EFFECT OF INFLATION ON THE PROFITABILITY AND VALUATION OF U.S. CORPORATIONS

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ABSTRACT

This study examines the inflation-related decline in real stock values since the mid 1960's. An analysis of aggregate and cross-sectional financial data suggests that the negative relationship between inflation and economic profits is sufficient to explain a large part and perhaps all of the price decline, but that between inflation and either dividends or book earnings would explain only a small part of the decline. The study also suggests that inflation has been positively associated with increased risk, both diversifiable and nondiversifiable, and the implied increase in the required rate of return may be a significant secondary depressant of stock values.

1. Introduction

A surprising empirical result which has received some attention but no satisfactory explanation in the finance literature is the negative or close to zero correlation between the nominal market rates of return on corporate equity and the contemporaneous rates of inflation, with a much stronger negative correlation between real rates of return and inflation.[1] This finding based on annual or more frequent observations since the turn of the 20th century in the U.S. (and also for a shorter period in some other countries) has apparently characterized expected as well as unexpected inflation. Since traditional economic theory predicts that under competitive pressures, with inflation expected to continue, the firm's prices, required rates of return, and, for an unlevered company, costs, profits, dividends and stock prices would rise at the same rate as prices generally,[2] such theory would have led one to anticipate an extremely high positive correlation between the nominal market rates of return and at least expected inflation (and close to a zero correlation between the real rates of return and inflation).

Obviously, this disparity between the implication of traditional theory and the empirical findings may reflect the unreality of some of the assumptions made in the development of that theory. Thus, real activity and real required rates of return may not be invariant to the general rate of inflation; all prices and costs may not be affected proportionately; major market imperfections such as taxes may affect differentially the impact of

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[1]E.g., see Jaffe and Mandelker (1976), Nelson (1976), and Fama and Schwert (1977).

[2]For a levered firm, profits, dividends and stock prices would, of course, be expected to rise more than the rate of inflation.

inflation on different costs, prices and realized and required returns; and the existence of net financial assets in the corporate balance sheet, not reflected in traditional theory, and their functional dependence on the price level as well as on real activity may significantly affect the relationship between inflation and both corporate profitability and valuation.

This paper will attempt to determine whether the unexpectedly adverse effect of inflation on common stock prices and on the realized market rates of return is attributable to its impact on the expected cash flow of return (the numerator of the stock price equation), on the required rate of return or market discount factor (the denominator), or on some combination of the two.[1] In the examination of the effect of inflation on expected cash flow, a distinction will be drawn between dividends and earnings per share and between reported book earnings and estimated economic earnings per share which is theoretically more relevant to the return the market should be discounting.

While previous studies have addressed some of the subjects covered in this paper, none has been as comprehensive or arrived at the same main conclusions. We find that the inflation-related decline in the value of stocks is attributable at least in part to a decline in real dividends and earnings, and that this adverse impact of inflation is larger for inflation-adjusted earnings than for book earnings and dividends. The decline may also be attributable in part to a decrease in the relevant price-earnings multiple stemming from an increase in the required rate of return, the latter apparently reflecting an increase in earnings uncertainty.

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[1]Fama (1981) maintains that the negative relationship between stock market returns and both expected and unexpected inflation may be a spurious statistical artifact, but as discussed later in this paper, his analysis is subject to questions and in any case cannot explain the results we obtain.

The empirical analysis in this paper supporting these conclusions will first address briefly the relationship between stock prices and inflation (Part 2) and then examine carefully the impact of inflation upon (a) dividends and book earnings per share (Part 3); (b) economic earnings per share (Part 4), and (c) the required rates of return on stock (Part 5). Another section will analyze the impact of inflation on the required rates of return on stocks from the viewpoint of modern capital asset pricing theory (Part 6). The next section will reexamine briefly the negative correlation between realized real stock market returns and the rate of expected as well as unexpected inflation previously noted in the literature (Part 7). The final section will summarize the major findings of this study (Part 8).

2. Inflation and Stock Prices

An assessment of the negative relationship between real stock prices and inflation is presented in Table 1. In these specifications, the S&P Composite Stock Price Index (deflated by the Consumer Price Index) is regressed against a time trend and contemporaneous and lagged inflation rates. The lagged inflation rates are included as proxies for expected inflation and also in recognition of the possibility that some learning effects may be manifest over a sample period which witnessed a transition to higher levels of inflation. The sum of the inflation coefficients may be interpreted as a point estimate of the long run impact of inflation on stock prices. The linear specification implies that a one-percentage point increase in the rate of inflation is associated in the long run with a 19% decline in real stock values.[1] In the semi-log specification, this semi-elasticity may be directly obtained as the

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[1]The sum of the inflation coefficients is about -1105, and since the average value of the deflated stock price index over this period is 59.6, a semi-elasticity of about -19 is implied.

sum of the inflation coefficients, again -19. The linear and semi-log specifications were estimated with a first-order autocorrelation correction, and the size of the coefficient suggests nonstationarity in the series. The third specification which attempts to correct for this defect, is a first-difference variant of the semi-log estimation, and the implied inflation semi-elasticity here falls to -10.

