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INFLATION AND THE VALUATION OF CORPORATE EQUITIES

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ABSTRACT

This paper examines the relationship between inflation and the return on individual corporate securities. This question is of substantial importance in light of the puzzling behavior of the stock market over the last decade. Conventional financial theory holds that equity should be a good inflation hedge since it represents a claim of real rather than nominal assets. Yet a negative relationship between both expected and unexpected inflation and stock market returns has been widely documented. This relationship, which appears to antedate the surge in inflation over the last 15 years. might provide an explanation for the market's surprising recent performance.

This paper studies differences across firms in the response of stock market values to changes in expected inflation in an effort to explore the reasons for the aggregate negative relationship between inflation and stock market values. Two opposing hypotheses about the impact of inflation on market valuation are contrasted. The "inflation illusion" hypothesis holds that investors are not able to see through nominal accounting statements and respond to reported rather than real profits. The opposing "tax effects" hypothesis holds that firms which report spuriously high profits due to inflation are penalized because the extra tax burden incurred reduces real profits.

The results from the 1970's strongly bear out the predictions of the tax effects hypothesis. Aggregate calculations suggest that the interaction of inflation and taxation can account for a large part of the decline in the stock market which has been observed over the past decade. A significant part of the remainder appears to be due to increasing investor awareness of the need to adjust for historic cost depreciation.

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This paper examines the relationship between inflation and the return on individual corporate securities. This question is of substantial importance in light of the puzzling behavior of the stock market over the last decade. Investors in the stock market have received a negative real rate of return over the last 15 years. Over the last decade the value of the q ratio of the market value of the corporate capital stock to its replacement cost has declined from 1.05 to .561. The evident low and declining market valuation of corporate capital in the face of high inflation has important implications for economic performance and poses a serious challenge to reigning theories of market efficiency.

Conventional financial theory holds that equity should be a good inflation hedge since it represents a claim on real rather than nominal assets. To the extent that firms are net debtors, real equity values should be increased by unexpected inflation. Yet a negative relationship between both expected and unexpected inflation and stock market returns has been widely documented. This relationship, which appears to antedate the surge in inflation over the last 15 years, might provide an explanation for the market's surprising recent performance.

The apparently anomalous relationship between inflation and market valuation may cast doubt on the widely accepted hypothesis of market efficiency. Certainly the recent performance of the stock market raises the possibility that stock prices may not be rationally related to underlying economic realities. Shoven, Brainard and Weiss (1980) find the decline in the market valuation of corporate capital inexplicable on the

[1] Studies demonstrating the negative relationship between inflation and stock market returns include Bodie (1976), Fama and Schwert (1977), Jaffe and Mandellcer (1976) and Nelson (1976).

basis of changes in expected future profitability, real interest rates, or risk premia. Modigliani and Cohn (1979) suggest that the market valuations of corporate capital reflect a systematic confusion of real and nominal interest rates. Shiller (1980), on the basis of volatility considerations, is also led to doubt the rationality of market valuations.

This paper studies differences across firms in the response of stock market values to changes in expected inflation in an effort to explore the reasons for the aggregate negative relationship between inflation and stock market values. Two opposing hypotheses about the impact of inflation on market valuation are contrasted. The "inflation illusion" hypothesis holds that investors are not able to see through nominal accounting statements and respond to reported rather than real profits. It implies that by choosing accounting methods such as FIFO inventory valuation which raise reported profits, in the presence of inflation with no impact on real economic income firms can increase their market value. The alleged failure of investors to recognize that only real, not nominal, interest payments should be treated as costs in computing profits is a lynchpin of the Modigliani-Cohn hypothesis.

The opposing "tax effects" hypothesis advanced by Feldstein (1979, 1980) and Summers (1981) holds that firms which report spuriously high profits due to inflation are penalized because the extra tax burden incurred reduces real profits. As Feldstein and Summers (1979) discuss, the effective tax rate on real corporate capital income is very sensitive to the rate of inflation. The "tax effects" hypothesis explains the recent decline in the market in terms of the extra tax burden caused by historic cost depreciation and FIFO inventory accounting.

These two hypotheses offer opposing predictions as to the characteristics of firms which benefit from increases in the expected rate of inflation. For example, the inflation illusion hypothesis would predict that unlevered firms using FIFO inventory accounting, and having substantial depreciation allowances would benefit relative to other firms since their relative reported profits would increase. The "tax effects" hypothesis has the opposite implication since these firms would have the greatest increase in their real tax burdens arising from inflation. Since firms differ widely in their depreciation practices, methods of inventory accounting, and leverage, the elements of truth in these two hypotheses can be examined. These differences in firm characteristics are the basis for the empirical work reported here. The econometric tests are based on data on 1200 firms over a 15 year period.

The results from the 1970's strongly bear out the predictions of the tax effects hypothesis. Aggregate calculations suggest that the interaction of inflation and taxation can account for a large part of the decline in the stock market which has been observed over the past decade. A significant part of the remainder appears to be due to increasing investor awareness of the need to adjust for historic cost depreciation.

Section I of this paper outlines the theory of market valuation and firm behavior which provides the basis of the empirical tests and develops the implications of the competing hypotheses. Section II discusses the construction of the variables and econometric methods used in the empirical work. The third section presents the empirical results and some further tests. The fourth section of the paper relates the results to the problem of explaining aggregate movements in the stock market. A final section summarizes the results and suggests directions for future research.

I. Inflation and Stock Market Valuation

This section outlines the theory of market valuation underlying the empirical tests in this paper. A central issue in modelling the market valuation of firms is the choice between a model which values firms only on the basis of their current assets, and one which assumes that market value of firms at a point in time includes the market's valuation of future investment opportunities. The former view is appropriate only if it is assumed that firms expect to earn no inframarginal returns on future investments. The large marginal adjustment costs found in Summers (1981) suggest that in fact firms do earn substantial inframarginal returns. This inference is supported by the substantial fraction of the variance in market returns which is due to fluctuations in the q ratio. For these reasons, in what follows, it is assumed that firms are valued as going concerns. That is, it is assumed that firms are committed to find future investment plans, and that changes in the expected return on these investments are incorporated in current market valuations.[2]

The simplest valuation model in which stock market prices depend on the present value of future expected real dividends is postulated. That is:

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[2]Ideally, it would be desirable to recognize that future investment plans respond to the same developments which influence current market valuation. This makes it impossible to obtain analytical expressions for the change in market value occurring due to inflation. I discuss the simultaneous determination of investment and market valuation in more detail in Summers (1981). The envelope theorem insures that for small changes in the rate of inflation the assumptions made here will not introduce error.

$$V_{it} = \sum_{s=t}^{\infty} \frac{Div_{is}^{e}}{(1+\rho_i)^{s-t}} \tag{1}$$

Where $_i$ is the appropriate discount for firm i given its risk characteristics,[3] and V_{it} is the total value of the firm.

It is assumed that firms are expected to grow at rate g, and to finance a constant fraction (1 - b) of new investment out of retained earnings with the remainder financed out of debt issues. These assumptions about financial policy are satisfactory for the issues considered here. New share issues are a negligible source of finance for the large unregulated corporations which comprise the sample. While inflation may induce some increase in debt equity ratios, as argued by Gordon (1980), the envelope theorem suggests that omitting this effect should not distort the results. Recognizing that retentions and dividends exhaust after tax profits, it follows that:

$$V_{it} = \sum_{s=t}^{\infty} \frac{{}_tP_{is}^{e}}{(1+\rho_i)^{s-t}} - \frac{(1 - b)gK_t(1 + p_i)}{(\rho_i - g)} \tag{2}$$

where ${}_tP_{is}^{e}$ represents the expectation at time t of the profits of firm i at the time s, and K represents the current replacement cost of the capital stock and b the fraction of new investment financed using debt. Equation (2) is the familiar statement that the market valuation of a firm represents the present value of expected future profits less adjustments to avoid double counting retentions.

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[3] Since the focus of this study is on differences between individual firms personal taxes are neglected here. As discussed below, taking account of personal taxation would not change the substantive results. The assumption of a constant real discount rate ρ is made for simplicity and could easily be relaxed.

Equation (2) provides a basis for examining the impact of changes in the expected rate of inflation on security returns. The one period holding return on a share of stock is the sum of the dividend yield and capital gain. That is:

$$R_{it} = \frac{Div_{it}}{V_{it}} + \frac{V_{it+1} - V_{it}}{V_{it}} \tag{3}$$

since the assumption that the number of shares outstanding is constant insures that total market valuation is proportional to the price of an individual share of stock. Equations (2) and (3) imply that the ex-post real return on a security is given by:[4]

$$R_{it} = \rho + \sum_{s=t}^{\infty} \frac{({}_{t+1}P^{e}_{is} - {}_{t}P^{e}_{is})}{(1 + \rho_i)^{s}\, V_{it}} \tag{4}$$

Equation (4) implies that the return on a security has two components, the required expected rate of return which equals the discount rate ρ, and a second term reflecting news which leads to the revision of expectations about future profits.

