1}}}{\dfrac{(1 - \alpha)P}{(1 + h)^{t_1}}} = \frac{1}{(1 - \alpha)(1 + h)^{t_2}} - 1 ,$$

where $t_2 = t - t_1$. The benefit γ is obtained over t_2 days. On an annual basis, it is

$$(1 + \gamma)^\lambda - 1 = 1/[(1 - \alpha)(1 + h)^{t_2}]^\lambda - 1 ,$$

where $\gamma = 360/t_2$.

It can be shown that the derivative of γ with respect to h is negative, which means that the percentage benefit decreases as inflation increases. Moreover, if h is sufficiently large, the expression $(1 - \alpha)(1 + h)^{t_2}$ could be greater than 1, in which case γ is negative and it will certainly be advantageous for the purchasing firm to forgo the discount.

Changing the Discount Per cent

The financial manager who wants to get as great a cash flow as possible from the firm's sales and to exploit the firm's credit to the utmost should take the effect of inflation on γ into account and consider an increase in the nominal rate of discount so as to maintain a desired level of γ, the *real* percentage benefit resulting from the discount. It is thus of interest to determine the discount rates that will yield the same real benefit as does a given discount in the absence of inflation. To do so, note first that in the absence of inflation (i.e., $h = 0$), $\gamma_0 = 1/(1 - \alpha) - 1$. Given an inflation rate $h \neq 0$, put

$$\frac{1}{(1 - X)(1 + h)^{t_2}} - 1 = \frac{1}{1 - \alpha} - 1 = \gamma_0 ,$$

and solve for X, the rate of discount which makes the real percentage benefit equal the no-inflation rate, γ_0:

$$X = 1 - \frac{1 - \alpha}{(1 + h)^{t_2}} .$$

A numerical example will illustrate this. Suppose the credit policy is '2/10 net 30' and the inflation rate is zero. Then $\alpha = 0.02$ and $\gamma_0 = 1/(1 - 0.02) = 0.0204$, which translates into 0.438 on an annual basis. Now with a 12% p.a. inflation rate, $(1 + h)^{t_2} = 1.0063$ $(=1.12^{1/18})$, i.e., over 20 days the inflation comes to 0.63%. Substituting $(1 + h)^{t_2} =$ $= 1.0063$ in the expression for X we obtain $X = 0.0262$, i.e., a 2.62% discount at 12% p.a. inflation will yield the same real percentage benefit as a 2% discount in the absence of inflation; in other words, the discount rate must be raised significantly if it is to provide the same real percentage benefit. If this is not done, the selling firm can expect the number of cash-paying purchasers to decline, with adverse effects on the seller's liquidity.

Fig. 5 shows the values for X for different credit terms and for a variety of annual inflation rates. Fig. 6 portrays the ratio X/α for selected inflation rates and credit periods.

Changing the Credit Period

Instead of changing the percentage discount and keeping the credit period unchanged, the selling firm may adjust its credit terms to inflation by shortening the credit period, keeping the discount per cent unchanged. The opportunity cost of forgoing the discount is given by

$$APC = 1/[(1 - \alpha)(1 + h)^{t_2}]^{\lambda} - 1 .$$

If $h = 0$, this reduces to $1/(1 - \alpha)^{360/t_2} - 1$. When $h > 0$, t_2 may be shortened to some value t_2^* such that

$$1/[(1 - \alpha)(1 + h)^{t_2^*}]^{360/t_2^*} - 1 = 1/(1 - \alpha)^{360/t_2} - 1 .$$

Solve for t_2^* to get

$$t_2^* = \frac{t_2[\log(1 - \alpha)]}{\log(1 - \alpha) - t_2[\log(1 + h)]} .$$

Values of t_2^* can be derived from this expression for various combinations of t_2, α, and h. Note that the derivative of t_2^* with respect to h is negative which means that other things being equal, the higher the inflation rate the shorter should be the credit period for a constant real opportunity cost. Note that $t_2^* = t_2$ when $h = 0$, and when h approaches infinity, t_2^* approaches zero. Fig. 7 exhibits the values of $t^* = t_1 + t_2$ (to the nearest whole day) for a variety of combinations of t, α and h. For example, a credit policy '2/10 net 30' in the absence of inflation gives the same real percentage benefit as '2/10 net 24' with annual inflation of 15%. In Fig. 8 we present the ratios t^*/t for selected combinations of t, α, and h.

INFLATION, DEPRECIATION, INCOME TAX, AND CAPITAL BUDGETING

A characteristic of investment in a fixed asset is that the cash flow derived from it is obtained long after it was acquired. For both financial reporting and income tax calculations, an asset's cost is spread over its lifetime so that the depreciation expense can be matched with the revenues. The depreciation, however, is based on the historical cost of the asset, and it is well known that during periods of inflation this is less than current replacement cost. Over the years, various tax incentives have been introduced which in part aim to provide real or close to real depreciation in periods of inflation, the most important being accelerated depreciation and the investment tax credit.[6]

The Effect of Inflation on a Project's Net Present Value

The net present value (NPV) of an investment project is a widely accepted measure of investment profitability. Like other measures of profit and profitability, special care is required in applying the NPV criterion to a cash flow in conditions of inflation--a project that would be accepted in the absence of inflation, could very well be rejected when inflation is present, and inflation increases a project's riskiness. Investment incentives are ignored for the time being.

Neutral inflation. We begin the analysis by assuming a neutral inflation, i.e., an inflation in which all prices increase at the same rate, h.

---

[6] The class life asset depreciation range system (ADR) is another such incentive. The system provides upper and lower limits for recommended lifetimes of broad classes of assets, so that a firm may not need to work with more than one lifetime. However, the ADR system is not as important an incentive as the two mentioned here and will therefore not be discussed.

Suppose the cost of capital in real terms is k, say 10% p.a., so that an investment of $100 will only be attractive if the cash flow at the end of the year is at least $110 in real terms. If the cash flow is exactly $110, the net present value (NPV) of the investment is 0 (= -100 + 110/1.1). If the real cash flow exceeds $110, the project's NPV is positive and it will be accepted.

With a 20% neutral inflation, the minimum nominal cash flow required is $132, since its real value is only $110. The project's NPV is then

$$NPV = -100 + \frac{\$132/1.2}{1.1} = -100 + \frac{\$132}{1.32} = 0 \ .$$

The proper cost of capital adjusted for inflation deduced from this example is 32%. More generally, if k is the <u>real cost of capital</u>, then the <u>nominal rate</u>, k_N, is

$$k_N = (1 + k)(1 + h) - 1 \ .$$

Should an investment project be evaluated in current or constant dollars? Given that all cash flow components are affected proportionally by inflation, either way will lead to the same investment decision provided that in current dollars the cash flow is discounted by the nominal cost of capital, k_N, and that in constant dollars it is discounted by the real cost of capital, k. To see this, ignore depreciation for the moment and assume that the real annual net cash flow in year t is S_t and that with an inflation (neutral) rate, h, the current annual net cash flow is $S_t(1 + h)^t$. Applying the nominal discount rate to the nominal annual net cash flow, the NPV computed from current amounts is

$$NPV = -I + \sum_{t=1}^{n} \frac{S_t(1 + h)^t}{[(1 + k)(1 + h)]^t} = -I + \sum_{t=1}^{n} \frac{S_t}{(1 + k)^t} \ ,$$

where I is the initial investment outlay and $(1 + k)(1 + h) = 1 + k_N$. Alternatively, the real cost of capital can be applied to the real cash flow to obtain the right-most expression directly.

It is clear that when all cash flow items are affected by inflation in the same proportion applying the nominal cost of capital to the current cash flow yields the same NPV and the same accept-reject decisions as applying the real cost of capital to the cash flow in constant dollars.

In practice, not all the cash flow items are affected by inflation in the same way, and thus the two evaluation methods do not generally yield the same results. To demonstrate this, let T be the tax rate and let D_t be the depreciation in year t. In the absence of inflation, the cash flow for year t is

$$(1 - T)(S_t - D_t) + D_t = (1 - T)S_t + TD_t ,$$

and the project's NPV is

$$NPV_0 = -I + \sum_{t=1}^{n} \frac{(1 - T)S_t}{(1 + k)^t} + \sum_{t=1}^{n} \frac{TD_t}{(1 + r)^t} ,$$

where the 0 subscript denotes 'no inflation', k is the firm's cost of capital and r is the riskless interest rate. Note that the firm may consider the tax-shelter, TD_t, a nonrisky cash flow (the firm can carry a loss backward and forward, thereby reducing its tax bill in years of profit), and discount it using the riskless rate, r.

While S_t will be affected by inflation, the tax shelter is computed on the basis of book value so that its nominal value will be unchanged.

The NPV with inflation, NPV_{inf} is

$$NPV_{inf} = -I + \sum_{t=1}^{n} \frac{(1 - T)S_t(1 + h)^t}{[(1 + k)(1 + h)]^t} + \sum_{t=1}^{n} \frac{TD_t}{[(1 + r)(1 + h)]^t}$$

$$= -I + \sum_{t=1}^{n} \frac{(1 - T)S_t}{(1 + k)^t} + \sum_{t=1}^{n} \frac{TD_t/(1 + h)^t}{(1 + r)^t} .$$

Three main conclusions follow from the comparison of NPV_0 and NPV_{inf}

1. Since NPV_{inf} is the correct net present value under inflation, the firm can separate its cash flow into two components. That part of the cash flow whose nominal value changes proportionally to the price level, will not be affected by inflation. The depreciation tax shelter, however, will be reduced in value. For both components, though, it is true that *one can either apply the real rate of discount to the constant dollar cash flow, ar the nominal rate of discount to the nominal value of the cash flow.*

It can be seen that $NPV_0 > NPV_{inf}$ which means that, other things being equal, investment projects become less attractive under inflation. The higher the inflation rate, the greater the gap between NPV_0 and NPV_{inf}. Moreover, it is quite possible that $NPV_0 > 0$ while $NPV_{inf} < 0$ so that a project which would be accepted in the absence of inflation may be rejected when there is inflation.

3. Firms having fixed obligations (such as lease contracts) may gain from inflation since the NPV of their fixed commitments decreases in real terms.

Non-neutral inflation. In reality, inflation is rarely neutral. The price of oil, for example, has in recent years risen much faster than the price of larger cars, and the prices of food products do not change at the same rate as the prices of durable goods, and so on. If stockholders consume a well-mixed basket of goods and services, it is only reasonable to assume that their required rate of return on investment will change proportionally to the average price change. Thus, the firm's cost of capital changes from k to $(1 + k)(1 + h) - 1$ with inflation. The firm which produces only a limited number of products may increase its prices by a rate h^* which generally differs from h. Thus, under inflation a project's NPV will be

$$NPV_{inf} = -I + \sum_{t=1}^{n} \frac{(1 - T)S_t(1 + h^*)^t}{[(1 + k)(1 + h)]^t} + \sum_{t=1}^{n} \frac{TD_t}{[(1 + r)(1 + h)]^t} .$$

Under a neutral inflation, the real cost of capital, k, can be considered constant. Since h^* differs from h, however, inflation introduces a new dimension of risk to the firm. The differential inflation rates increase the business risk of all firms, a fact that may increase the real cost of capital and thus reduce NPV.