To obtain additional insights into the reasons for the adverse effect of inflation on common stock prices, it will be convenient to consider two simple stock valuation models, which will permit us to analyze the inflation impact on stock values in terms of the impact on the underlying parameters. Let X represent next period's expected cash flow to the investor measured in current dollars. If this cash flow is growing at a real growth rate g, and there is a sustained inflation π, then the nominal growth rate is $(1+g)(1+\pi)-1$. Assume that the investor discounts the nominal cash flows at a before-tax nominal rate r_m, and that these flows are subject to proportional taxes t.[1] If the stock will be held in perpetuity, its price may be written as

$$P = \sum_{i=1}^{\infty} \frac{X[(1+g)(1+\pi)]^{i-1}(1-t)}{[1+r_m(1-t)]^i} = \frac{X(1-t)}{r_m(1-t)-g-\pi}$$

When the stock is held in perpetuity, capital gains are never realized and so no capital gains tax is ever paid. If, on the other hand, we assume that the share is held for one year, taxes are paid annually, and are assessed on capital gains at the same proportional rate as on dividends,[2] taxes drop out of the price expression:

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[1]Clearly, this is a simplifying assumption.

[2]Again, this is a simplifying assumption.

$$P' = \frac{X}{r_m - g - \pi}$$

These two expressions represent extreme cases and we believe that actual capital gains tax incidence lies somewhere between the two assumptions.

Writing the nominal discount rate as the sum of a real required return, ρ_m, and the inflation premium, the stock price equations become

$$P = \frac{X(1-t)}{\rho_m(1-t) - g - \pi t} \quad \text{and} \quad P' = \frac{X}{\rho_m - g}$$

The question now arises as to what extent the inflation-induced decline in stock prices can be attributed to the impact of inflation upon the parameters of these valuation expressions. In working with the first model, there will be a direct effect stemming from the appearance of inflation in the denominator of the right-hand side, a consequence of nominal taxation. This direct effect is perverse, implying that an increase in inflation should increase stock prices, if it is assumed that X, ρ_m and g are unaffected by inflation. In this model, there will also be an effect due to shifts in the personal tax rate, since inflation, with no change in the schedule of nominal tax rates, increases the effective tax rate on real personal income.[1] Such an increase, however, will exert a stimulating influence on stock prices since $\partial P/\partial t > 0$, still holding X, ρ_m and g constant. Thus these effects of a tax increase are contrary to the empirical evidence. In the second model, neither taxes nor inflation appear explicitly, although there remain indirect effects which will be discussed in Section 5.

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[1]An estimated increase between 1950 and 1978 of about three percent in the effective rate of personal taxation is documented in a Ph.D. Dissertation by Joel Hasbrouck (1981).

In the next two sections we will consider the effect of inflation on the real flow of dividends and earnings. Subsequently, we shall attempt to infer the effect of inflation on the real required rate of return as distinguished from the market realized return. It will be seen that changes in inflation affect the cash flows and the impact is distributed in a complicated pattern over a period of years. To facilitate use of the valuation models in a later section, it will be necessary to interpret them in a comparative statics sense. In considering two alternative regimes with different inflation rates, we shall assume that the inflation impact on the cash flows is, in effect, instantaneous, and thereafter real growth occurs at the same rate as existed prior to the inflation.

3. Dividends, Book Earnings and Inflation

Since stock prices presumably discount the expected flow of future return and this return basically takes the form of dividends and capitalized future dividends, this section of the paper will start with an examination of the relation between dividends per share and the rates of inflation. Because it is corporate earnings which make dividends possible and the level of dividend payout tends to be sticky to new developments which may be transitory, the relation between earnings and inflation will be also be analyzed. It is not clear to what extent the market relies on book earnings per share, the earnings figure which is published, or attempts to estimate and act on the basis of economic earnings per share which require appropriate adjustments for changes in the real capital assets and the real debt of the corporation. The relation between book earnings and inflation will be examined in this section, and will be followed in the next section by the estimation of economic earnings and an analysis of how inflation affects them.