It is clear from equation (4) that inflation can affect security returns only by causing revisions in expectations of future profitability.[5] Shareowners will earn the required rate of return ρ unless new information arrives which leads to revisions of expectations. Firms

[4]Note that at time t + 1, profits at time t are known with certainty, so the superscript is superfluous for s = 0.

[5]This statement is true for the model used here. Inflation might also affect security returns by causing changes in ρ. Since the focus of this study is on cross-sectional differences in the relation of inflation to security returns, this issue is not discussed here. The possibility that inflation affects required returns is recognized in the empirical work reported below.

whose profits differ in their sensitivity to inflation should differ systematically in their response to changes in the expected rate of inflation, but when expected inflation is constant their returns should be independent of its level. This important distinction is neglected in many earlier studies of the relationship between inflation and stock prices. Kessel (1956), Alchian and Kessel (1960) and Hong (1977) all provide tests of the "debtor-creditor" hypothesis based on comparisons of the performance of high and low debt firms in periods of high and low inflation. Unless the inflation is unexpected, any advantages or disadvantages of leverage should be capitalized into stock prices so differences in leverage should not affect the rate of return on securities.

French, Ruback and Schwert (1980) make a similar point and focus on unexpected inflation in studying the impact of inflation on cross-sectional variations in security returns. The theory developed here suggests that security returns should depend on revisions of expectations about the entire future path of inflation rather than on unexpected inflation in the current period. It is easy to imagine circumstances where these concepts would differ substantially. Consider for example, an announcement of a shift towards a more expansionary monetary policy. This would have little effect on the contemporaneous rate of inflation, but a potentially large effect on expected future rates of inflation. Only under very restrictive conditions will unexpected inflation be a satisfactory proxy for the revision in long run inflationary expectations.

Inflation may affect expected future profits in at least three ways, through its impact on expectations about the level of economic activity, its impact on the taxes paid by firms with given real pre-tax profits, and its "inflation illusion" impact on investors' expectations about future profitability. Since this study focuses on differences between firms, it focuses on the last two of these effects. Both relate to the differences between real and reported taxable profits in the presence of inflation. The relationships may be clarified by the following identities. Letting P_{it} represent real pre-tax profits and A_{it} the measurement error in profits due to inflation it follows that real after-tax profits are given by:[6]

$$P^R_{it} = (1 - \tau)(P_{it} + A_{it}) - A_{it} = (1 - \tau)P_{it} - \tau A_{it} \qquad (5)$$

If we assume that investors misperceive a fraction μ of the inflation error as real profits, perceived real profits are given by:

$$P^P_{it} = (1 - \tau)P_{it} - (\tau - \mu)A_{it} \qquad (6)$$

If investors fully perceive inflation's effects, $\mu = 0$ and this expression reduces to (5). The effect of inflation on perceived profits thus depends on the sign of the inflation adjustment A_{it}, and on the term $(\tau - \mu)$ reflecting the difference between the tax and misperception effects. Notice that it is possible that the extra taxes firms pay on phantom inflation profits are exactly offset by the extra illusory profits the market perceives. In this case, where $\mu = \tau$ the size of the inflation adjustment has no impact on perceived real profits.

[6] A should be thought of as representing the cumulative effect of historic cost depreciation, FIFO inventory accounting and the effects of leverage. These separate components are analyzed below.

Combining equations (4) and (6) yields an expression for the impact of changes in the expected rate of inflation on security returns:

$$\frac{dR_{it}}{d\Delta\pi^e} = + (\tau - \mu) \sum_{s=t}^{\infty} \frac{\left(\frac{dA_{is}}{d\pi}\right)}{(1 + \rho_i)^{(s-t)} V_{it}} \tag{7}$$

where it has been assumed that inflation has no affect on real pre-tax profitability. This assumption is relaxed in the empirical work reported below. Assuming, as will be justified below, that A is proportional to invested capital yields the more easily interpreted expression:

$$\frac{dR_{it}}{d\Delta\pi^e} = + (\tau - \mu) \frac{\left(\frac{dA_{it}}{d\pi}\right)}{(\rho - g)V_{it}} \tag{8}$$

The three major interactions between inflation and reported profits considered here arise from historic cost depreciation accounting, FIFO inventory accounting, and nominal accounting for net financial liabilities. Because firms differ substantially in the sensitivity of their reported or taxable profits to these accounting conventions, theory suggests that the response of market prices to movements in the expected rate of inflation should also vary. Expressions are derived below which relate the firm's response to changes in inflation to measurable firm characteristics. Because the original motivation for this study was an effort to understand the relationship between inflation and movements in aggregate market valuation, the aggregate impact of each of these adjustments is also considered. Throughout it is assumed that inflation is balanced so that firms realize no real capital gains on their physical assets and that the pre-tax rate of profit is constant. The possibility that the adjustments to profits may be perceived to differing extents is recognized by allowing for a different value of μ for differing inflation adjustments.

FIFO Inventory Accounting

American firms are permitted wide latitude in choosing methods of inventory accounting but are required to use the same methods for both reporting and tax purposes. Two methods, FIFO and LIFO, are in common use. Firms using the former method will show and be taxed on illusory inflation profits whenever prices rise, because the appreciation in the nominal value of their inventories will show up as income, due to the understatement of costs of goods sold. Despite the apparent tax advantage to LIFO approximately 60 percent of US non-financial corporations, with almost half of all inventories, continue to use FIFO inventory accounting. The Department of Commerce estimates that false inventory profits totaled over $40 billion in 1979 and in 1980. In 1980 the voluntary overstatement of inventory profits raised taxes by about 18 billion, compared to total corporate profits taxes of 61 billion. The persistence of FIFO inventory accounting, given the substantial increase in effective tax rates which it causes, is of course a major puzzle. Possible explanations include executive compensation schemes based on reported profits, or the perception on the part of managers that shareholders and potential creditors can be "fooled" by higher reported profits.

The appropriate adjustment to reported profits for phantom inventory profits is:

$$A_{INV} = \pi \cdot FIFO \cdot INV \tag{9}$$

where FIFO represents the fraction of a firm's inventories which are treated using FIFO accounting,[7] and INV is the replacement cost of inventories. If a firm uses FIFO accounting for all its inventories, the replacement cost equals the book value. For simplicity, it is assumed that firms which are currently FIFO have a constant annual probability λ of switching to LIFO, so equation (9) in conjunction with (8) implies that:

$$\left(\frac{dR_{it}}{d\Delta\pi^e}\right)_{INV} = \frac{-FIFO \cdot INV \cdot (\tau - u_{INV})}{(\rho_i - g + \lambda)\ V_{it}} \tag{10}$$

where the subscript on the derivative indicates that it refers to the partial effect of inflation assuming no effects other than those on inventories.

Historic Cost Depreciation

For both book and tax purposes, firms calculate deprecation on a historic cost basis. That is, each year they deduct a fraction of each asset's original acquisition cost rather than its replacement cost. This can dramatically understate true depreciation based on replacement cost. Feldstein and Summers (1979) estimate that replacement cost depreciation exceeded book depreciation by $39.7 billion for the nonfinancial corporate sector in 1977. The understatement had risen to $50 billion by 1980. The understatement of depreciation due to historic cost accounting depends on past as well as contemporaneous inflation, since it is the difference between the current price level and the price level at the time of acquisition. The adjustment to profits due to historic cost

[7] This calculation has a small approximation error because it implicitly assumes that inventories turnover very quickly. A detailed discussion of the adjustment of reported profits for the effects of inflation may be found in Shoven and Bulow (1976).

depreciation can be approximated if it is assumed that depreciation is exponential and the rate of inflation has been approximately constant. That is:

$$A_{DEP} = \delta(K^R - K^H) = \delta K^H \left(\frac{\pi^P}{g + \delta + \pi^P} \right) = \frac{DEP \cdot \pi^P}{g + \delta + \pi^P} \tag{11}$$

where K^H is the book value of the capital stock, K^R is its replacement cost, δ its rate of depreciation and DEP the value of current depreciation allowances.[8] The change in the present value of future inflation adjustments from a change in the expected rate of inflation may be derived as follows.

The present value of future depreciation allowances may be written as the sum of depreciation allowances on existing capital and on capital which will be put in place in the future:

$$PVD_t = \int_t^\infty \delta K^H e^{-(\delta + \rho + \pi^e)(s - t)} ds + \int_t^\infty (g + \delta) K^R e^{-(\rho - g)(s-t)} \cdot$$

$$\int_s^\infty \delta e^{-(\delta+\rho+\pi^e)(u - s)} du ds \tag{12}$$

Carrying out the integrals in (12) yields:

$$PVD = \frac{(\rho + \delta + \pi^P) \cdot DEP}{(\rho - g)(\delta + \rho + \pi^e)} \tag{13}$$

where π^P represents the average past rate of inflation and π^e represents the expected subsequent rate of inflation. Differentiating (13) and using (8) yields:

[8] To verify this calculation note that $K^H = \frac{\delta + g}{\delta + g + \delta} K$.

$$\left(\frac{dR_{it}}{d\Delta\pi^e}\right)_{DEP} = \frac{-(\rho + \delta + \pi^p) \cdot DEP \cdot (\tau - \mu_{DEP})}{(\rho - g)(\delta + \rho + \pi^e)^2 V_{it}} \tag{14}$$

This discussion has so far assumed that tax and reported depreciation are equal and calculated exponentially. In fact many firms report depreciation on a straight line basis, but take exponential depreciation for tax purposes. While this would necessitate altering (14), if $\mu_{DEP} \neq 0$, it does not appear that the difference is quantitatively important.