Riskless interest rate. In the absence of inflation the tax shelter TD_t is assumed riskless and the riskless discount rate, r, applies to it. In the presence of inflation which includes unexpected elements, the depreciation tax shelter is no longer riskless, and a rate $r^* > r$ should be applied to it. The difference between the two, $r^* - r$, is simply the risk premium for the uncertainties of inflation. Both neutral and non-neutral inflation increase the riskiness of the cash flow. The result is higher discount rates and lower NPV.

Ranking Mutually Exclusive Investment Projects: Incentives not Considered

This section focuses on the ranking of mutually exclusive investment projects. To simplify the discussion, without any loss of generality, the same cost of capital k will be used to discount the uncertain component of the cash flow and the certain depreciation tax benefit.

Nelson (Charles R. Nelson, "Inflation and Capital Budgeting," Journal of Finance, XXXI, No. 3, June 1976, pp. 923-31), has examined some of the implications of inflation for the ranking of investment projects. Among other things he demonstrates that the NPV ranking of mutually exclusive investment projects depends, in general, on the rate of inflation. He showed that at higher rates of inflation, ranking will usually change in favor of projects with shorter duration. Nelson also demonstrates that inflation generally affects replacement policy: the higher the rate of inflation the greater the likelihood of replacement being deferred.

When projects with unequal lifetimes are compared, their net present values are not adequate as a measure of relative profitability, since the length of time over which a given amount of profit is generated must be taken into account. For example, if projects A and B have $NPV_A = \$100$ and $NPV_B = \$200$, respectively, project B should not automatically be preferred to A without regard to the project's lifetime. If, for example, the lifetimes are 2 and 10 years for A and B respectively, project A might very well be preferred. In particular, it will be preferred if it can be assumed that other equally profitable investments will become available in years 3 through 10. If so (such an assumption is common in replacement-chain analyses), the profitability of investments can be compared on the basis of their uniform annuity series (UAS), which is defined as the annuity whose present value equals the NPV,

$$NPV = \frac{UAS}{(1 + k)} + \frac{UAS}{(1 + k)^2} + \cdots + \frac{UAS}{(1 + k)^n} .$$

Thus if a project's net present value is $200 and its lifetime 10 years, its UAS, assuming a 9% cost of capital, is $31.16, since

$$200 = \frac{31.16}{1.09} + \frac{31.16}{(1.09)^2} + \cdots + \frac{31.16}{(1.09)^{10}} .$$

Similarly, if the NPV is $100 and the lifetime is 2 years, the UAS is $56.85. The UAS criterion leads to selection of the second project, and this is justified if it can be assumed that an equally profitable investment will appear in two years' time.

Fig. 9 compares five investment projects; the UAS is the basis for capital budgeting of projects with unequal lifetimes and the cost of capital is taken as 9%. What the five projects have in common is (a) they all require the same initial outlay, and (b) in all five, the UAS is $100.

Assume now an inflation of 20% p.a. The cost of capital is $(1.09)(1.2) - 1 = 0.308$, the (book-value) depreciation is unchanged and S_t rises by 20% p.a. starting in the first year. Fig. 10 illustrates the cash flow of project B with and without inflation.

The real NPV of project B in the presence of 20% p.a. inflation is

$$\mathrm{NPV}_B = -1000 + \frac{752.17}{1.308} + \frac{852.61}{1.308^2} = 73.4 \ .$$

The UAS_B is then derived by solving $73.39 = \mathrm{UAS}_B/1.09 + \mathrm{UAS}_B/1.09^2$, where $1.09 = 1.308/1.2$; this UAS_B which equals \$41.72 is thus a real value, its nominal value being $(41.72)(1.2) = \$50.06$ in the first year, and $(41.72)(1.2^2) = \$60.08$ in the second. The real NPV and UAS of the five projects, A through E is as follows:

	A	B	C	D	E
n	1	2	5	10	∞
NPV	15.28	73.39	239.87	472.15	1,111.11
UAS	16.65	41.72	61.67	73.57	100.00

With no inflation, the UAS of all five projects is \$100.00; thus the table shows that a project's UAS is reduced by inflation (unless, as with project E, its infinite); moreover, the shorter the lifetime, the greater the decrease. It is clear from the example that when mutually exclusive investment projects differing in lifetimes are ranked by NPV or UAS, inflation could change the ranking because it affects the real value of the tax shelter differently in each case.

The effect of inflation on the internal rate of return (IRR) can now be examined. The following figure lists the no-inflation cash flow of five investments as well as their nominal IRR (IRR_N) and real IRR (IRR_R) in the face of a 20% inflation rate. In the absence of inflation the IRR of all five five projects (IRR_0) is 10%.

	F	G	H	I	J
n	1	2	5	10	∞
I_0	1,000	1,000	1,000	1,000	1,000
S_t	1,200.00	652.38	327.59	225.49	200.00
D_t	1,000.00	500.00	200.00	100.00	0.00
$(1 - T)S_t + TD_t$	1,100.00	576.19	263.80	162.75	100.00
IRR_N	22.00	22.76	24.77	27.12	32.00
IRR_R	1.70	2.30	3.98	5.93	10.00

The project's real IRR given an inflation rate h, is

$$IRR_R = \frac{1 + IRR_N}{1 + h} - 1 ,$$

where IRR_N is the nominal value of IRR. IRR_N and IRR_R are shown in the last two lines of the figure. To show their derivation, consider project G:

	Year 0	Years 1, 2 with no inflation	20% inflation, years: 1	2
I_0	-1,000			
S_t		652.38	782.86	939.43
D_t		500.00	500.00	500.00
$(1 - T)S_t + TD_t$		576.19	641.43	719.72

The project's IRR_N is 22.76%, since

$$-1{,}000 + \frac{641.43}{1.2276} + \frac{719.72}{1.2276^2} = 0$$

and

$$IRR_R = \frac{1.2276}{1.20} - 1 = 2.3\% \ .$$

Comparison of the IRR_R of the five projects shows that the profitability of short-live projects is more adversely affected by inflation, and project J with infinite lifetime is not affected at all. Thus inflation may alter the IRR ranking of projects with unequal lifetimes.

The Effectiveness of Investment Incentives

This section reexamines capital budgeting, this time considering the main investment incentives and their effectiveness at times of inflation. Landskroner and Levy (Yoram Landskroner and Haim Levy, "Inflation, Depreciation and Optimal Production," European Economic Review, Vol. 12, 1979, pp. 353-67) have examined the effectiveness of two accelerated depreciation methods, the double declining balance (DDB) and the sum-of-the-years-digits (SYD) as investment incentives.

To determine effectiveness, they compare the present value of the depreciation tax shelter TD_t for assets of various lifetimes and under alternative inflation rates. In the absence of inflation, the present value of the tax shelter is given by

$$PV(TD) = \sum_{i=1}^{n} \frac{TD_t}{(1 + r)^t} ,$$

whatever the method. Once inflation at an annual rate h is taken into account, the tax saving is

$$PV(TD, h) = \sum_{t=1}^{n} \frac{TD_t/(1 + h)^t}{(1 + r)^t} = \sum_{t=1}^{n} \frac{TD_t}{[(1 + r)(1 + h)]^t} .$$

Clearly, accelerated depreciation is generally a more effective investment incentive than straight-line depreciation (SL) because with the accelerated methods the bulk of the asset is depreciated in the early periods. But the relative effectiveness of DDB and SYD is not necessarily clear.

Fig. 11 presents the present value of the depreciation using the three methods and assuming that the real discount rate is $r = 0.05$, for different lifetimes and inflation rates. The figure disregards the tax rate T, which is assumed constant, i.e., it does not affect relative effectiveness. A number of conclusions concerning the relation between the parameters and the methods of depreciation may be drawn from the figure. First, as the inflation rate increases, the accelerated methods have an increasing advantage over SL. This is because higher inflation rates mean higher nominal discount rates which in turn increase the relative weight of the charges in the early years. Second, it can be observed that short service life and high inflation rate, separately or together, favor DDB over the SYD. At the high end of the inflation range, the greater the rate of inflation, the later the point at which DDB becomes preferable. However, this delaying effect is fairly small: assuming the 5% real discount rate used in Fig. 11, the point at which DDB and SYD change place is 5-6 years for annual inflation rates of up to 20%, 6-7 years for inflation rates of 20-35%, and 7-8 years for 40% inflation. This stability of the relative effectiveness of the depreciation methods is the most important result of Fig. 11. In the relevant range of inflation for the U.S. ($h \leq 20\%$), if $h \leq 5$, DDB is the more effective, and SYD is the most effective if $h > 5$.

In Figs. 12 and 13, the present value of the tax depreciation charge is illustrated as a function of the asset's service life for selected inflation rates, with an assumed real discount rate of 5%. As can be seen, the curves in Fig. 13 are closer to the horizontal axis than those of Fig. 12; this implies that the tax saving declines as the inflation rate increases under all these methods. Also, the SYD and DDB curves cross each other, which illustrates the fact that the relative effectiveness of the accelerated method is a function of inflation rate and service life.

Inflation reduces the firm's real net cash inflows because depreciation is based on historical cost and is not adjusted to change with inflation, while revenues and cash expenses usually increase with inflation. Comparing the present value of straight-line depreciation in the absence of inflation with the present value under an inflation rate of h%, it is obvious that PV(TD) > PV(TD, h): i.e., inflation reduces the firm's real tax savings. The DDB and SYD accelerated-depreciation methods will reduce this inflation loss. However, it is an interesting question to what extent these procedures protect the firm against inflation loss, or how much compensation they provide for it. Fig. 14 shows the ratio of the present value of depreciation of the two accelerated methods under inflation to the present value of the straight-line method in the absence of inflation.

A greater-than-unity entry means that the accelerated method overcompensates for inflation, less than unity means undercompensation, and unity exact compensation. For example, if an asset has a service life of eight years, both accelerated methods will overcompensate for inflation at a rate of 1% p.a.: the real present value of depreciation is increased by 1% under DDB and by 2% under SYD, as compared with SL in the *absence* of inflation. Taking the same asset but assuming 5% inflation, both accelerated methods undercompensate the firm for inflation: the present value of depreciation is reduced by 11% under DDB and by 9% under SYD. The main finding of Fig. 14 is that the accelerated methods provide full protection only at very low inflation rates, up to 1% of inflation with DDB and up to 2% with SYD. This result is independent of the asset's service life. It is interesting to note that within the range of inflation rates in which the accelerated methods overcompensate for inflation, overcompensation increases with the asset's lifetime. The rate of increase, however, is greater for SYD: for example, at an inflation rate of 1%, using SYD, the ratio increases from 1.00 for a 3-year asset to 1.08 for a 20-year asset; using DDB, the increase is only from 1.01 to 1.02. That is, during periods of low inflation the accelerated methods will induce investment in long-lived projects. The opposite occurs when inflation exceeds 2%. At this level, the degree of undercompensation increases with the asset's life; the accelerated methods thus encourage investment in short-lived assets that minimize inflation losses.