The regressions of the logs of annual real dividends per share (obtained from the S&P Composite Stock Index dividend series) on the contemporaneous and lagged rates of inflation (measured by the CPI) over the period 1946 through 1978, with a time trend introduced as an additional explanatory variable, are presented in Table 2.[1] The time trend variable is added to hold constant the normal upward movement in dividends as a result of profits earned on reinvested income. We also computed these regressions including the FRB Index of Industrial Production as an additional explanatory variable to hold constant cyclical influences on dividends, but we do not present these results since the effect of inflation on dividends is not changed significantly.[2] The regressions in Table 2, including both those with first and second order serial correlation corrections, indicate that with the normal upward movement in dividends held constant, a one percentage point increase in the rate of sustained inflation lowers the real level of dividend payout by about 5%. In these regressions, the small effect of current inflation is probably attributable to the general stickiness in dividend payout.[3,4]

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[1]Quarterly regressions were also computed and gave similar qualitative results.

[2]If inflation did affect the level of real economic activity as well as the level of real dividends, we would of course be interested both in the dividend-inflation regressions with and without this additional explanatory variable.

[3]Using second and third degree Almon lags to avoid the problem of multicollinearity among the current and lagged inflation terms in Table 2 pointed to a depressant effect on dividends of about 2% associated with a sustained one percentage point rate of inflation.

[4]In assessing the impact of inflation upon dividends and book earnings, there exists the possibility that a portion of this impact is transitional in nature. It should be noted that it is much more difficult to introduce expected and unexpected inflation into the analysis of dividends and earnings than into the analysis of market rates of return, where the effect of expectations is incorporated more rapidly.

However, since changes in dividend payout might be expected to lag changes in earnings, especially if the permanence of the change in earnings is uncertain, it is necessary to examine the effect of inflation on expected earnings to assess further the prospective effect of inflation on the expected flow of future dividends. The normal dividend lag might be intensified not only by the uncertainty of the permanence of the change in earnings associated with inflation but by the uncertainty of additional working capital needs which might after an appropriate time lag more appropriately be financed by external sources of funds.

The statistical relationships between annual real book earnings per share for corporations as a whole over the 1946-1978 period are presented in Table 2. Current inflation seems to favorably affect real book earnings in the same year, perhaps reflecting a lag of wages behind prices, but to adversely affect real book earnings in the next three years, with not much influence thereafter. The adverse effect of sustained inflation on real book earnings is approximately 5%, a result quite close to that obtained for dividends.[1,2] To examine further effects of inflation on book profits, we shall determine whether the aggregate time-series results for corporations as a whole are supported by corresponding findings for different groups of companies.

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[1]Again similar results were obtained from the linear as well as log regressions, from quarterly as well as annual relationships and for Almon lag structures. The results did not appear to be sensitive to the use of a CPI or gross national product deflator.

[2]In an extension of the analyses to cover the 1930-1978 period, the results were not significantly changed. Inflation and deflation were introduced as separate variables along with either a time trend or industrial production, and the regression suggested that a 1% inflation depressed dividends by about 5%. Similarly, 1% inflation in this period depressed deflated book earnings per share by about 4%.

First a sample of 224 companies was selected from the primary Compustat industrial file covering the 1958-1977 period. The primary criterion for selection was data availability and in addition, for analytical convenience, certain types of companies were excluded.[1] The sample was then divided among 13 major industries. When the number of companies in an industry exceeded 13, the largest 13 (on the basis of net worth) were selected.

Second, two generalized least squares regressions, one weighted and the other unweighted, were computed between the standardized book earnings per share reported on the Compustat tape deflated by the gross national product (g.n.p.) implicit price deflator and both the rates of inflation in the same year and five prior years (again measured by the g.n.p. deflator) and a time trend.[2] The standardization of book earnings per share, which was carried out to facilitate aggregation, was accomplished by considering one standardized share in each company to be equal to $100 of that company's book equity in 1958 valued in 1972 dollars.[3] An average standardized book earnings per share figure was computed for each industry and this series was used in the panel estimations. The weighting was by number of standardized shares, but since

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[1]These were firms which were affected by major mergers or acquisitions, had fiscal year changes or fiscal years ending other than in the fourth quarter, used inventory accounting methods other than LIFO, FIFO or average cost, or which were utilities, mining companies or conglomerates.

[2]The actual regression fitted was:

$$\left(\frac{EPS}{PGNP}\right)_{it} = a_i + b_i TIME + \sum_{k=0}^{5} c_k DP_{t-k}$$

where EPS is the earnings per share (standardized) for industry i, PGNP is the GNP deflator, TIME is a linear time trend and DP is inflation in PGNP. See notes to Table 3.

[3]The number of standardized shares in any year (t) subsequent to 1958 was obtained by multiplying the number of standard shares in 1958 by the ratio of the actual number of (adjusted) shares in year t to the actual number in 1958.

the weighted and unweighted regressions gave similar results, only the former are presented in Table 3. Only linear (as distinguished from log) regressions were estimated for this analysis since book earnings per share were occasionally negative for individual corporations and industries.