Firm leverage. The third adjustment to reported profits is for the effect of inflation on nominal financial assets and liabilities of the firm. Firms that are net debtors will underestimate their profits in the presence of inflation. The appropriate interest deduction in calculating profits includes only the real component of interest rates. Feldstein, Poterba and Dicks-Mireaux (1981) estimate that in aggregate nonfinancial corporations realized a gain of $74 billion on their net financial liabilities in 1979. The adjustment for the extra deduction of nominal interest payments is given by:

$$A_{DEBT} = \pi \cdot DEBT \tag{15}$$

where DEBT represents the market value of the firm's outstanding net financial liabilities.

The impact of a change in the expected rate of inflation on expected future profitability depends on the response of interest rates to such changes in expected inflation. This issue is examined in Summers (1981b). Here it is assumed that a one point increase in the expected rate of of inflation raises nominal interest rates by η points. It is probably reasonable to suppose that $\eta \approx 1$ during the recent period. The impact of a change in the expected rate of inflation on security returns operating through this effect is given by:

$$\left(\frac{dR_{it}}{d\Delta\pi^e}\right)_{DEBT} = \frac{(1 - \eta + \tau\eta - \mu_{DEBT}\eta)}{(\rho - g)(V_{it})} \qquad (16)$$

There is a second correction which must be made to reflect the effects of changes in the rate of inflation on the market value of long term debt. An increase in the long run expected rate of inflation will lead to an upwards movement in long-term interest rates, causing firms to realize a capital gain on their existing debt. Unlike the other adjustments to profits which depend on the level of inflation, this one depends only on its rate of change. Its impact on security returns is given by:

$$\left(\frac{dR_{it}}{d\Delta\pi^e}\right)_{DEBTCG} \quad \frac{LT_{DEBT}(1 - e^{-RT})(\eta \cdot (1 - \mu_{DEBTCG}))}{R} \qquad (17)$$

Since unrealized capital gains are not taxed, τ does not appear in (17). The term $(1 - \mu_{DEBTCG})$ rather than μ_{DEBTCG} enters because this adjustment represents an addition to rather than a spurious component of reported profits.

The adjustments described here do not exhaust the ways in which inflation causes real and reported profits to diverge. Firms have a variety of nominal assets and liabilities which do not show up on the standard balance sheet. These include long term leases, pension obligations and nominal labor contracts. These are all neglected because of data limitations. It is hoped that these omissions will not badly bias the overall results though they may be of great importance in evaluating the experience of any individual firm.

Before turning to the econometric estimates, it is useful to examine the extent to which these factors can explain the observed negative relationship between stock market returns and changes in the expected rate of inflation. This can be done by estimating:

$$\frac{dR}{d\Delta\pi^e} = \left(\frac{dR}{d\Delta\pi^e}\right)_{INV} + \left(\frac{dR}{d\Delta\pi^e}\right)_{DEP} + \left(\frac{dR}{d\Delta\pi^e}\right)_{DEBT} + \left(\frac{dR}{d\Delta\pi^e}\right)_{DEBTCG} \tag{18}$$

These variables can be calculated for the non-financial corporate sector using data from the Federal Reserve Board's National Balance Sheets and the National Income and Product Accounts. The details of the calculations are described in an appendix. Table 1 displays estimates of the $\frac{dR}{d\Delta\pi^e}$ under the assumptions that $\mu = 0$, which corresponds to full rationality on the part of investors, and to $\mu = 1$, which corresponds to complete accounting illusion. The calculations are based on equations (10), (14), (16) and (17). It is assumed throughout that ρ, the required real rate of return, is 10 percent, and that g, the expected rate of growth, is .03. These figures are approximate averages of the historical experience. In performing the calculations it is also assumed that inflation has no effect on expectations about future tax law changes. Feldstein and Summers (1980) show that this is reasonable given the timing of past tax reform. Finally, it is assumed $\lambda = 0$, so switchovers to LIFO are not anticipated, and that $\eta = 1$, so interest rates rise point for point with changes in the expected rate of inflation.

TABLE 1

Impact of a 1 Percent Change in Inflationary Expectations on Aggregate Security Returns in 1979

	"Rational Investers" ($\mu = 0$)	"Inflation Illusion" ($\mu = 1$)
$\left(\frac{dR}{d\Delta\pi^e}\right)_{INV}$	-4.21	3.75
$\left(\frac{dR}{d\Delta\pi^e}\right)_{DEP}$	-4.01	3.57
$\left(\frac{dR}{d\Delta\pi^e}\right)_{DEBT}$	2.91	-2.59
$\left(\frac{dR}{d\Delta\pi^e}\right)_{DEBTCG}$	1.85	0
Total	-3.46	4.73

Note: Calculations are performed as described in the Appendix. The estimates are based on data on the non-financial corporate sector at the end of 1979.

At the outset the approximate nature of the calculations in Table 1 should be stressed. The exact figures are sensitive to the choice of ρ and g, and to the other assumptions made. The calculations do however suggest that if the assumption of rationality is maintained, inflation corporate tax interactions can explain a sizable fraction of the decline in the stock market during the last decade. It is reasonable to suppose that the rate of expected long term inflation has risen by 7 points over this interval. This implies that about a 25 percent fall in the level of the market relative to a normal rate of return would result from inflation-tax interactions even if real pre-tax profits and required rates of return were unaffected. In fact market returns during the 1965-1980 period fell short of their long run average level by a total of almost 100 percentage points.

The results in Table 1 also underscore the potential importance of irrationality if it exists. The market would rise by 4.73 percent for each percent of expected inflation if investors responded only to reported profits without regard to inflation adjustments. If as Modigliani and Cohn suggest investors do adjust reported profits for depreciation and inventory accounting effects but do not take account of the impact of nominal interest deductibility, then each 1 percent increase in the rate of expected long-term inflation would reduce market value of 10.8 percent. None of these calculations purport to examine all the channels through which inflation affects security returns. Inflation will also affect expected future profitability, and the required rate of return.

Aggregate data are clearly not rich enough to identify the extent to which the market recognizes the effects of inflation discussed here. Since firms differ substantially in their leverage inventory accounting policies and extents depreciation of cross-section data can shed light on the market's recognition of inflation. Before turning to the econometric tests, it is useful to examine the extent of inter-firm variation in inflation susceptibility. Estimates of the impact of inflation on the security returns for the 30 Dow Jones companies under the assumptions of complete rationality and full illusion are displayed in Table 2, along with the components of the effects of inflation. The data underlying these calculations are described in more detail in the succeeding section. They indicate that inflation adversely affects the market valuation of most firms, if all the effects are perceived. The effect ranges up to 8.5 percent for United Technologies and 10.62 percent for Chrysler. These calculations suggest that a percentage point change in the expected long term rate of inflation would have reduced the Dow Jones Average by about 20 points in 1978. Some heavily levered companies such as Woolworth actually are predicted to benefit from inflation. If investors do not make appropriate adjustments, for inflation the market value of most firms would be radically different from that derived with full adjustment, except for those firms which are highly levered and therefore benefit from inflation.

Comparison of the first three columns indicates that the relative magnitudes of the different inflation effects vary widely across firms. Many of the Dow firms use LIFO, so that the inventory effect is zero, but this effect is substantially negative for the remaining companies. The depreciation effect is particularly important for large capital intensive manufacturing concerns, such as the auto and steel companies. Leverage also varies widely. Thus the data are likely to have significant power in revealing differences in the extent to which the inflation adjustments are recognized. The approach taken to this problem is described in the next section.