Investment tax credit. The investment tax credit was first incorporated into the federal income-tax law in 1962. Under its provisions, business firms could claim a specified percentage of the dollar amount of new investment in certain assets as a credit against their income tax. Originally, the credit was 7% of new investment in assets with a lifetime of eight or more years, 2/3 of 7% for assets with six or seven years of life, 1/3 of 7% for assets with four or five years of life; no credit could be claimed for assets with a lifetime of less than four years. The tax credit was twice suspended and reinstated as Congress used it to encourage investment when economic conditions required it. In 1975, the basic credit rate was raised from 7 to 10%.

The investment tax credit supplements the accelerated-depreciation methods in encouraging capital investments. In view of the data of Figs. 11 and 14, the investment tax credit clearly makes economic sense. It provides an additional incentive for capital investments in years of undercompensation under accelerated depreciation. Furthermore, as seen in Fig. 14, the degree of undercompensation increases with the asset's life, and this justifies the higher tax credit for assets with longer lifetimes provided by the law.

Fig. 15 is similar to Fig. 14, except that it shows the ratio of present value of DDB and SYD depreciation *plus* the present value of the investment tax credit (assuming a 10% rate) to (as before) SL without inflation, for $r = 0.05$. Comparing Figs. 14 and 15, two conclusions emerge. First, it is evident that the investment tax credit adds a significant tax saving for assets with various service lives. Due to the tax structure, the ratios of Fig. 15 are roughly equal for service lives of 3 to 8 years, particularly for inflation rates in the range 5-10%. The second conclusion is that with inflation rates of 5% or more, the tax credit is not a strong enough incentive and does not fully compensate for inflation even when combined with accelerated depreciation.

Ranking of Mutually Exclusive Investment Projects: Incentives Considered

To see the effect of accelerated depreciation and investment tax credit on the ranking of projects, we examine the NPV and UAS of projects A through E (Fig. 9) and the IRR projects F through J (p. 33). The incentives assumed are as follows:

Project A, F - no incentives
Project B, C - double declining balance depreciation (DDB)
Project C, H - DDB with a switchover to straight line (SL) plus 3.33% investment tax credit
Project D, I - DDB with a switchover to SL, plus 10% investment tax credit
Project E, J - 10% investment tax credit.

Each of the projects requires an initial investment of $1000, all of it depreciable and eligible for investment tax credit.

The results under the assumption of 20% inflation are summarized in Fig. 15 and presented graphically in Fig. 17.

Several valid points seem to emerge in spite of any reservation one might have about generalizing from numerical examples. First, the profitability of short-lived assets is more adversely affected by inflation than that of long-lived assets (other things being equal). This applies to both the UAS and IRR. Second, the tax incentives currently in force are quite inadequate as inflation compensation for assets with lives of about 10 years or less. Calculations, not presented above, show that such investments do not receive full compensation if the inflation exceeds 10% p.a. Third, the combination of inflation and investment incentives could change the ranking of investment projects by both UAS and IRR. It should also be borne in mind that unexpected inflation adds additional risk not considered in the analysis.

Can Overcompensation or Undercompensation for Inflation be Avoided?

Is there a simple procedure for adjusting the depreciation tax benefit so that its real value is the same under any inflation rate as it is under no inflation? Clearly, one way to achieve this is by adjusting depreciation to the general price level, at least for tax purposes. However, this method has its drawbacks. It can also, for example, be argued that a replacement cost method should be used.

There is, however, a method by which exact compensation can be given to the firm and which does not require price-level adjustment or replacement-cost determination. Recall that under- or over-compensation are measured relative to PV(TD); *a possible solution is to allow a tax credit of PV(TD) at the time the asset is purchased.* This has a few notable advantages.

First, exact compensation is given regardless of the rate of inflation and the asset's service life. Second, the procedure removes the *uncertainty* of inexact compensation, since the firm knows the real value of the tax benefit in advance. Removing such uncertainty is in itself an incentive, assuming that firms are risk averse. Third, because the method is insensitive to the inflation rate, it avoids the need for frequent legislation in response to changing inflation rates and changing expectations concerning them.

Finally, Congress might also want to use the tax credit as a fiscal policy tool. This would be quite easy to implement. For example, if Congress wished to stimulate investment, a credit of 1.10PV(TD) would be allowed whereas if a slowdown was sought the credit would be reduced to 0.90PV(TD).

INFLATION AND COMMON STOCK RETURNS

The determinants of stock prices and returns have long been a target of theoretical and empirical research by students of finance and capital markets. The capital asset pricing model (CAPM) developed by Sharpe, Lintner, and Mossin, which is an extension of the portfolio selection framework suggested by Markowitz, has opened the way to a better understanding of capital assets. This model distinguishes between diversifiable and nondiversifiable risk, and showed that as the number of securities in a portfolio increases, the relative importance of the nondiversifiable risk increases while the importance of each security's own risk diminishes. The model was developed on a set of restrictive assumptions but, as Lintner (Lintner, John, "Inflation and Security Returns," the Journal of Finance, XXX, No. 2, May 1975, pp. 259-80) asserts, "subsequent work has shown that the essential structure of the model is remarkably robust to generalizations" (p. 263).

Nevertheless, most of the studies to date have been concerned with nominal rather than real returns on capital assets. With the persistent inflation of recent years, the question must be asked how stock returns and price react to inflation. Here, classical as well as recent findings must be considered.

The Classical Theory and the Cost of Capital under Inflation

The classical model of the effect of inflation on the cost of capital and stock prices advanced by Irving Fisher (Fisher, Irving, The Purchasing Power of Money, Macmillan, New York, 1920) and John Burr Williams (Williams, John Burr, Theory of Investment Value, Harvard Univeristy Press, Cambridge, 1938) reaches three major conclusions. First, the real return on capital assets is invariant to the price level, since the returns depend on production functions which are not affected by the general price level. Second, the real rate of interest is also invariant to the price level. Third, the real market value of claims against capital assets is equal to the real return on capital goods capitalized at the real rate of interest. Since the real return as well as the real rate of interest is invariant to the price level *per se*, it is clear that the real market value is also invariant.

In this classical framework where the stock price in the present is invariant to a future neutral inflation, one can derive the cost of capital in the simple case of an all-equity firm which distributes all its earnings as dividends (an assumption that can be relaxed without altering the results of the analysis). In the absence of inflation the cost of capital, k, of such a firm is given by

$$P_0 = \sum_{t=1}^{\infty} \frac{d_t}{(1 + k)^t} = d \sum_{t=1}^{\infty} \frac{1}{(1 + k)^t} = \frac{d}{k} ,$$

and

$$k = \frac{d}{P_0} = \frac{e}{P_0} ,$$

where P_0 denotes the present market price of the stock, and d_t is the dividend per share in year t, which by assumption is equal to e_t, the earnings per share in year t. Note also that it is assumed for simplicity that earnings and hence dividends are constant over time. Assume now a fully anticipated neutral inflation, prices being expected to rise at a rate of 100h% p.a., and that the firm's revenues and expenses, and therefore its earnings, are also expected to grow at the same rate. Since the firm distributes all its earnings as dividends, its *nominal* cost of capital, k_N, is given by

$$P_0 = \frac{d(1 + h)}{(1 + k_N)} + \frac{d(1 + h)^2}{(1 + k_N)^2} + \frac{d(1 + h)^3}{(1 + k_N)^3} + \cdots$$

$$= \frac{d(1 + h)}{k_N - h}$$

and $k_N = d(1 + h)/P_0 + h$. Comparing this result with the zero inflation case in which $k = d/P_0$ it is clear that

$$k_N + 1 = (1 + h)(1 + k)$$

or

$$k_N = k(1 + h) + h = k + h + kh ,$$

Where k is the real cost of capital and k_N is the nominal cost of capital.

This approach can be clarified by considering a simplified numerical example. Suppose that in the absence of inflation the minimum required real rate of return on investment is 10%, i.e. the firm requires a minimum return of \$110 on a \$100 investment with a duration of one year. What will be the effect of an expected rate of inflation of, say, 10% on the nominal cost of capital, k_N? Using $k_N = h(1 + k) + h$, the result is $k_N = 0.10(1.10) + 0.10 = 21\%$.

Stock Prices and Inflation in the Classical Framework

This section deals with the relationship between stock prices and inflation, a subject which has been the source of some confusion.

Consider a simple case of *no growth*, that is a firm with constant earnings per shares, e, and which distributes all of these earnings as dividends so that $e = d$. The price of the stock in period t is given by

$$P_t = \frac{d}{1+k} + \frac{d}{(1+k)^2} + \cdots = \frac{d}{k}\,.$$

The price of the stock one year later, in period $t + 1$, is the same, i.e. $P_{t+1} = P_t$.

Now assume a fully anticipated neutral inflation. Today's stock price is given by the capitalization of the new stream of dividends (= earnings) which, by the definition of neutral inflation, will rise at the inflation rate (k_N denotes the new nominal cost of capital):

$$P_t = \frac{d(1+h)}{1+k_N} + \frac{d(1+h)^2}{(1+k_N)^2} + \cdots = \frac{d(1+h)}{k_N - h} = \frac{d(1+h)}{k(1+h)} = \frac{d}{k}$$

i.e. there is no immediate impact on the stock price, since $k_N - h = k(1 + h)$. However, the price of the share one year later is given by

$$P_{t+1} = \frac{d(1+h)^2}{1+k_N} + \frac{d(1+h)^3}{(1+k_N)^2} + \cdots = \frac{d(1+h)^2}{k_N - h}\,,$$

i.e., $P_{t+1} = P_t(1 + h)$ so that the end-of-period share price rises at the inflation rate. Thus, under the assumptions made, common stocks do provide a hedge against inflation.

In the classical framework, the return to the stock of a levered firm increases when the inflation rate over the remaining life of the outstanding debt increases above its expected value. Since the total real value of the firm is invariant to the price level, the loss of real market value of such debt is accompanied by a gain in the real market value of the stock.

Lintner (Lintner, John, "Inflation and Common Stock Prices in a Cyclical

Context," in National Bureau of Economic Research, 53rd Annual Report, Sept. 1973), points out that subsequent works in the classical framework have replaced leverage by the concept of net debtor position (i.e. financial liabilities in excess of financial assets). Firms in a net debtor position will enjoy real capital gains when inflation rates rise above the expected rates over the remaining life of their debt.

Since the consolidated balance sheet of U.S. nonfinancial corporations has consistently been in the net-debtor position since 1945 (see Lintner 1973 *op cit*) the classical theory would predict that the current market value of their stocks should show a more than proportionate capital gain in current money terms to the rates of inflation.