Table 2

THE EFFECT OF INFLATION ON THE VALUE OF THE DOW JONES COMPANIES-1978

	$(\frac{dR}{d\Delta\pi^e})_{I\mu}$	$(\frac{dR}{d\Delta\pi^e})^a_{DEP}$	$(\frac{dR}{d\Delta\pi^e})^a_{DEBT}$	$(\frac{dR}{d\Delta\pi^e})^a_{DEBTCG}$	Full Rationality (μ=0)	Inflation Illusion (μ=1)
Alcoa	-10.18	-7.97	0.23	1.93	-7.55	8.44
Allied Chemical	0.00	-9.91	7.24	2.34	0.92	1.26
American Brands	-16.06	-3.30	8.35	1.87	-3.96	5.18
American Can	0.00	-4.35	-2.78	1.14	-2.63	3.36
American Telephone & Telegraph	- 0.24	-8.78	11.34	3.17	4.39	-1.09
Bethlehem Steel	0.00	-11.00	6.00	3.00	0.36	2.35
Chrysler	-49.22	-24.60	38.23	8.21	-10.62	16.76
Dow Chemical	0.00	-7.55	1.09	1.03	-2.39	3.04
Esmark	-12.59	-9.06	8.73	3.56	-3.27	6.09
Exxon	0.00	-4.89	0.99	0.69	-1.37	1.84
General Electric	0.00	-2.90	-2.91	0.45	-2.62	2.74
General Foods	-7.43	-2.99	0.01	0.66	-4.85	4.91
General Motors	0.00	-7.75	-2.18	0.32	-4.93	4.68
Goodyear	0.00	-10.40	8.26	3.26	2.12	1.01
International Harvester	0.00	-7.47	17.41	4.45	9.71	-4.68
International Nickel Company	-12.09	-5.93	14.85	3.79	2.12	1.49
International Paper	0.00	-7.82	4.43	1.90	0.11	1.60
Johns-Manville	0.00	-10.83	8.84	3.72	2.67	0.94
Kodak	0.00	-2.45	-2.84	0.05	-2.75	2.49
Minnesota Mining & Manufacturing	-2.28	-2.01	-0.95	0.29	-2.49	2.47
Owens-Illinois	0.00	-21.73	7.71	4.53	-2.89	6.61
Proctor & Gamble	0.00	-1.27	-0.39	0.28	-0.59	0.78
Sears	0.00	-1.46	-1.49	0.77	-0.79	1.39
Standard Oil (CA.)	0.00	-5.86	1.03	0.85	-1.70	2.28
Texaco	0.00	-8.49	3.81	1.22	-1.26	2.21
Union Carbide	0.00	-9.69	4.28	2.24	-0.61	2.54
United States Steel	0.00	-8.68	7.36	2.74	2.04	0.62
United Technologies	-10.05	-6.03	-4.15	2.14	-8.56	9.53
Westinghouse	0.00	-5.79	-8.24	1.06	-6.36	6.61
Woolworth	0.00	-11.00	20.07	3.84	8.63	-4.27

II. Data and Methods

The theory in the preceding section implies that the real return on equity in the i_{th} firm should be a function of the change in the expected long run rate of inflation. That is:

$$R_{it} = \alpha + \beta_i \Delta\pi^e + u_{it}$$

where α is the required rate of return ρ and β_i measures the sensitivity of the valuation of security i to "inflation" news, and u_{it} is a stochastic error which reflects other "news" which has an impact on security i. The discussion above suggests that β_{1i} should be a function of the characteristics of the firm. In particular, it is natural to postulate that:

$$\beta_i = \gamma_o + \gamma_1 D_{INV} + \gamma_2 D_{DEP} + \gamma_3 D_{DEBT} + \gamma_4 D_{DEBTCG} + \varepsilon_i \qquad (19)$$

where the variables D_{INV}, D_{DEP}, D_{DEBT}, and D_{DEBTCG} are specified so that $\gamma_1 D_{INV} = (\frac{dR_i}{d\Delta\pi^e})_{INV}$ and so forth.

Combining expressions (19) and (20) leads to an equation which can be estimated econometrically:

$$R_{it} = \alpha + \Delta\pi^e(\gamma_o + \gamma_1 D_{INV_{it}} + \gamma_2 D_{DEP_{it}} + \gamma_3 D_{DEBT_{it}} + \gamma_4 D_{DEBTCG_{it}}) + \Delta\pi^e \varepsilon_i + u_{it} \quad (21)$$

Equation (21) is estimated using cross-section-time series data on a large sample of firms. The principal complication comes from the composite error term in (21). It may not satisfy the necessary conditions for ordinary least squares regression. If inflation news is correlated with other information which affects security prices, u_{it} will be correlated with $\Delta\pi^e$. It is also likely that the required rate of return ρ_i varies across firms. Inconsistent estimates would result if these variations are correlated with the firm

Construction of the Variables

Inflation Expectations

Equation (18) is estimated using a sample of firms drawn from the 1979 Compustat tapes for the period 1963-1978. There are two major data problems: the construction of measures of inflation expectations and the measurement of expected firm sensitivity to inflation. The issue of measuring inflationary expectations is taken up first. A discussion of the sample selection is presented after the construction of the firm-specific variables is described.

A major problem in testing equation (18) is the development of measures of the change in long term inflationary expectations. As noted above previous studies of inflation and security returns have used unexpected inflation as a proxy for the revision in inflationary expectations. This procedure does not avoid the need to specify a model of inflationary expectations. It is very likely to substantially overstate the revision in long-term inflation forecasts which actually takes place, since rational investors would expect the inflation rate to exhibit some tendency to return to its mean.

In an effort to insure the robustness of the results, five alternative measures of the change in inflation expectations were used in the empirical tests. All are based only on information available at the point when the expectation was to have been formed. This represents an important improvement over previous empirical work. Most previous studies have estimated statistical models of inflation over the entire sample period and then used the residuals as estimates of unexpected inflation. This is inappropriate since it assumes that investors used subsequent information to estimate the stochastic

10 To see this consider the case where inflation has a univariate ARMA representation By construction the residuals will sum to zero. Since the revision in inflation expectations is proportional to unexpected inflation in this special case, the revisions over the sample period must also sum to zero.

characteristics which effect inflation sensitivity. A lesser problem is that the error term in (21) is not likely to be spherical because of year and firm effects as well as heteroscedasticity induced by the presence of $\Delta\pi^e$.

Issues of efficiency are ignored because of the very large sample used in this study. Potential inconsistency is avoided by adopting a fixed effects formulation. That is, it is assumed that the composite error term in (21) may be approximated as:

$$\Delta\pi^e\varepsilon_i + \mu_{it} = V_i + V_t + V_{it} \qquad (22)$$

This error term includes both year and firm effects. With this specification of the error term, (21) can be consistently estimated by adding period dummies to estimate the V_t, and taking deviations from firm means to eliminate nuisance parameters V_i. This approach, which will generate consistent standard errors save for the effects of heteroscedasticity, is preferable to the GLS techniques becoming fashionable in financial economics because it allows for the possibility that the errors are correlated with the right hand side variables.[9]

As is well known, fixed effects will reduce the efficiency of the estimates, if in fact the orthogonality of the residuals is satisfied. If any of the variables in (21) exhibits errors in variables, the use of fixed effects may exacerbate the bias. Therefore, estimated equations are reported below which do not make allowance for year and firm effects.

In all the estimates reported in this paper, observations on each firm were weighted by the firm's mean real market value. This was done to make the data set more representative of the entire non-financial corporate sector and to reduce the weight placed on small firms with highly irregular returns.

9 Several studies including French Ruback and Schwert (1981) use Zellers' (1962) seemingly unrelated regression technique.

process followed by inflation. The importance of this issue may be highlighted by considering the recent American experience. Any model estimated over the entire sample period will generate a mean unexpected inflation of zero. Thus the standard procedure would deny _a priori_ the possibility that rising inflationary expectations over the sample period could account for the low average return on the market.

This point is reinforced by the results in Table 3, which displays estimates of ARMA models for quarterly CPI inflation over various sample periods. It is clear that investors' perception of the process generating inflation should have changed markedly over the last 25 years. The mean decadal rates of inflation which heavily influence the long term forecast have varied from 1.75 to 7.47 percent. The data reject the hypothesis that a common model fits the 1960-70 period and 1970-80 period at the 5 percent confidence level.

The alternative measures of the revision in inflation expectations used here are displayed in Table 4. The first series, $\Delta\pi^e$, is based on the "rolling ARMA" procedure described in Feldstein and Summers (1978). To generate each year's observation, an ARMA (1,1) process was fitted to the rate of inflation as measured by the percentage change in the consumer price index using quarterly data on the preceding 10 years. Data only on the preceding 10 years rather than on the entire interval were used because of the instability in the inflation process. The estimated process as of each date is then used to forecast the rate of inflation for the succeeding 10 years. The "permanent" inflation expectation is then taken to be the discounted weighted average of these forecasts with a discount rate of 8 percent.

TABLE 3

Alternative ARMA Models for CPI Inflation

Interval	Mean	ϕ	Θ	Standard Error
1950-59	2.27	-.472 (.162)	-.972 (.135)	2.85
1955-64	1.57	.696 (.441)	.535 (.522)	1.43
1960-69	2.53	.978 (.037)	.668 (.156)	1.31
1965-74	5.26	1.009 (.008)	.362 (.151)	1.6
1970-79	7.47	.859 (.114)	.137 (.206)	2.12
1960-79	5.00	.968 (.034)	.355 (.119)	1.84

Note: All model are ARMA (1,1). First order autoregressive and moving average. They are of the form $\pi_t = \phi\pi_{t-1} + \varepsilon_t - \Theta\varepsilon_{t-1}$

Table 4.4

Alternative Measures of the Change in Expected Inflation

	$\Delta\pi_1^e$ ARMA	$\Delta\pi_2^e$ VAR	$\Delta\pi_3^e$ LIVINGSTON	$\Delta\pi_4^e$ SHORT RATE	$\Delta\pi_5^e$ LONG RATE
1963	-.12	-.067	-.052	-.250	-2.070
1964	.25	-.040	.046	.270	-.040
1965	.45	.023	.081	.600	.210
1966	.51	.233	.229	.440	1.160
1967	.64	.082	-.073	.580	.750
1968	.08	.279	.653	.400	.300
1969	.69	.530	1.005	1.660	1.420
1970	-.20	.314	.171	-2.770	.470
1971	-.57	-.132	-.627	-.470	-.740
1972	.25	.016	.035	.880	.450
1973	1.88	.676	2.383	1.730	.550
1974	2.14	1.702	1.874	-.220	2.150
1975	-1.65	-.612	-2.367	-.630	-.070
1976	-.42	-.173	.133	-1.520	-1.440
1977	.860	.271	.226	1.880	.130
1978	3.34	.622	1.346	2.920	.950

Correlation Matrix

	π_1^e	π_2^e	π_3^e	π_4^e	π_5^e
π_1^e	1.0	.828	.913	.346	.458
π_2^e	.959	1.0	.884	.271	.751
π_3^e	.974	.978	1.0	.457	.614
π_4^e	.656	.642	.723	1.0	.317
π_5^e	.885	.900	.916	.641	1.0

Note: The variables are constructed as described in the text. The correlation matrix exhibits correlations between levels below the principal diagonal and between changes above the diagonal.

The principal weakness of the ARMA inflation forecasts is the limited information set which they employ. Market participants should base their inflation expectations on more than the past history of prices. The second measure of inflationary expectations is based on a rolling vector auto regressive procedure as described in Sims (1980) and Litterman (1980). Inflation forecasts were generated using a 4 variable system with the rate of money growth, the treasury bill rate, and the growth rate of real output included as well as the rate of inflation. Preliminary experimentation suggested that the results were insensitive to the inclusion of additional variables. Four lags on each variable were included. In order to insure "reasonable" results a Bayesian procedure was used in the estimation as described in Litterman (1980). Again inflation is estimated as a discounted weighted average of forecasts for the succeeding 10 years.

Much of the information which is used in forecasting inflation does not show up in measurable time series. There is also the possibility that the market does not forecast inflation in a statistically rational way. An alternative measure of inflationary expectations $\Delta\pi_3^e$ is based on the Livingston survey of inflation expectations. Expected inflation is taken to be the average of the annual CPI inflation forecasts made by a panel of forty experts surveyed by Joseph Livingston of the Philadelphia Bulletin. The series used is provided in Carlson (1977) who discusses necessary adjustments to the raw data.

There is substantial controversy (Pesando (1975), Mullineaux (1978) and Carlson (1977)) over whether these forecasts satisfy rationality restrictions. Even if they fail rationality tests, they may nonetheless be good indicators of the changes in inflation expectations which actually guide market valuations. A significant limitation of these measures from the point of view of this study is that the inflation rate is forecast over only a one year horizon. There is an additional timing problem since the survey measures inflation expectations as of October rather than the end of the year.

The last two measures of changes in the expected rate of inflation are based on movements in interest rates. Fama (1975) has argued that movements in expected inflation account for a large fraction of the variance in short term interest rates. Summers (1981b) suggests that this conclusion is highly sensitive to the choice of a sample period. Nonetheless it may be reasonable to use changes in interest rates as indicators of changes in inflation expectations. Expectational theories of the term structure imply that Fama's conclusion, if valid, should hold for long-term interest rates as well. The measure $\Delta\pi^e$ is based on the change in the one year treasury bill rate, while $\Delta\pi^e$ is based on the change in the BAA bond rate. The latter measure is probably preferable because of its longer horizon, though the relation between the short rate and expected inflation is much better documented. An additional virtue of the long term bond yield is that it should be aligned closely with the rate at which firms discount nominal liabilities of the type under consideration here.

The lower part of the table exhibits the correlation matrix of these measures of the change in the level of expected inflation. The correlations of the changes in the levels are displayed above the principal diagonal while the correlations between the levels are exhibited below the diagonal. The measures cohere fairly well. The pairwise correlations of the first differences range from .913 between $\Delta\pi^e$ and $\Delta\pi_3^e$ to .271 between $\Delta\pi_2^e$ and $\Delta\pi_4^e$. As one would expect the correlations between the levels of the variables are greater.

In Table 5, these measures of the change in expected inflation are related to real aggregate security returns. The relation, which is documented more fully in Summers (1982), is strongly negative for all five measures. The estimated impact of a one percentage point increase in long term expected inflation ranges from a 2.1 percent decline in the market using $\Delta\pi_4^e$ to a 28 percent decline using $\Delta\pi_2^e$. These results are broadly consistent with the calculations in the preceding section under the assumption of rationality.

Firm Specific Variables

Estimates of D_{INV}, D_{DEP}, D_{DEBT}, D_{DEBTCG} and R_{it} are derived from information on the 1979 Standard and Poor's Compustat Tape. The tape contains basic accounting information of some 2000 large industrial concerns for the past 20 years. Because of data limitations, the sample here was confined to the years 1963-78. All firms for which all the necessary information was available were included in the sample, except those with suspected data errors. The final sample contained 13,584 observations. Because reporting of the necessary data coverage was greater in later than in earlier years, there are 1154 observations in the years 1963-68, compared to 6378 in the 1969-73 period and 6053 the 1974-78 period.[9]

The sample appears to be fairly representative of the non-financial corporate sector as a whole. The principal difference is that utilities are excluded from consideration here. The correlation between the mean return on firms in the sample and that on the market as a whole is

[9] There are fewer observations for the latest period because some of the 1978 data were not available when the tape was constructed.

TABLE 5

Impact of Alternative Measures of Expected Inflation on the Aggregate Market Return

Inflation Measure	Intercept	Slope	R^2/DW
$\Delta\pi^e_1$	.133 (.036)	-.096 (.029)	.394 2.32
$\Delta\pi^e_2$	.147 (.025)	-.281 (.047)	.693 2.60
$\Delta\pi^e_3$	.120 (.029)	-.121 (.027)	.549 2.51
$\Delta\pi^e_4$	.092 (.044)	-.021 (.024)	-.016 2.26
$\Delta\pi^e_5$	.100 (.041)	-.046 (.025)	.137 2.38

Note: Regressions are of the form SRET = $\alpha + \beta\Delta\pi^e_i$ where SRET is taken from Ibbotsen and Sinquefield (1978), and the $\Delta\pi^e_i$ are constructed as described in the text. All regressions are run on 16 annual observations spanning the period 1963-78. Standard errors are in parenthesis.

very high. Moreover, as will be seen below, the mean estimates of the inflation sensitivity variables correspond quite closely to those reported in Table 1.

Compustat contains information on the number of common shares outstanding and the price per share at the end of each year. The product of these figures yields our measure of U_{it}. The real return R_{it} is calculated according to:

$$R_{it} = \frac{Div_t}{S_{t-1}} + \frac{S_t}{S_{t-1}} - 1 - \pi_t \tag{22}$$

where S_t denotes the security's price at the <u>end</u> of year t, and Div_t and π_t refer to totals during year t. The value of π_t is taken to be the December to December change in the CPI.

Equation 10 implies that:

$$\left(\frac{dR_i}{d\Delta\pi^e}\right)_{INV} = \gamma_1 D_{INV} = \gamma_1 \frac{INV_{it} FIFO_{it}}{V_{it}} \tag{23}$$

where $\gamma_1 = \dfrac{(\tau - \mu_{INV})}{\rho - g + \lambda}$. The value of FIFO inventories is estimated as the book value of inventories if the firm reports that any non-LIFO method of accounting is its principal method. Otherwise, the value of FIFO inventories is taken to be zero. This procedure is flawed because many firms account for part of their inventories using each method. There is, however, little alternative given the difficulty of valuing LIFO inventories.

Equations (12) and (20) imply that :

$$\left(\frac{dR_i}{d\Delta\pi^e}\right)_{DEP} = \gamma_2 D_{DEP} = \frac{\gamma_2(\rho + g + \pi^p)\cdot DEP}{(\alpha + \rho + \pi^e)^2 V_{it}} \tag{24}$$

where $\gamma_2 = \dfrac{(\tau - \mu_{DEP})}{(\rho - g)}$. The value of DEP is estimated as depreciation reported for accounting purposes. While it would be preferable to use tax depreciation, this information is not available on the tape. The value of δ is estimated as the ratio of reported depreciation to gross plant and equipment. Gross plant and equipment is used because most firms report depreciation on a straight line basis. The value of π^P is taken to be the average rate of inflation during the preceding 10 years. Expected inflation is measured using each of the five inflation expectations series reported above. Finally, ρ is taken to be .10 in forming D_{DEP}. This estimate may be too high if investors recognize that future depreciation allowances have different risk characteristics than the remainder of a firm's cash flow. A zero or even a negative real rate might be appropriate in some situations as discussed in Bulow and Summers (1982). Because of this difficulty and the absence of data on tax depreciation any results regarding depreciation should be viewed with caution.