Empirical Evidence

The accumulated empirical evidence on the relationship between inflation and stock prices do not confirm the classical view. While the classical theory concludes that common stocks provide a hedge against inflation, the empirical evidence is that they fail to do so.

Lintner has examined the relationship between annual stock price changes and annual changes in the general price level. His main findings are as follows:

1. A simple regression between the annual percentage change in stock prices and the annual percentage change in the wholesale price index over a 70-year period showed *no correlation* between these two variables. This result is obtained largely because high inflation rates and serious deflation tend to reduce stock returns. Lintner found that a 10% deflation would reduce stock prices by 15% and that a 10% inflation would reduce them by 4.1%.

2. When percentage changes in earnings and interest rates were added to the equation, the explained variance of stock price changes (i.e., the dependent variable) rose to about 33%. Deflation was the most powerful explanatory variable in the equation. A 10% price fall was estimated to *reduce* prices by 33%. A 10% inflation, on the other hand, was estimated to *reduce* stock prices by about 6.7%. Since these are estimates in a multiple regression analysis where percentage changes in earnings and interest rates are included as explanatory variables, these effects on stock prices are *net* of the effect of earnings and interest rates.

Lintner's conclusion is that the classical theory of the relationship between changes in the price level and stock prices is not valid. He notes that the classical theory will hold if (a) the *real* returns to ownership of capital goods and (b) the real interest rate are invariant to inflation, and that there is a good reason to believe that neither premise holds.

Additional evidence contradicting the classical theory is provided in the work of Zvi Bodie (Bodie, Zvi, "Common Stocks as a Hedge Against Inflation," Journal of Finance, XXXI, No. 2, May 1976, pp. 459-70). Bodie's approach to the question of common stock returns and inflation is essentially a portfolio approach. He focuses on the variance of a bond free of default. The risk of such a bond originates solely from the *inflation uncertainty*. Bodie tried to find out to what extent an investor can reduce the uncertainty of the real return on such a nominal bond by combining it with a well diversified portfolio of common stocks.

Consider Fig. 18, in which the expected return and standard deviation of a default-free bond (B) and a well diversified portfolio of common stocks (S) are shown. Elementary portfolio theory shows that B and S can be combined into a portfolio whose expected return and standard deviation lie along the curve BS. The precise location of the portfolio depends on the proportion of investment allocated to B and S, and Bodie was concerned with the proportions that bring the portfolio's variance (or standard deviation) to a minimum. If a combination of B and S can result in a portfolio such as H in the figure, where the standard deviation of H (σ_H) is smaller than the standard deviation of B (σ_B), then, equities do provide (at least some) hedge against inflation. Clearly, common stocks provide a perfect hedge agains inflation when $\sigma_H = 0$ and a partial hedge when $\sigma_H > 0$. The <u>cost of hedging</u> is defined as the difference between the mean real return on the nominal bond (μ_B) and the mean real return on the minimum variance portfolio (μ_H). In Fig. 18, $\mu_B - \mu_H < 0$. The cost is negative since combining a well diversified portfolio of common stocks with B, not only decreases the risk from σ_B to σ_H, it also increases the return from μ_B to μ_H.

The situation described by Fig. 18 is not the only possible one, however. Consider Fig. 19 in which the minimum variance portfolio, H, is not located between the points B and S, but on the extension of the curve SB beyond B. Portfolio theory advises that to attain portfolio H B must be <u>held</u> long and S <u>short</u>. If empirical findings indicate that the minimum variance portfolio includes the well-diversified stock portfolio S with a negative proportion, i.e., S is held short, the situation corresponds to Fig. 19, and the conclusion is that stocks do not provide a hedge against inflation (when held in long position). The cost of hedging in Fig. 19 is positive; $\mu_B - \mu_H > 0$, so that one can reduce the variance below σ_B, but only at the cost of reducing the expected value below μ_B.

Using data for 1953-72, Bodie found that the minimum variance portfolio could indeed by attained only when the common stock portfolio were held short (!), not long. To attain the minimum variance portfolio, the investor must sell short about $0.03 worth of equity for every $1.03 invested in nominal bonds. By doing that, the hedger can eliminate roughly 18% of the variance of the real return on the bonds. The cost of such a hedge would have been a reduction in expected return of 0.34 percent.

Furthermore, Bodie found that not only is the real return on equity negatively correlated with unanticipated inflation, but it is also inversely related to anticipated inflation. The estimate he obtained was that an increase of 1 percentage point in the expected rate of inflation is associated with a decline of 4 percentage points in the real return on equity.

Explaining the Empirical Evidence

Lintner (Lintner, John, "Inflation and Security Returns," The Journal of Finance, XXX, No. 2, May 1975, pp. 259-80), has advanced a new theory to explain the negative relationship between inflation and stock prices. He assumes neutral inflation so that the firm's input and output prices all rise proportionally. He further assumes that capital stock and current rates of real investment are proportional to physical output, depreciation is taken at replacement cost for tax purposes, corporate profits are taxed at a fixed rate and dividends are a fixed fraction of after-tax profits. With these assumptions, the excess of current dollar outlays for fixed investment over gross funds retained from operations (retained earnings plus depreciation) is a fixed fraction of current dollar sales. These excess outlays are denoted by bS_t where b is a constant fraction of sales, S_t.

Because sources of funds must equal their application, Lintner argues that additional external financing is needed to cover increases in cash and accounts receivable. Assuming that cash balances are a fixed ratio of current dollar sales, that a fixed proportion of sales is made on credit, and that the collection period of receivables is not affected by inflation, Lintner argues that the additional demands for external funds is a fixed fraction, a, of the increase in current dollar sales. The total demand for external funds is therefore $F_t = bS_t + aS_t$. Fig. 20 presents a numerical example which demonstrates that in these circumstances the ratio of external funds to sales, F_t/S_t increases with inflation rates. The assumptions are: 10% inflation from year 1 to year 2, and 30% inflation from year 2 to year 3; $a = 0.6$, and $b = 0.1$. As can be seen, the ratio of external financing to sales increases from 15.4% in year 2 to 23.8% in year 3. Since by assumption profits before and after tax rise proportionally to sales and since dividends are a fixed proportion of net profit, it follows that the ratio of external to internal financing (retained earnings plus depreciation) also increases with inflation. It is important to note that the dependence on external financing increases when inflation *rates* increase, i.e. when the price level rises at an increasing rate. If the price level rises at a constant rate, external funds will be proportional to sales and internal funds; if inflation rates decline, the dependence on external funds will decrease. The case of constant inflation rates is illustrated in the last column of the figure in which the inflation rate is assumed to be 10% from year 3 as well as from year 1 to year 2. As can be seen, $F_t/S_t = 15.4\%$, as in the year 1 column.

This analysis leads Lintner (1975, *op. cit.*) to conclude (pp. 273-74) that under the assumptions made, the real value of the firm's profits will not change with inflation, but more external financing will be required with rising inflation. Consequently, the share of the *outstanding* stock in the firm's profits (whose real value is unchanged) is reduced. This in turn reduces the *outstanding* equity value.

IS INDEXATION THE ANSWER TO ALL INFLATION PROBLEMS?

In a number of countries, among them some Latin American countries and Israel, indexation has been tried as a way of coping with inflation. The procedure involves price level adjustment of such items as depreciation, inventory, and wages. Theoretically, applying complete indexation could provide the answer to inflation for the firm. In practice, complete indexation is virtually impossible to achieve. One practical difficuly is the fact that inflation is not neutral and different revenue and cost items are affected differently. In particular, suppose that wages and other cost items are affected proportionally to the Consumer Price Index while the firm's product price rises more slowly. This situation would reduce the firm's profit. The uncertainty about future prices increases the real cost of capital and reduces investment. Indexation may reduce this uncertainty in some cases but increase it in others. For example, an exporting firm may suffer losses if exchange rates do not fully adjust to changes in the price level, since indexation (say, of wages) only reduces the firm's flexibility. The history of indexation shows that in fact it does not provide an effective means of fighting inflation. Its mere existence, moreover often creates the illusion that a way has been found, an illusion that prevents search for a really effective solution.

Fig. 1: Inflation Rates in Selected Countries, 1961-79.

Year	United States	Canada	United Kingdom	Australia	Brazil	Netherlands
1961	1.0	0.0	3.9	1.0	43.3	2.9
1962	1.0	1.9	2.8	0.0	60.8	0.0
1963	1.9	1.0	1.8	1.0	82.0	4.7
1964	0.9	1.8	4.5	3.7	84.4	5.4
1965	1.8	3.7	5.1	4.9	41.0	6.0
1966	3.6	3.5	4.1	2.6	46.0	4.0
1967	3.8	3.5	2.4	5.0	32.8	3.4
1968	4.1	4.1	4.6	2.6	22.0	3.8
1969	5.3	4.4	5.4	2.8	22.5	7.4
1970	5.9	3.4	6.3	3.9	22.0	3.6
1971	4.3	2.7	9.4	6.1	20.0	7.5
1972	3.2	4.7	7.1	5.8	16.1	7.8
1973	6.3	7.5	9.2	9.4	12.8	7.9
1974	10.8	10.9	16.0	14.5	27.0	9.8
1975	9.1	10.7	24.2	24.2	28.8	10.5
1976	5.8	7.5	16.5	16.5	41.9	8.8
1977	6.5	8.0	15.8	15.8	43.7	6.4
1978	7.8	9.0	8.3	7.9	38.7	4.1
1979	13.1	12.5	21.3	12.3	61.0	5.2
Average						
1961-72	3.1	2.9	4.8	3.2	41.1	4.7
1972-79	8.5	9.4	15.9	14.4	36.3	7.5
1961-79	5.1	5.3	8.9	7.2	39.3	5.8

Fig. 2: Income, Tax and Dividends of Non-Financial Corporations in the United States, 1973-1977

(in billions of dollars)

	1973	1974	1975	1976	1977
Income before tax	92.7	102.9	102.3	130.6	141.8
Tax	39.6	42.7	40.8	53.7	57.0
Income after tax	53.1	60.2	61.5	76.9	84.8
Inflation-adjusted income after tax	36.3	16.8	37.5	48.3	53.2
Dividends	23.9	25.4	28.8	32.2	37.9
Pay-out ratio (%) based on					
reported income	45.0	42.2	46.8	41.9	44.7
adjusted income	65.8	151.2	76.8	66.7	71.2

Source: David Hale, "Inflation Accounting and Public Policy Around the World," Financial Analysts Journal, November/December 1978, pp. 28-40.