Equations (16), (17), and (20) suggest that the adjustments for leverage and capital gains in the outstanding debt are given respectively by:

$$\left(\frac{dR_{it}}{d\Delta\pi^{e}}\right)_{DEBT} = \gamma_3 D_{DEBT} = \gamma_3 \cdot \frac{DEBT_{it-1}}{V_{it-1}} \tag{25}$$

where $\gamma_3 = \dfrac{\left(\tau - \mu_{DEBT}\right)}{(\rho - g)}$ and:

$$\left(\frac{dR_{it}}{d\Delta\pi^{e}}\right)_{DEBTCG} = \gamma_4 D_{DEBTCG} = \gamma_4 \frac{LTDEBT_{it-1}\cdot(1-e^{-rT})}{r_{it-1}} \tag{26}$$

where $\gamma_4 = (1-\mu_{debtcg})$. The principal problem in constructing both D_{DEBT} and D_{DEBTCG} is determining the market value of outstanding long term debt. This is done by capitalizing interest payments on long term debt using the BAA bond yield.

There is little basis for gauging the maturity structure of outstanding long term debt. The effective maturity, T, is reduced by the fact that some apparently long term obligations have variable interest rates and almost all corporate bonds are call protected. For the firms which report the information it appears that a substantial fraction of long term debt is payable within five years. Therefore, in valuing the long term debt and calculating. DEBTCG, a five year maturity is assumed. The value of r in (26) 9s also taken to be the end of year BAA bond yield.

The firm's net indebtedness, DEBT in (25), is then calculated as the sum of the market value of long term debt, current liabilities, and accounts payable less financial assets and accounts receivable. This definition of debt ignores at least three potentially important nominal obligations, long term leases, pension liabilities, and long term labor contracts. The assets in firm pension funds are also neglected. Bulow (1979) argues that these far exceed liabilities when the latter are properly valued. The omissions are necessary given data limitations. It is to be hoped that the omitted variables are largely independent of the included ones. A very weak reed of evidence in support of this view is the apparent difficulty investigators (e.g. Friedman (1981)) have had in relating pension funding decisions to firm characteristics.

Some characteristics of the sample are presented in Table 6. Several features of the data warrant comment. Potentially the largest effect of increases in the expected rate of inflation is due to the capital gains which firms realize as the market value of their debt declines. The mean interest rate over the sample period was about 8 percent. The mean of .953 of D_{DEBTCG}

Table 6

Characteristics of the Sample

Variable	Mean	Standard Deviation
D_{INV}	.1339	.2173
D_{DEP}	.2818	.2218
D_{DEBT}	.093	.304
D_{DEBTCG}	.943	1.15

Correlation Matrix

	D_{INV}	D_{DEP}	D_{DEBT}	D_{DEBTCG}
D_{INV}	1.0			
D_{DEP}	.168	1.0		
D_{DEBT}	.151	.539	1.0	
D_{DEBTCG}	.202	.632	.737	1.0

Note: The construction of the variables is described in the text.

implies an average ratio of long term debt to market value of equity of .23. This contrasts with the ratio of total net debt to equity of .094 implied by the mean of D_{DEBT}. The sample mean is less than usual estimates of debt-equity ratios due to the exclusion of utilities from the sample and the inclusion of trade credit as a financial asset. The mean D_{INV} of .1339 represents the mean ratio of FIFO inventories to equity. For the 82 percent of firms using FIFO, the mean ratio of inventories to equity was .169 . Finally, it is interesting to note that in this sample the potential effect of inflation on depreciation allowances exceeds its impact on inventories by a wide margin.

The correlation matrix in the lower half of the table reveals that net debt, long term debt, and the value of the bonds represented by future depreciation allowances are quite highly correlated. This indicates that hedging against the losses incurred if inflation reduces real depreciation allowances may be an important consideration in leverage decisions. It implies that omitting depreciation allowances from consideration as has been done in some earlier studies may badly bias estimates of the effects of leverage. The presence of FIFO inventories appears to be only weakly associated with the other characteristics affecting the sensitivity of stock market returns to inflation.

This discussion of the data has focused on the limitations of the variables used here. While these difficulties suggest caution in interpreting the quantitative magnitude of the coefficients, the opposing qualitative implications of the tax and illusion hypotheses implies that γ_1 and γ_2 are negative, reflecting the impact of inflation on FIFO and depreciation intensive firms, while γ_3 and γ_4 are positive, reflecting the impact of inflation on firms' debt. The illusion view has exactly opposing implications for the signs. These clear differences imply that data problems should not preclude distinguishing the two hypotheses even if the extent of inflation cannot be precisely estimated.

III. Results

The results of estimating (20) with various specifications of the error term and the five alternative measures of inflation expectations are presented in Table 7. The estimates of the parameters of central concern are very insensitive to the error specification, so only the equations estimated allowing for both year and fixed effects are discussed below. The results are surprisingly insensitive to the choise of the proxy for inflationary expectations. In general, the results using π_1^e, π_2^e and π_3^e are very similar, with somewhat deviant results obtained when the interest rate variables π_4^e and π_5^e are used as proxies for expected inflation.

Because the coefficients are difficult to interpret, the values of the μ_i implied by the first five equations in Table 7 are presented in Table 8. The calculations assume that $\rho=.1$ and $\gamma=.03$. The arbitrariness of these assumptions mean that the estimates of μ must be treated with a great deal of caution.

The estimates of the effects of FIFO inventory accounting strongly bear out the tax effects hypothesis. In all of the equations, the estimated value of γ_1 is negative, implying that FIFO firms suffer when the expected inflation rate increases. In most cases the coefficient is highly statistically significant. This finding contradicts the widespread view that it is rational for firms to use FIFO accounting because it raises the market value of their stock due to investor irrationality. Not only do investors

Table 7

BASIC REGRESSION RESULTS

Equation	Inflation Measure	Intercept	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	Yr. Effects	Firm Effects
7.1	π_1^e	–	–	-.100 (.009)	.022 (.013)	.042 (.010)	.009 (.003)	.385	✓	✓
7.2	π_2^e	–	–	-.105 (.016)	.103 (.021)	.025 (.017)	.015 (.005)	.382	✓	✓
7.3	π_3^e	–	–	-.120 (.008)	.019 (.011)	.043 (.009)	.007 (.002)	.390	✓	✓
7.4	π_4^e	–	–	-.012 (.006)	-.074 (.009)	.034 (.007)	.0002 (.002)	.380	✓	✓
7.5	π_5^e	–	–	-.008 (.011)	-.013 (.017)	.042 (.011)	-.0009 (.003)	.376	✓	✓
7.6	π_1^e		-.002 (.008)	.101 (.009)	.025 (.013)	.041 (010)	.0034 (.0029)	.365	✓	–
7.7	π_1^e		-.022 (.009)	-.107 (.0157	.094 (.021)	.025 (.017)	.0059 (.0049)	.362	✓	–
7.8	π_3^e	-.0003 (.008)		-.124 (.008)	.023 (011)	.043 (.009)	.0032 (.0026)	.370	✓	–
7.9	π_4^e	.077 (.011)		-.014 (.0068)	-.077 (.009)	.0372 (.0072)	-.0024 (.002)	.361	✓	–
7.10	π_5^e	.006 (.009)		.010 (.011)	.018 (.017)	.047 (.011)	-.004 (.003)	.357	✓	–
7.11	π_1^e	–	-.185 (.004)	-.098 (.010)	.058 (.013)	.053 (.011)	.0029 (.0032)	.293	–	✓

Table 7, cont.

BASIC REGRESSION RESULTS

Equation	Inflation Measure	Intercept	γ_0	γ_1	γ_2	γ_3	γ_4	R^2	Yr. Effects	Firm Effects
7.12	π_2^e	-	-.366 (.007	-.099 (.017)	.117 (.022)	.013 (.018)	.020 (.005)	.304	-	✓
7.13	π_3^e	-	-.151 (.003)	-.120 (.009)	.061 (.011)	.050 (.009)	.001 (.003)	.265	-	✓
7.14	π_4^e	-	-.005 (.003)	-.007 (.008)	-.104 (.010)	.047 (.008)	-.0022 (.002)	.033	-	✓
7.15	π_5^e	-	-.171 (.005)	-.021 (.012)	.082 (.019)	.016 (.013)	-.0024 (.0037)	.183	-	✓
7.16	π_1^e	.108 (.002)	-.180 (.004)	.100 (.009)	.060 (.013)	.046 (.010)	-.0029 (.0031)	.275	-	-
7.17	π_2^e	.128 (.003)	-.353 (.007)	-.103 (.016)	.108 (.021)	.0097 (.0181)	.0092 (.005)	.286	-	-
7.18	π_3^e	.0786 (.0028)	-.148 (.004)	-.124 (.009)	.064 (.011)	.046 (.009)	-.002 (.003)	.250	-	-
7.19	π_4^e	.039 (.003)	.0007 (.003)	-.012 (.008)	-.107 (.010)	.048 (.008)	-.0039 (.002)	.032	-	-
7.20	π_5^e	.066 (.002)	-.161 (.005)	-.024 (.012)	.072 (.019)	.022 (.013)	-.007 (.004)	.165	-	-

Note: Estimate of Equation (20) using procedures described in the text. Standard errors are in parentheses. Note that standard errors do not reflect uncertainty in measuring inflation expectations.

see through the phantom profits caused by FIFO accounting, but also they recognize the extra tax liabilities which are generated.

The values of INV in Table 8 suggest that the full effect of FIFO accounting on subsequent tax liabilities is recognized by the market. The average estimate of INV using the different inflation concepts is .017. This calculation assumes that investers expect FIFO firms to continue to use FIFO forever. If a switchover is expected to occur, so $\lambda>0$, the results imply that the market overdiscounts future tax liabilities. It should be acknowledged that the estimated values of μ vary quite widely depending on the choice of inflation measure. The negative estimates of μ may reflect the choice of too high a discount rate, or the negative signal about management quality provided by firms which stay with FIFO when the expected inflation rate increases.

These estimates are inconsistent with the same earlier work on accounting changes and excess security returns which found that firms which switched inventory accounting methods did not have abnormal returns. While these results have been interpreted as implying market efficiency, in fact they suggest the opposite given the presence of tax effects. The results here indicate that firms which switch form FIFO to LIFO should realize large excess returns. Assuming an 8 percent expected inflation rate, and assuming that investors are fully rational, FIFO firms with an inventory to market value ratio of .25 would realize an excess return of about 15 percent by switching to LIFO. The failure to find such excess returns in earlier studies may reflect anticipations of switchovers, or a tendency on the part of firms to change accounting methods in years when there is already adverse news about profits. When a variable reflecting switchovers was added to the equations reported here it had a consistent positive sign.

The estimates of γ_2, the coefficient of D_{DEP} are anomalous, implying that investors fail to perceive the effect of inflation on future depreciation allowances. Firms which should be hurt most by increases in expected inflation appear to benefit from them. The estimates of μ in Table 8 suggest that investors perceive a little less than half of the correct adjustment to profits for the effects of historic cost depreciation. However, the estimates vary greatly depending on the choice of inflation measure. The equations estimated using the interest rates as inflationary expectation variables actually yield the predicted negative coefficients. This may be because the market regards future tax shields as a nominal riskless bond and so discounts them at the nominal interest rate rather than at the required return on equity. The equation estimated using the vector autoregressive inflation expectations implies that the market is wholly oblivious to the effects of historic cost depreciation.

It is difficult to explain the results obtained using the first three inflation measures, in terms of rational behavior. No simple errors in variables argument can account for the fact that the regression coefficients have the unexpected sign. One tenuous possibility is that increases in expected inflation are associated with expected tax relief in the form of accelerated depreciation. This relief may actually be expected to exceed the cost of inflation. Alternatively, it is conceivable that firms' other unmeasurable net nominal assets are negatively correlated with the value of their depreciation bond. The negative correlation of D_{DEP} and D_{DEBT} lends some credance to this argument. It may be, however, that investors simply fail to perceive the long run effects of historic cost depreciation. It is plausible that perception of this inflation adjustment to profits would lag behind the others because, unlike the others, it depends on a long distributed lag of rates of inflation, and not just on the contemporaneous rate. This view is strongly supported below.

The estimates of γ_3 decisively contradict the Modigliani-Cohn hypothesis that in estimating profitability the market confuses nominal and real interest rates. The results are unaffected by the choice of expected inflation proxy. In all cases, the estimate is positive and statistically significant, implying that more highly levered firms benefit from increases in expected inflation. Presumably, this is because of the extra tax shields generated by the deductibility of nominal interest payments. The coefficients are substantively as well as statistically significant. Equation 7.1, for example, implies that a firm with debt-equity ratio of .4 would gain 1.7 percent relative to an unlevered firm from a one point increase in the expected rate of inflation.

The estimates of DEBT in Table 8 all lie between .2 and .33, suggesting that a small fraction of the effects of nominal interest deductability may not be perceived by the market. However, this suggestion is highly speculative given the possible failure of the assumption that the Fisher effect holds exactly for nominal interest rates, and the arbitrariness in the choice of discount and growth rates. These results contradict those of French, Ruback and Schwert (1980) who could not find support for the debtor-creditor hypothesis. This is probably due to the use here of changes in expected inflation, rather than unexpected inflation, and differences in the sample period studied. An additional possibility is the more satisfactory fixed effects econometric technique used here.

The estimates of γ_4, the effect of long term debt, are imprecise and very mixed. Surprisingly, the results are much more plausible when the variables π_1^e, π_2^e, and π_3^e are used than they are when interest rates are used to proxy inflation expectations.

Table 8

Perceived Fraction of Inflation Adjustments to Real Profitability

Equation	μ_{INV}	μ_{DEBT}	μ_{DEBT}	μ_{DEBTCG}
1	-.200 (.063)	.654 (.091)	.206 (.070)	.100 (.30)
2	-.235 (.102)	1.22 (.147)	.325 (.129)	-.500 (.50)
3	-.340 (.056)	.633 (.077)	.199 (.063)	.301 (.20)
4	.416 (.042)	-.018 (.063)	.262 (.049)	.982 (.20)
5	.444 (.077)	.409 (.129)	.206 (.077)	1.09 (.30)
Average	.017	.579	.240	.394

Note: These calculations assume $\rho=.1$, $g=.03$, $\gamma=1$, $\lambda=0$, $\tau=.5$. Estimates of μ are calculated from Equations 7.1-7.5 in Table 7 using equations (23)-(26) in the text. Standard errors are in parentheses.

The estimates range from -.500 when π_2^e is used as an inflation proxy, to 1.09 when π_5^e, the BAA bond yield is the proxy. The latter is the variable which a priori should have been expected to be most closely associated with capital gains on outstanding long term debt. The average value of μ_{DEBTCG} is .394, suggesting some irrationality on the part of investors. Unlike the others, this estimate does not depend on the choice of a discount rate. Apart from data problems, it may represent rational valuation, if firms do not realize gains by repurchasing outstanding debt and interest rates display excess volatility.

The robustness of these results was examined by estimating alternative specifications of (20). Taking account of personal tax effects by using tax returns as the dependent variable had only a negligible impact on the estimates. Efforts to use alternative specifications of the required rate of return, allowing it to depend on the risk free rate as suggested by many models of market equilibrium, also did not alter the results. Nor did assuming that a firm's expected rate of return depended on characteristics, such as its debt equity ratio and β. These modifications to the specification have little effect because only a negligible fraction of the variance in ex-post returns is due to variations in expected returns. The fact that allowing each firm to have its own expected return had little effect on the results suggests that these results are not sensitive to the modelling of expected returns.

A potentially major qualification to these results is that inflation "news" may be correlated with other news which effects market returns. For example, Fama (1981) explains the negative correlation between market returns and inflation in terms of a negative correlation between inflation and real activity that affects profitability. This objection is probably not substantively important. The inclusion of year dummies in the equations captures any such aggregate news, so that the estimates do not suffer from this bias, except to the extent that inflation and "firm specific" news are correlated. This may be seen in a different way by recognizing that including year dummies, is equivalent to using the difference between firm and market returns as the dependent variable, and the difference between firm and average market characteristics as independent variables. The fact that this procedure has so little effect on the results provides strong evidence that the estimates here really do capture the effects of changes in expected inflation.

The stability of these estimates over time was also examined. As inflation has increased it is reasonable to conjecture that investors have become more aware of its distortionary effect on reported profits. The mean absolute revision in inflationary expectations was far greater in the latter half of the sample period than in the former, so that the payoff to studying firm sensitivities to inflation increased substantially. There is an econometric as well as an economic point at issue here. The greater coherence of the inflation measures, along with their greater size, during the 1970's suggests that the effects of inflation may be better estimated during this period than during the entire sample period.