Fig. 3: An Example Showing the Effect of 10% Neutral Inflation on the EPS of an Unlevered Firm ($)

	First Year	Second Year
Assets	100	110
EBIT	20	22
Tax	10	11
Net income	10	11
Number of shares	10	10
EPS	1	1.1
EPS^R	1	1

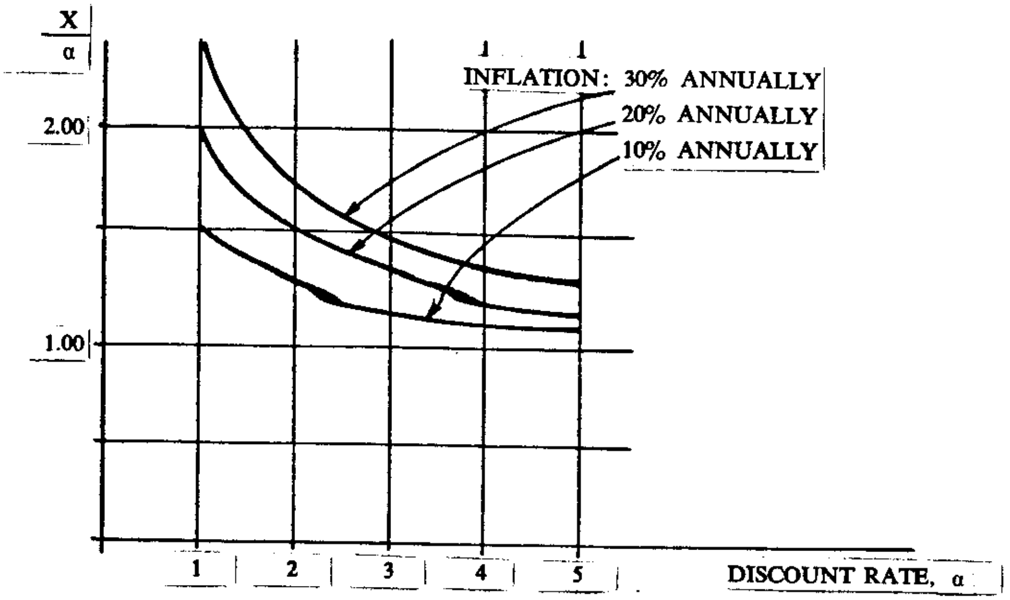
Fig. 4: An Example Showing the Impact of 10% Neutral Inflation on EPS^C *of a Levered Firm ($)*

	First year	Second year
Assets	100	110
Debt	50	50
Equity	50	60
EBIT	20	22
Interest	5	10.5
Taxable income	15	11.5
Tax	7.5	5.75
Net income	7.5	5.75
Number of shares	5	5
EPS	1.5	1.150
EPS^C	1.5	1.045

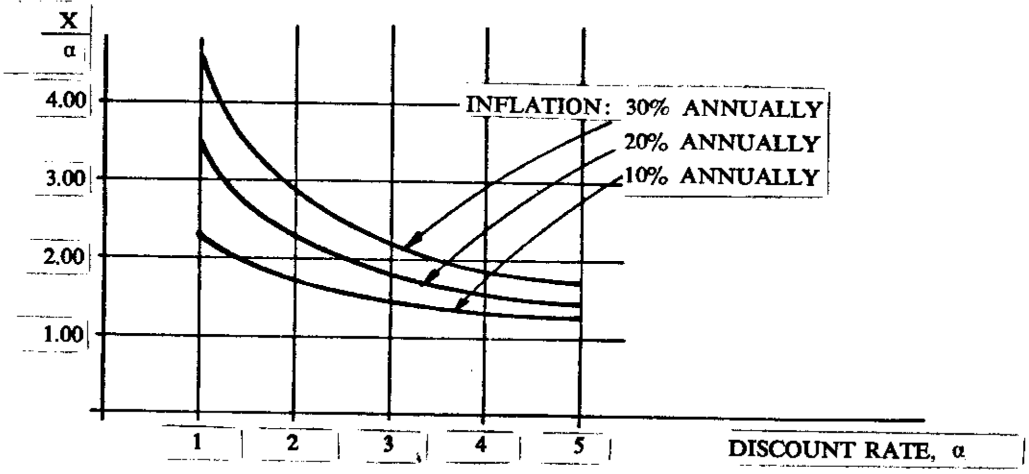
Fig. 5: Inflation-Adjusted Discount Per cent for Selected Credit Terms and Inflation Rates

ANNUAL INFL. RATE	NET 30 DAYS					NET 60 DAYS					NET 90 DAYS				
	1/10	2/10	3/10	4/10	5/10	1/10	2/10	3/10	4/10	5/10	1/10	2/10	3/10	4/10	5/10
5.	1.27	2.27	3.26	4.26	5.26	1.67	2.66	3.65	4.65	5.64	2.07	3.06	4.05	5.04	6.03
6.	1.32	2.32	3.31	4.31	5.31	1.80	2.79	3.79	4.78	5.77	2.28	3.27	4.26	5.24	6.23
7.	1.37	2.37	3.36	4.36	5.36	1.93	2.92	3.91	4.90	5.89	2.49	3.47	4.46	5.44	6.43
8.	1.42	2.42	3.41	4.41	5.41	2.06	3.05	4.04	5.03	6.02	2.69	3.68	4.66	5.64	6.62
9.	1.47	2.47	3.46	4.46	5.45	2.18	3.17	4.16	5.15	6.14	2.90	3.88	4.86	5.84	6.82
10.	1.52	2.52	3.51	4.51	5.50	2.31	3.30	4.28	5.27	6.26	3.10	4.08	5.05	6.03	7.01
11.	1.57	2.57	3.56	4.55	5.55	2.43	3.42	4.41	5.39	6.38	3.30	4.27	5.25	6.23	7.20
12.	1.62	2.62	3.61	4.60	5.60	2.56	3.54	4.53	5.51	6.50	3.49	4.47	5.44	6.42	7.39
13.	1.67	2.67	3.66	4.65	5.65	2.68	3.66	4.65	5.63	6.61	3.69	4.66	5.63	6.61	7.58
14.	1.72	2.71	3.71	4.70	5.69	2.80	3.78	4.77	5.75	6.73	3.88	4.85	5.82	6.79	7.77
15.	1.77	2.76	3.75	4.75	5.74	2.92	3.90	4.88	5.86	6.84	4.07	5.04	6.01	6.98	7.95
20.	2.00	2.99	3.98	4.97	5.96	3.51	4.48	5.46	6.43	7.41	5.01	5.97	6.93	7.89	8.85
25.	2.23	3.21	4.20	5.19	6.18	4.07	5.04	6.01	6.97	7.94	5.91	6.86	7.81	8.76	9.71
30.	2.44	3.43	4.41	5.40	6.38	4.61	5.57	6.53	7.50	8.46	6.77	7.71	8.65	9.59	10.54
35.	2.65	3.63	4.62	5.60	6.59	5.13	6.08	7.04	8.00	8.96	7.60	8.53	9.46	10.40	11.33
40.	2.85	3.83	4.81	5.79	6.78	5.62	6.58	7.53	8.48	9.44	8.40	9.32	10.25	11.17	12.10
45.	3.04	4.02	5.00	5.98	6.96	6.11	7.06	8.00	8.95	9.90	9.16	10.08	11.00	11.92	12.84
50.	3.23	4.21	5.18	6.16	7.14	6.57	7.52	8.46	9.40	10.35	9.91	10.82	11.73	12.64	13.55
60.	3.58	4.56	5.53	6.51	7.48	7.46	8.39	9.33	10.26	11.20	11.32	12.22	13.11	14.01	14.90
70.	3.92	4.89	5.86	6.83	7.80	8.29	9.22	10.14	11.07	11.99	12.65	13.53	14.41	15.29	16.18
80.	4.23	5.20	6.17	7.13	8.10	9.07	9.99	10.91	11.83	12.75	13.89	14.76	15.63	16.50	17.37
90.	4.53	5.49	6.46	7.42	8.39	9.81	10.72	11.64	12.55	13.46	15.07	15.93	16.79	17.64	18.50
100.	4.81	5.77	6.73	7.70	8.66	10.52	11.42	12.32	13.23	14.13	16.19	17.03	17.88	18.73	19.57

Fig. 6: The Ratio Between the Inflation-Adjusted Discount Per cent X and the No-Inflation Per cent α for Selected Inflation Rates and Net Periods.



(a) NET 30 DAYS



(b) NET 60 DAYS

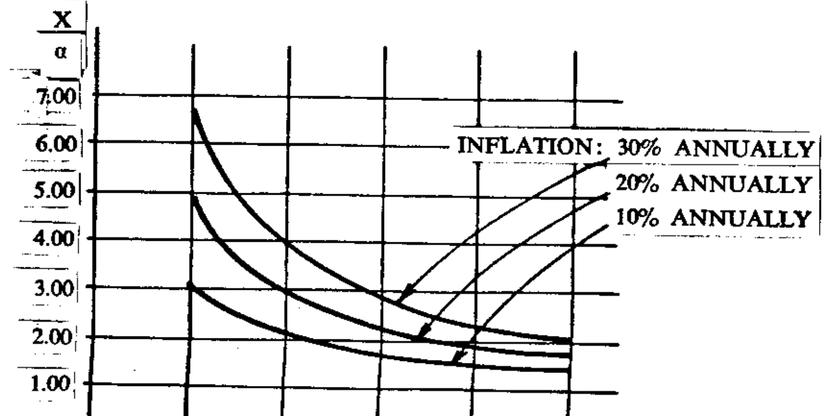
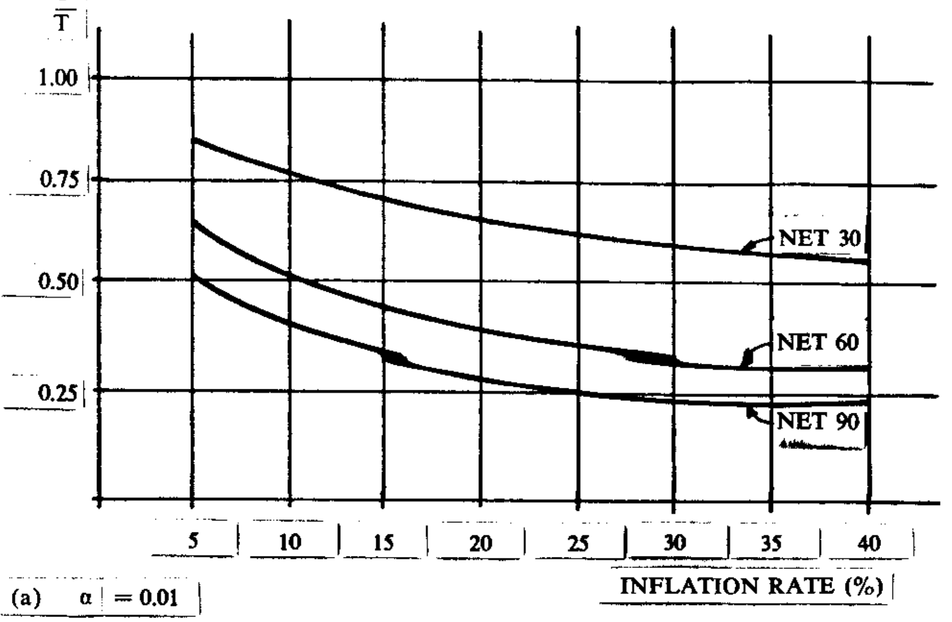


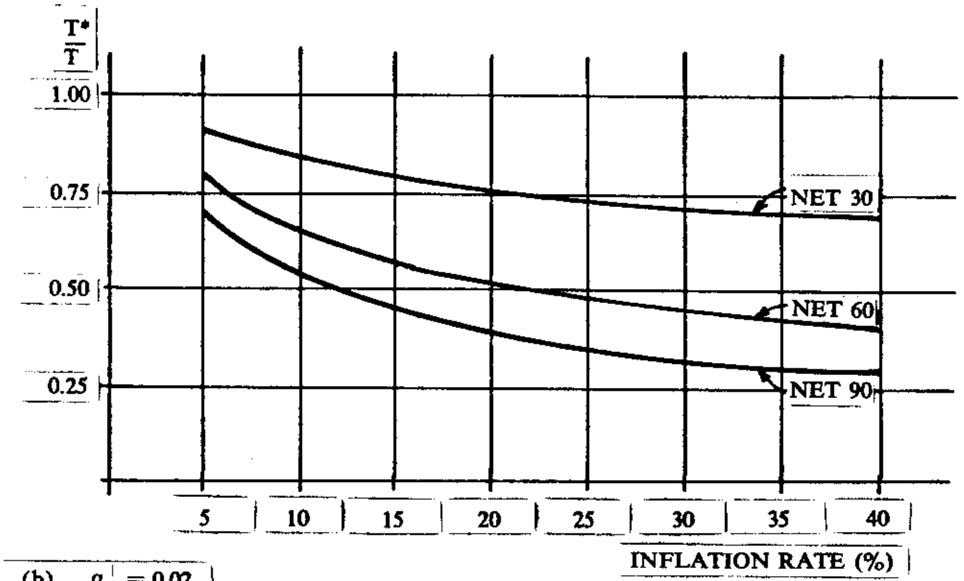
Fig. 7: *Inflation-Adjusted Credit Period for Selected Credit Terms and Inflation Rates*

ANNUAL INFL. RATE	NET 30 DAYS					NET 60 DAYS					NET 90 DAYS				
	1/10	2/10	3/10	4/10	5/10	1/10	2/10	3/10	4/10	5/10	1/10	2/10	3/10	4/10	5/10
5.	26.	28.	28.	29.	29.	40.	47.	51.	53.	54.	46.	62.	69.	73.	76.
6.	23.	27.	28.	29.	29.	39.	46.	49.	52.	53.	44.	59.	66.	71.	74.
7.	25.	27.	28.	28.	29.	35.	44.	48.	51.	52.	42.	56.	63.	68.	72.
8.	24.	27.	28.	28.	28.	34.	43.	47.	50.	51.	39.	53.	61.	66.	70.
9.	24.	26.	27.	28.	28.	33.	41.	45.	49.	50.	37.	51.	59.	64.	66.
10.	23.	26.	27.	28.	28.	31.	40.	45.	48.	50.	36.	49.	57.	62.	66.
11.	23.	26.	27.	28.	28.	30.	39.	44.	47.	49.	34.	47.	55.	61.	65.
12.	22.	25.	27.	27.	28.	29.	38.	43.	46.	48.	33.	45.	54.	59.	63.
13.	22.	25.	26.	27.	28.	28.	37.	42.	45.	47.	31.	44.	52.	56.	62.
14.	22.	25.	26.	27.	28.	28.	36.	41.	44.	47.	30.	42.	51.	56.	61.
15.	21.	24.	26.	27.	27.	27.	35.	40.	44.	46.	29.	41.	49.	55.	60.
20.	20.	23.	25.	26.	27.	24.	32.	37.	41.	43.	26.	36.	44.	50.	54.
25.	19.	22.	24.	25.	26.	22.	30.	35.	38.	41.	23.	33.	40.	46.	50.
30.	18.	22.	23.	25.	26.	21.	28.	33.	36.	39.	21.	30.	37.	42.	47.
35.	17.	21.	23.	24.	25.	20.	26.	31.	34.	37.	20.	28.	35.	40.	44.
40.	17.	20.	22.	24.	25.	19.	25.	29.	33.	36.	19.	27.	33.	38.	42.
45.	17.	20.	22.	23.	24.	18.	24.	28.	32.	35.	18.	25.	31.	36.	40.
50.	16.	19.	21.	23.	24.	17.	23.	27.	31.	33.	18.	24.	30.	34.	38.
60.	16.	19.	21.	22.	23.	16.	22.	26.	29.	32.	17.	22.	27.	32.	35.
70.	13.	18.	20.	22.	23.	16.	20.	24.	27.	30.	16.	21.	25.	30.	33.
80.	15.	18.	20.	21.	22.	15.	20.	23.	26.	29.	15.	20.	24.	28.	32.
90.	14.	17.	19.	21.	22.	15.	19.	22.	25.	28.	15.	19.	23.	27.	30.
100.	14.	17.	19.	20.	21.	15.	18.	22.	24.	27.	15.	19.	22.	26.	29.

Fig. 8: The Ratio Between the Inflation-Adjusted Net Period (T*) and the No-Inflation Net Period (T) for Selected Net Periods and Discount Per cents. Discount is offered in the First 10 days After Purchase.



(a) α = 0.01



(b) α = 0.02

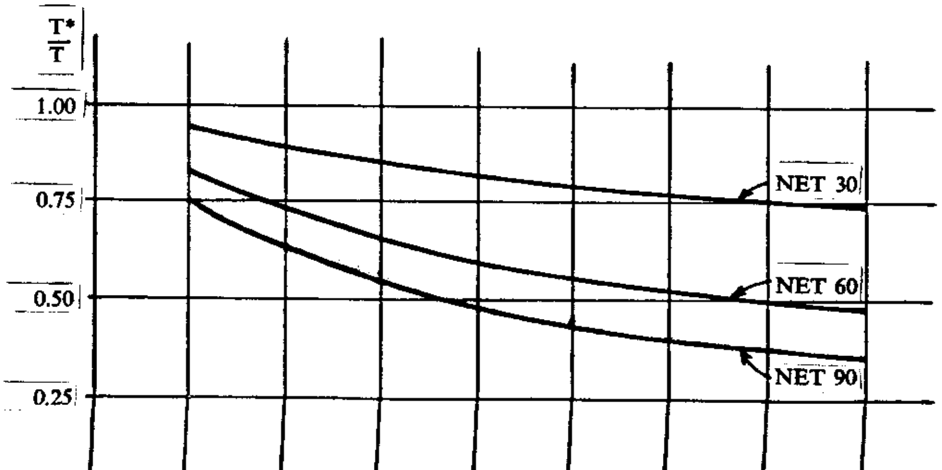


Fig. 9: Projects A-E Cash Flows and NPV and UAS

Project	A	B	C	D	E
n	1	2	5	10	∞
I	1000	1000	1000	1000	1000
S_t	1380	837	514	412	380
D_t	1000	500	200	100	0
$(1 - T)S_t + TD_t$	1190	668	357	256	190
NPV	92	176	390	642	1,111
UAS	100	100	100	100	100

Fig. 10: Project B's Cash Flow, With and Without Inflation

	0	1	2
I. No inflation			
I_0	-1000	-	-
S_t	-	836.95	836.95
D_t	-	500.00	500.00
$(1 - T)S_t + TD_t$		668.48	668.48
II. With Inflation			
I_0	-1000	-	-
S_t	-	1004.34	1205.21
D_t	-	500.00	500.00
$(1 - T)S_t + TD_t$		752.17	852.61

Fig. 11: Present Value of Depreciation by Selected Service Lives and Inflation Rates: SL, DDB, SYD, for $r = 0.05$

Inflation rate h		Service life of the asset, n								
		3	4	5	6	7	8	12	16	20
0.00	SL	0.908	0.886	0.866	0.846	0.827	0.808	0.739	0.677	0.623
	DDB	0.923	0.914	0.896	0.878	0.861	0.845	0.784	0.730	0.682
	SYD	0.923	0.908	0.894	0.880	0.867	0.854	0.804	0.759	0.718
0.02	SL	0.873	0.845	0.818	0.792	0.767	0.744	0.658	0.587	0.526
	DDB	0.907	0.882	0.858	0.835	0.813	0.792	0.716	0.652	0.598
	SYD	0.893	0.874	0.855	0.837	0.820	0.803	0.740	0.685	0.636
0.05	SL	0.825	0.788	0.753	0.721	0.690	0.661	0.561	0.482	0.419
	DDB	0.870	0.837	0.806	0.776	0.749	0.723	0.632	0.561	0.503
	SYD	0.852	0.827	0.802	0.779	0.757	0.735	0.659	0.595	0.540
0.10	SL	0.755	0.707	0.663	0.622	0.586	0.552	0.442	0.363	0.305
	DDB	0.816	0.772	0.731	0.694	0.661	0.629	0.528	0.453	0.396
	SYD	0.791	0.757	0.726	0.696	0.668	0.643	0.544	0.483	0.427
0.15	SL	0.694	0.638	0.588	0.544	0.505	0.469	0.360	0.286	0.235
	DDB	0.768	0.715	0.669	0.627	0.590	0.556	0.452	0.380	0.327
	SYD	0.737	0.698	0.661	0.628	0.597	0.569	0.475	0.405	0.351
0.20	SL	0.641	0.580	0.527	0.481	0.440	0.405	0.300	0.234	0.190
	DDB	0.725	0.666	0.616	0.571	0.533	0.498	0.395	0.327	0.279
	SYD	0.690	0.646	0.606	0.571	0.538	0.508	0.414	0.346	0.297
0.40	SL	0.486	0.418	0.381	0.319	0.283	0.254	0.176	0.133	0.106
	DDB	0.591	0.522	0.466	0.420	0.382	0.350	0.263	0.210	0.175
	SYD	0.547	0.495	0.451	0.414	0.381	0.353	0.270	0.217	0.181

Fig. 12: Present Value of Depreciation Stream of SL, DDB and SYD;
Rate of Inflation = 0.05, Rate of Discount = 0.05