In Table 9, results obtained for the 1972-1978 period while controlling for both year and firm effects are presented. Very similar results were obtained when alternative specifications of the error term were employed. The estimated regression coefficients are presented in the upper half of the table while the implied values of the μ_i are presented in the lower half. The results for the inventory and debt variables are consistent with those for

Table 9a

Regression Results for the 1972-78 Period

Equation	Inflation Measure	γ_1	γ_2	γ_3	γ_4	R^2
9.1	π_1^e	-.113 (.007)	-.003 (.010)	.046 (.008)	.0073 (.003)	.488
9.2	π_2^e	-.091 (.015)	.028 (.019)	.041 (.016)	.017 (.005)	.483
9.3	π_3^e	-.091 (.008)	-.021 (.012)	.046 (.009)	.010 (.002)	.496
9.4	π_4^e	-.003 (.007)	-.083 (.009)	.024 (.007)	.0004 (.0023)	.481
9.5	π_4^e	.0081 (.010)	-.080 (.010)	.046 (.010)	.0009 (.003)	.478

Table 9b

Perceived Fraction of Inflation Adjustments to Real Profitability

(1972-1978)

Equation	μ_{INV}	μ_{DEP}	μ_{DEBT}	μ_{DEBTCG}
9.1	-.137	.353	.178	.700
9.2	-.137	.696	.213	-.70
9.3	-.291	.479	.178	.27
9.4	.474	-.081	.332	.96
9.5	.556	-.060	.178	.91
Average	.094	.277	.215	.288

the whole sample. In the case of γ_1, γ_3, and γ_4, the hypothesis of equality between the estimates for the 1963-71 period (not shown) and the 1972-78 period cannot be rejected at the 5 percent level in any of the equations. This may be somewhat surprising for γ_1 since the likelihood of switchovers to LIFO accounting would seem to have increased. There may be a mover-stayer problem here as the probability of switchover assigned to a given firm that stayed with FIFO though the inflation of the 1970's actually declined.

The striking difference between the results for 1972-78 period is in γ_2, the estimated depreciation effect. In four of the five equations, the coefficient has the expected negative sign. The hypothesis of equality of the coefficients during the early and later period is rejected at astronomical levels of significance in all five equations. When the sample period is cut further to the 1974-78 period, the estimated inflation effect on depreciation is negative and significant in all five equations. The mean estimate of μ_{DEP} for the 1972-78 period is .277 for the 1972-78 period and .043 for the 1974-78 interval. Given the many uncertainties in the calculation these values seem consistent with the hypothesis that in the market during the 1970's market valuations accurately reflected the joint impact of inflation and taxes.

It is natural to conjecture that the change in the estimated depreciation effects reflects increasing market awareness of the need to adjust for the effects of historic cost depreciation. Recognition of this effect may have lagged because of its importance before high rates of inflation continued for several years. It is also the adjustment which is most difficult to perform given only basic accounting data. Certainly, the effects of historic depreciation received far more attention in the business press and among accountants during the 1970's than in the previous period. An additional possibility is that the difference in results during the 1970's is just a reflection of better inflation expectation measures.

Taken together these results suggest that in the latter half of the sample period tax effects far outweighed any effects of inflation illusion. The data strongly support the three major implications of the tax effects hypothesis, that inflation hurts FIFO firms which have little leverage and large depreciation allowances relative to other firms. These findings suggest that tax effects may account for a significant part of the negative relation between inflation and stock market returns and the consequent poor performance of the market during the 1970's. Increasing perception of the historic depreciation adjustment may also help to explain the market's poor performance. These issues are examined in the next section.

IV. Implications

This section examines the extent to which tax and inflation illusion effects can account for the observed negative relationship between increases in expected inflation and security returns. It goes on to examine the possible relation between increasing awareness of the effects of inflation and poor market performance during the 1970's.

Table 10 presents estimates of the effect of inflation on aggregate stock market returns based on the assumptions of full rationality, (μ_i=0), and the estimated values of the μ variables in the preceding section. The aggregate estimates of D_{INV}, D_{DEP}, D_{DEBT}, and D_{DEGTCG} are described in the appendix. In all the calculations the tax rate τ is taken to equal .5. The results are mixed. While the "full rationality" prediction is that each point of expected inflation should reduce stock market returns by 3.46 percent, the prediction using the actual estimates of the perception of inflation is that market returns should fall by .692 percent based on the estimates for the whole sample and 2.04 percent based on the estimate for the 1972-78 period. Note that these estimates do not depend on the assumptions about ρ and g underlying the calculations of μ. The estimate could be caluculated equivalently from the raw regression coefficients and the aggregate information.

It seems fair to conclude that inflation-corporate tax effects can account for some but not all of the negative relation between inflation and stock market returns. Some of the remainder may be due to the taxation of nominal rather than real capital gains at the personal level. These effects are largely due to FIFO inventory accounting. The findings here imply that

Table 10

Predicted Impact of a 1 Percent Change in Inflationary Expectations on Aggregate Security Returns

	Rational Investors ($\mu = 0$)	Full Sample Estimates of μ	1972-78 Estimates of μ
$\left(\frac{dK}{d\Delta\pi^e}\right)_{INV}$	-4.21	-3.84	-3.22
$\left(\frac{dK}{d\Delta\pi^e}\right)_{DEP}$	-4.01	.548	-1.64
$\left(\frac{dK}{d\Delta\pi^e}\right)_{DEBT}$	2.91	1.43	1.56
$\left(\frac{dK}{d\Delta\pi^e}\right)_{DEBTCG}$	1.85	1.12	1.31
TOTAL	-3.46	-.692	-2.04

Note: The estimates in the last two columns are based on the average estimates of μ presented in Tables 8 and 9. The estimates of aggregate market inflation sensitivity are for the entire nonfinancial corporate sector at the end of 1979. The calculations are described in the Appendix.

the market valuation of the non-financial corporate sector would be about 25 percent greater if this non-neutrality in the tax system were eliminated through tax reform or through firm switchovers to LIFO. This estimate may seem implausibly large. In 1979, however, extra taxes on FIFO inventories represented over one third of real after tax profits as measured in the NIPA.

The results suggest that leverage is of some significance in explaining aggregate returns. The two effects of leverage, ceteris paribus, cause each extra point of expected inflation to raise market valuation by three percent. This effect is likely to be much larger at present than previously because of increasing debt-equity ratios. It calls into question one part of the Modigliani-Cohn valuation hypothesis. However, their principal argument that investors compare real returns on equity with nominal bond yields is not tested here.

The difference between the estimates of inflation effects between the two sample periods is almost entirely due to the change in the estimated depreciation effect. This raises the possibility that part of the poor performance of the market may have been due to increasing investor awareness of the effects of historic cost depreciation. The data suggest that μ fell by at least .5 over the sample period. The average estimated value of μ_{DEP} was .97 for the 1963-71 period, .28 for the 1972-78 period, and .05 for the 1974-78 period. The effect of a change in μ_{DEP} may be calculated from equation (13). It is given by:

$$\frac{dR_{it}}{d\Delta\mu_{DEP}} = \frac{(\rho+\delta+\pi^{P}) \cdot DEP}{(p-g)(\delta+\rho+\pi^{e})} \qquad (27)$$

Under the assumptions made here, this expression equals 27.5. If the value of μ_{DEP} is conservatively estimated to have fallen by .5, about 14 percent of the decline in market valuation may be traceable to this source. If the estimate here that μ_{DEP} literally fell from 1 to 0 is accepted, learning about the effects of historic cost depreciation can account for a large fraction of the adverse market performance during the 1970's.

The suggestion that increasing awareness of the effects of historic cost depreciation can explain a significant part of the stock market's decline contradicts traditional theories of market efficiency that preclude irrational valuations. It is, however, plausible that this sort of inefficiency could remain for an extended period of time. There is no way that a single investor who recognizes an inflation accounting error inherent in market valuations can arbitrage it away. Unless the sign of future changes in expected inflation is known in advance, there is no strategy with even a positive expected value. If, as in the depreciation case, the market's irrationality leads to overvaluations, there is the additional difficulty of constraints on short sales. A final barrier to the rapid removal of an inefficiency of this type is the difficulty of knowing whether it exists. In order to make money, an investor must know not only right valuation rules, but also the one the market is using. For these reasons, along with those addressed above, the learning hypothesis seems plausible.

These results suggest that the joint effects of inflation and taxes, along with increasing investor awareness of the effects of inflation, can account for some of the decline in real stock market prices during the 1970's. The mean real return on the stock market over the 1926-78 period was 8.7 percent. The real return averaged -.001 percent over the 1970-78 period. The factors considered here can account for perhaps 40 percentage points of the 80 percentage point shortfall during the 1970's. The remainder may be due to declining real pre-tax rates of profit, increasing macro-economic risk and other collateral effects of the supply shocks that have buffetted the economy. These issues are explored in more detail in Summers (1982).

Appendix

This appendix describes the basis for the aggregate estimates reported in Table 1. The market value of equity at the end of 1979 was 952 billion dollars. The estimates in Feldstein, Poterba and Dicks-Mireaux (1981) imply that $\tau = .529$. The increment above the Federal rate of .46 represents state and local taxes. The value of FIFO inventories was estimated by dividing the IVA of \$43 billion by the 8.1 percent inflation, as measured by the GNP deflator which prevailed during the year. Total depreciation allowances for non-financial corporations were \$147.5 billion, which implies a δ of .095 since non-financial corporate equipment and structures totalled \$1555 billion. The value of π^p was taken to be .064, the average inflation rate during the preceding decade, while π^e was set at .08. Bulow and Shoven (1981) estimate the market value of long term debt at \$471 billion. The average maturity of this debt is taken to be 5 years. These estimates imply net indebtedness of corporations at \$367 billion. These are all the data necessary to use the formulae cited in the text.

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