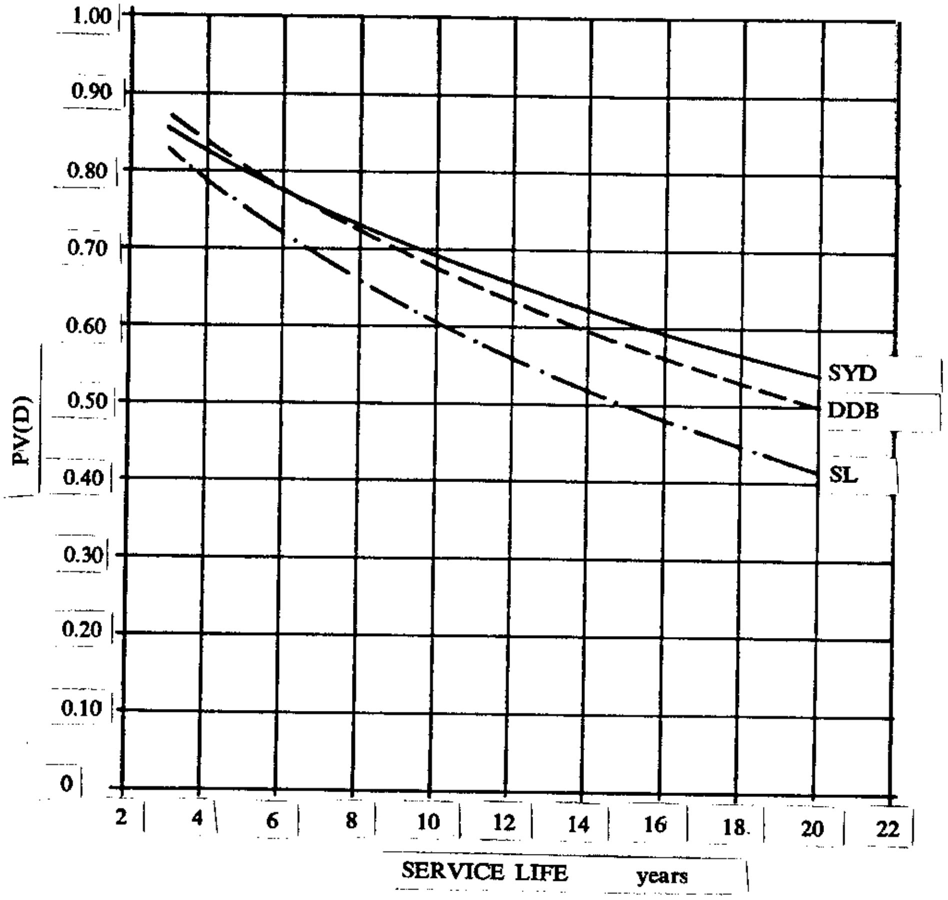


Fig. 13: Present Value of Depreciation Stream of SL, DDB and SYD; Rate of Inflation = 0.30, Rate of Discount = 0.05

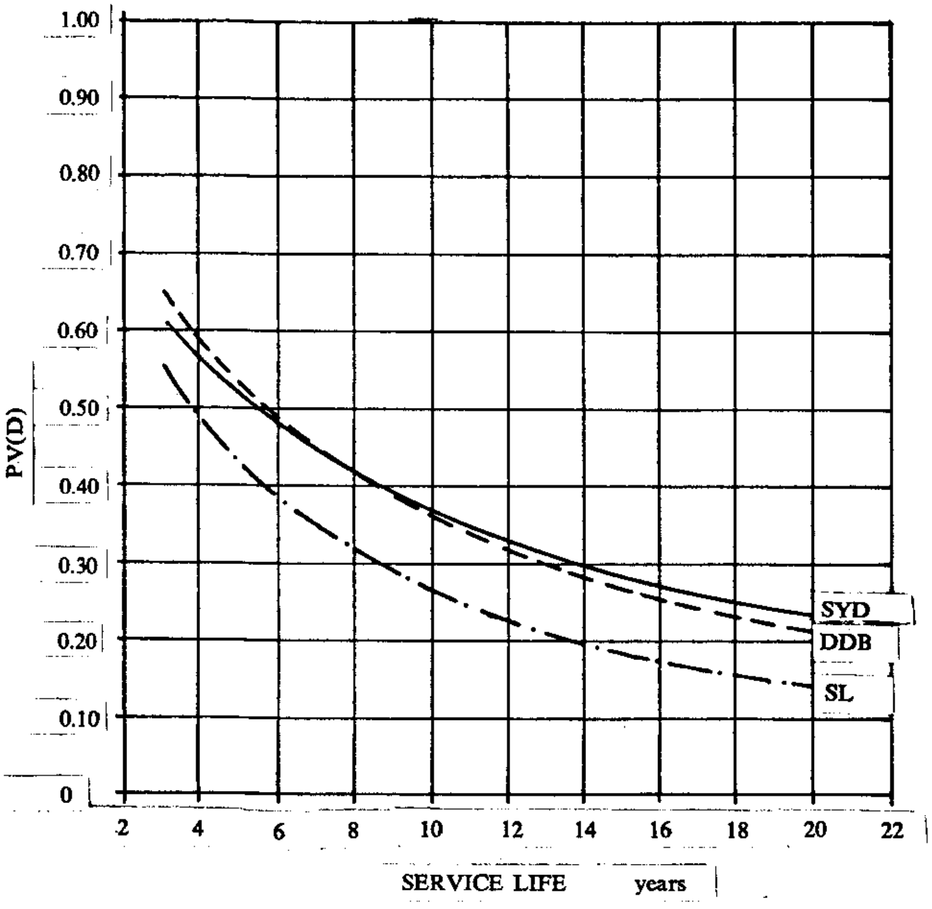


Fig. 14: Ratio of Present Value of DDB and SYD Depreciation under Inflation to SL Without Inflation, for r = 0.05

Inflation rate h		Service life of the asset, n									
		3	4	5	6	7	8	12	16	18	20
0.00	DDB	1.03	1.03	1.03	1.04	1.04	1.05	1.06	1.08	1.09	1.09
	SYD	1.02	1.02	1.03	1.04	1.05	1.06	1.09	1.12	1.14	1.15
0.01	DDB	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
	SYD	1.00	1.00	1.01	1.01	1.02	1.02	1.04	1.06	1.07	1.08
0.02	DDB	1.00	0.99	0.99	0.99	0.98	0.98	0.97	0.96	0.96	0.96
	SYD	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.01	1.02	1.02
0.03	DDB	0.99	0.98	0.97	0.96	0.96	0.95	0.93	0.91	0.91	0.90
	SYD	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96
0.05	DDB	0.96	0.94	0.93	0.92	0.91	0.89	0.86	0.83	0.82	0.81
	SYD	0.94	0.93	0.93	0.92	0.92	0.91	0.89	0.88	0.87	0.87
0.10	DDB	0.90	0.87	0.84	0.82	0.80	0.78	0.71	0.67	0.65	0.64
	SYD	0.87	0.85	0.84	0.82	0.87	0.80	0.75	0.71	0.70	0.69
0.15	DDB	0.85	0.81	0.77	0.74	0.71	0.69	0.61	0.56	0.54	0.52
	SYD	0.81	0.79	0.76	0.74	0.72	0.70	0.64	0.60	0.58	0.56
0.20	DDB	0.80	0.75	0.71	0.68	0.64	0.62	0.53	0.48	0.46	0.45
	SYD	0.76	0.73	0.70	0.67	0.65	0.63	0.56	0.51	0.49	0.48
0.40	DDB	0.65	0.59	0.54	0.50	0.46	0.43	0.36	0.31	0.29	0.28
	SYD	0.60	0.56	0.52	0.49	0.46	0.44	0.37	0.32	0.30	0.29

Fig. 15: Ratio of Present Value of Depreciation of DDB and SYD Plus the Value of the Investment Tax Credit (Assuming 10%) to SL with Zero Inflation, $r = 0.05$

Inflation rate h		Service life of the asset, n								
		3	4	5	6	7	8	12	16	20
0.00	DDB	1.03	1.06	1.06	1.09	1.10	1.13	1.16	1.18	1.21
	SYD	1.02	1.05	1.06	1.09	1.10	1.14	1.18	1.22	1.26
0.01	DDB	1.01	1.04	1.04	1.07	1.07	1.10	1.11	1.12	1.13
	SYD	1.00	1.03	1.04	1.07	1.08	1.11	1.14	1.17	1.20
0.02	DDB	1.00	1.02	1.02	1.04	1.04	1.07	1.06	1.07	1.07
	SYD	0.98	1.01	1.01	1.04	1.05	1.08	1.10	1.12	1.13
0.03	DDB	0.99	1.00	1.00	1.02	1.01	1.04	1.02	1.02	1.01
	SYD	0.97	0.99	0.99	1.02	1.02	1.05	1.06	1.07	1.08
0.05	DDB	0.96	0.97	0.96	0.97	0.96	0.98	0.95	0.93	0.92
	SYD	0.94	0.96	0.95	0.98	0.97	1.00	0.99	0.98	0.98
0.10	DDB	0.90	0.90	0.87	0.88	0.86	0.87	0.81	0.77	0.75
	SYD	0.87	0.88	0.86	0.88	0.88	0.88	0.84	0.82	0.80
0.15	DDB	0.85	0.83	0.80	0.80	0.77	0.77	0.71	0.66	0.64
	SYD	0.81	0.81	0.79	0.80	0.78	0.79	0.74	0.60	0.68
0.20	DDB	0.80	0.78	0.74	0.73	0.70	0.70	0.63	0.59	0.56
	SYD	0.76	0.75	0.73	0.73	0.71	0.72	0.65	0.61	0.59
0.40	DDB	0.65	0.61	0.56	0.55	0.52	0.52	0.45	0.41	0.39
	SYD	0.60	0.59	0.55	0.54	0.52	0.52	0.46	0.42	0.40

Fig. 16: The NPV, UAS, and IRR of Projects under Different Incentive-Assumptions[a]

n	1	2	5	10	∞
Project	A	B	C	D	E
NPV					
No incentives, no inflation	91.7	175.9	389.0	641.8	1,111.1
Incentives, no inflation	91.7	194.9	446.8	774.9	1,211.1
Incentives and 20% inflation	15.3	118.0	321.2	621.5	1,211.1
UAS					
No incentives, no inflation	100.0	100.0	100.0	100.0	100.0
Incentives, no inflation	100.0	110.87	114.85	120.7	109.0
Incentives and 20% inflation	16.7	67.3	82.6	96.8	109.0
Project	F	G	H	I	J
IRR					
No incentives, no inflation	10.0	10.0	10.0	10.0	10.0
Incentives, no inflation	10.0	11.8	12.6	13.7	11.1
Incentives and 20% inflation	1.7	5.2	7.1	9.7	11.1

---

[a] See text, p. 39.

Fig. 17: The Effect of Investment Incentives on UAS and IRR under 20% p.a. Inflation as a Function of a Project's Lifetime

Fig. 17:

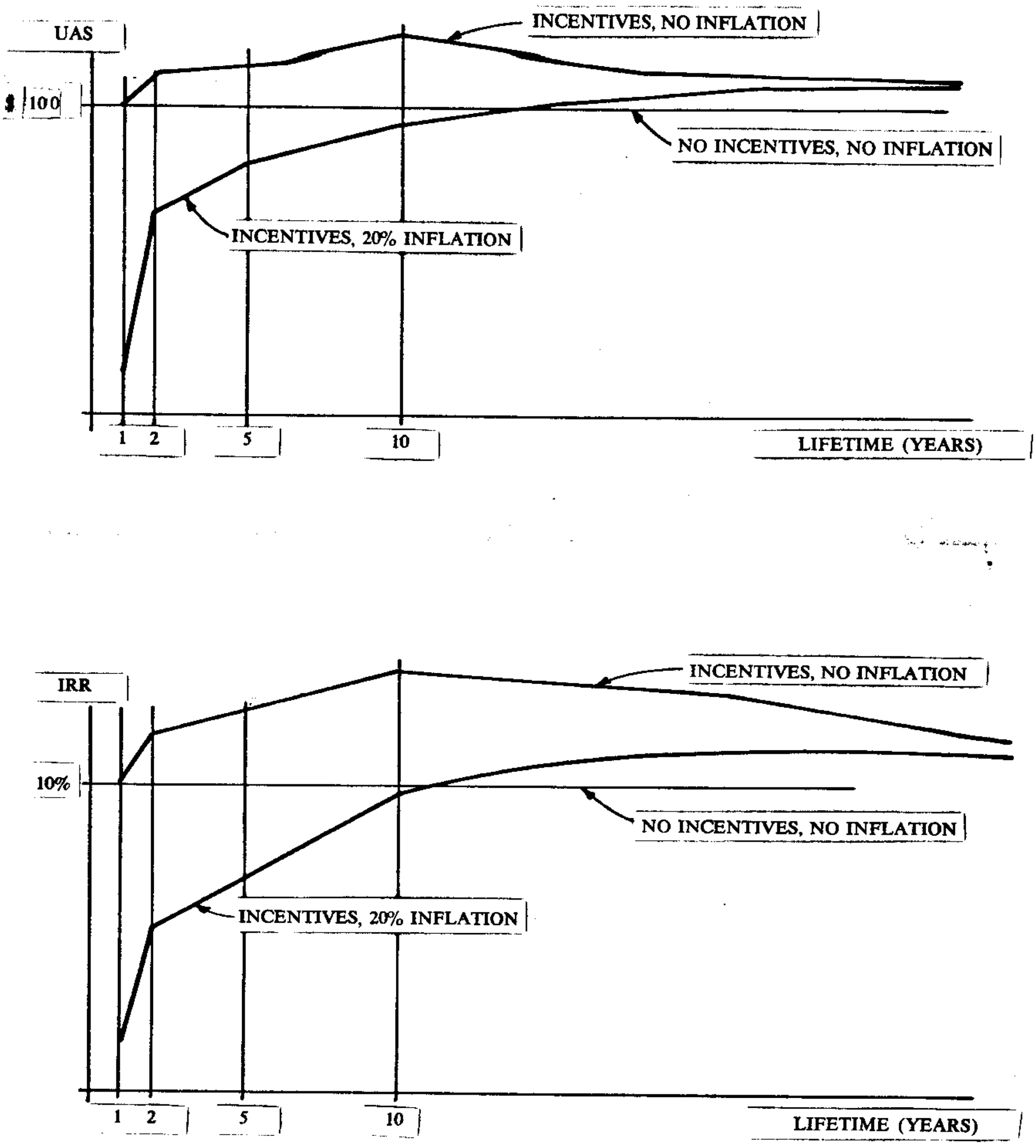


Fig. 18: The Efficient Frontier Between S and B. The Stock Portfolio S is Held Long at the Minimum Variance Portfolio, H

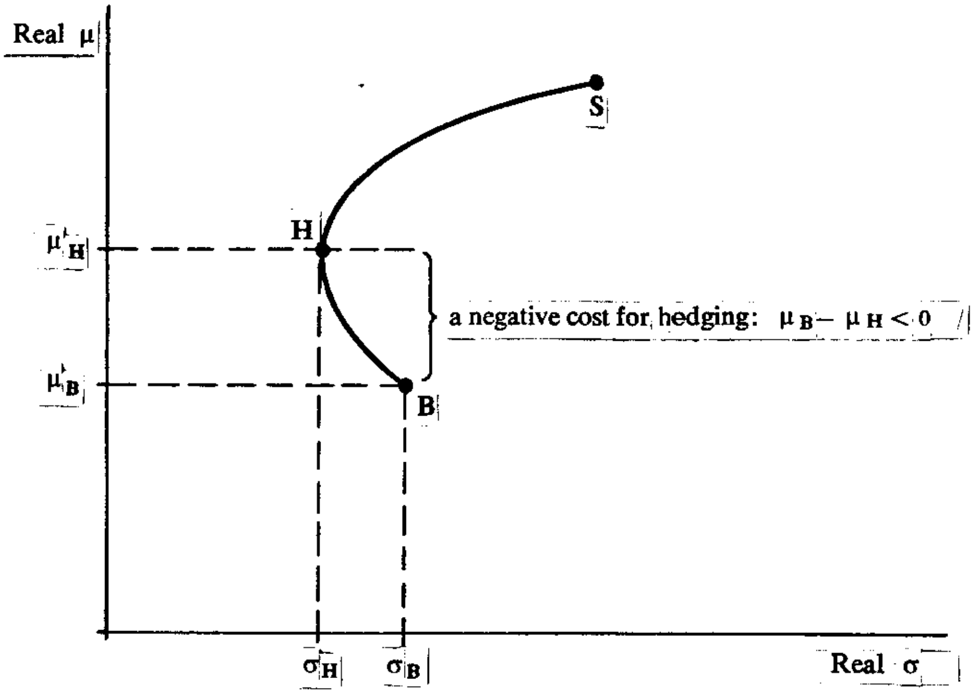


Fig. 19: The Efficient Frontier Between S and B. The Stock Portfolio S is Held Short at the Minimum Variance Portfolio, H

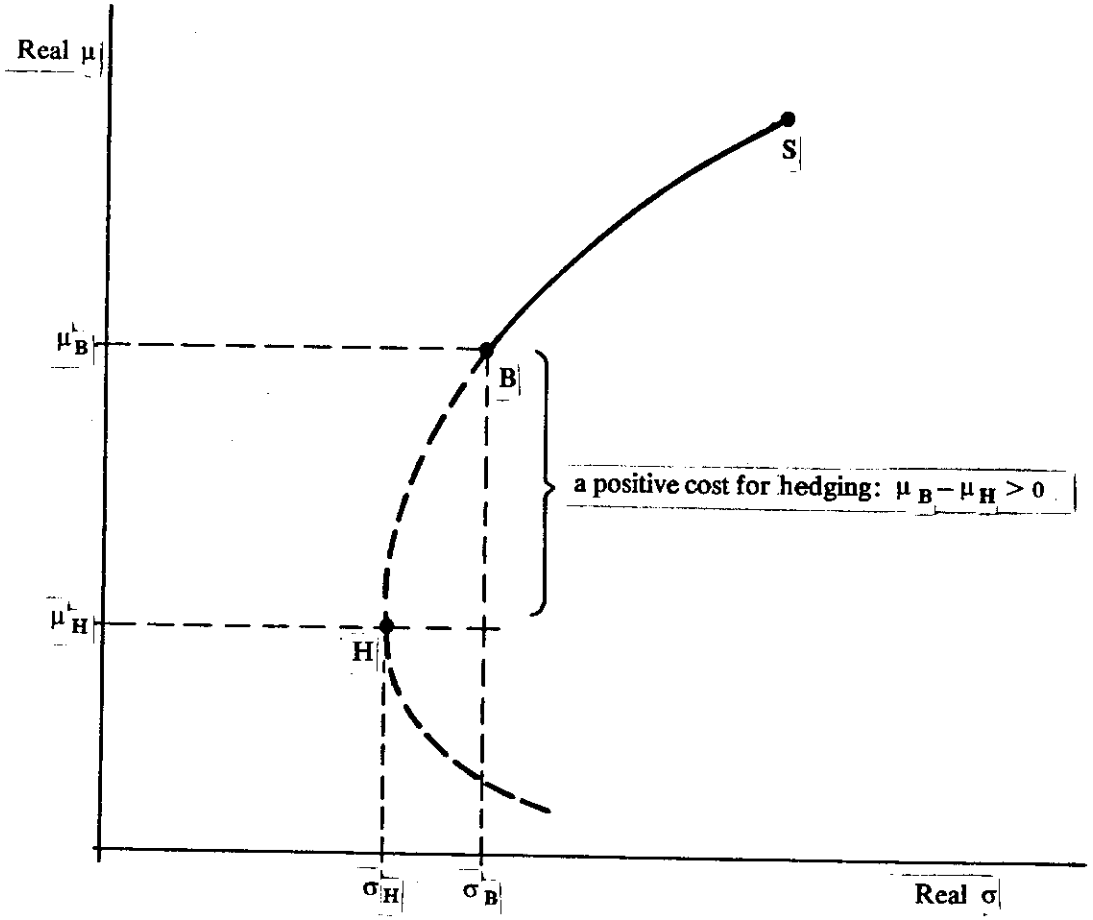


Fig. 20: The Need for External Funds under Constant Inflation Rate and under Increasing Inflation Rate

	Year 1	Year 2	Year 3	
			case 1	case 2
Inflation rate p.a.		10%	30%	10%
S_t	1,000	1,100	1,430	1,210
ΔS_t	-	100	330	110
$bS_t = 0.1S_t$	100	110	143	121
$a\Delta S_t = 0.6\Delta S_t$	-	60	198	66
$F_t = (3) + (4)$	-	170	341	187
F_t/S_t, %	-	15.4	23.8	15.4

SOURCES AND SUGGESTED REFERENCES

Bodie, Zvi, "Common Stocks as a Hedge Against Inflation," Journal of Finance, XXXI, No. 2, May 1976, pp. 459-70.

Brigham, Eugene F., Financial Management, The Dryden Press, 1977.

Fisher, Irving, The Purchasing Power of Money, MacMillan, New York, 1920.

Hale, David, "Inflation Accounting and Public Policy Around the World," Financial Analysts Journal, November/December 1978, pp. 28-40.

Hicks, John R., Value and Capital, 2nd ed., Clarendon Press, Oxford, 1957.

Kepcke, R.W., "Current Accounting Practices and Proposals for Reform," New England Economic Review, Federal Reserve Bank of Boston, September/October 1976.

Landskroner, Yoram, and Levy, Haim, "Inflation, Depreciation and Optimal Production," European Economic Review, Vol. 12, 1978, pp. 353-67.

Lintner, John, "Inflation and Security Returns," The Journal of Finance, XXX, No. 2, May 1975, pp. 259-80.

Lintner, John, "Inflation and Common Stock Prices in a Cyclical Context," in National Bureau of Economic Research, 53rd Annual Report, September 1973.

Modigliani, Franco, and Cohn, Richard A., "Inflation, Rational Valuation and the Market," Financial Analysts Journal, March/April 1979, pp. 24-44.

Nelson, Charles R., "Inflation and Capital Budgeting," Journal of Finance, XXXI, No. 3, June 1976, pp. 923-31.

Williams, John Burr, Theory of Investment Values, Harvard University Press, Cambridge, 1938.