For all industries as a whole, the regression points to a statistically insignificant negative impact, -2.2%, for a one percentage point increase in inflation.[1] For a similar analysis relating dividends to inflation, the results implied that a one percentage point increase in inflation was associated with a statistically significant 6% decline in real dividends per share.[2]

4. Economic Earnings and Inflation

A number of earlier studies have attempted to adjust reported corporate book earnings to construct measures of true or economic earnings under inflation and to examine the statistical relationship of these appropriately adjusted earnings measures to contemporaneous inflation. However, there is no consensus in the findings of these studies. Thus Shoven and Bulow (1976) concluded that the impact of their inflation adjustments upon reported profits was uneven, with no generalization possible on the effect of inflation on real economic earnings. Cagan and Lipsey (1978) using a somewhat more comprehensive set of adjustments also drew no conclusions about adjusted earnings behavior, but noted that "...the inflationary environment since the

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[1] As the average real book earnings per standardized share over the period is 16.20, and the implied impact of a .01 increase in inflation is -36.2 (.01) = -.362, the relative decline in real book EPS is -.362/16.20 = -2.2%.

[2] See Hasbrouck (1981).

mid-1960's has reduced the real profit rate, however measured, from the high level reached during the price stability of early 1960's."

In this section of the paper, we shall attempt to improve the analysis of these earlier studies, first by conducting the analysis on an industry as well as aggregate level to increase the number of effectively independent observations to the extent that errors are cross-sectionally uncorrelated, and second by applying more refined statistical procedures (generalized least squares) to achieve a further improvement over prior work.

Fully-adjusted earnings (E'_t) may be expresed as book earnings E_t plus the adjustments indicated:

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\begin{aligned}
E'_t = E_t &+ \left[D_t - D'_t\right] + \left[\left(I^r_t - I^r_{t-1}\right) - \left(I^b_t - I^b_{t-1}\right) - \pi^i_t I^r_{t-1}\right] \\
&+ \left(\pi^k_t - \pi_t\right) K_{t-1} + \left(\pi^i_t - \pi_t\right) I^r_{t-1} \\
&+ \pi_t \, NFL_{t-1} - \left(B_t - B_{t-1}\right)
\end{aligned}
$$

where D_t and D'_t represent historical and replacement cost depreciation; I^r_t and I^b_t are the replacement cost and book value of inventories; π^i_t, π^k_t, π_t are the inflation rates in the inventory price index, in the appropriate capital goods price index, and in the general price level; K_t is the replacement value of fixed assets; B_t represents the market value of debt and NFL_t is the market value of net financial liabilities. We compute these adjustments for the aggregate of all firms based on the Cagan-Lipsey estimates and for individual companies using refinements of algorithms developed by Parker (1977).[1] Three alternative measures of economic profits are used in this study. The first set (REPSCLA) is based on book earnings per share

[1] The procedures are described at greater length in a Ph.D. dissertation by Joel Hasbrouck (1981).

scaled by the ratio of Cagan-Lipsey adjusted income to book income where the adjusted income reflects adjustments for inventory valuation, capital consumption and decline in purchasing power of net financial liabilities. The second measure (REPSCLB) includes all adjustments except change in market value of debt, while the third measure (REPSCLC) is inclusive of all adjustments. The reason for estimating economic earnings with and without the market value of debt adjustment lies in the size and volatility of this correction, as well as its "one-time" nature. The first measure is similar to one which has been used by Modigliani and Cohn (1979) and differs from the second in that the latter includes capital gains on physical assets and land.

Three sets of regressions are presented in Table 4 corresponding to the three measures of economic profits. Another group of real economic earnings regressions is presented in Table 3 entailing a similar analysis for individual industries based on the same 224 Compustat companies and 1958-1977 period which were used in Part 3. To aggregate the results on an industry basis as well as for all industries combined, the weighting again is by number of standardized shares.

The regressions of aggregate real economic earnings per share on inflation, lagged inflation and time (Table 4) indicate that inflation persisting over a year negatively affects real economic earnings per share with fairly substantial (up to five year) time lags. The linear regressions with allowance for a full five-year time lag point to about 11% depressant effect on real economic earnings as a "result" of a one percentage point sustained increase in the annual rate of inflation. (This estimate is based on the average real economic earnings per share over the period covered.)

In alternative specifications, the value of the FRB total index of industrial production was substituted for the time trend in order to hold constant the level of economic activity. In these specifications, the negative impact of inflation is partially mitigated relative to those with the time trend. Thus, with real activity held constant, the estimated impact of a one percentage point increase in sustained inflation on fully-adjusted economic earnings is approximately 9% (Equation 8).

The impact of inflation upon economic earnings was also investigated using log specifications. There is much more variability in the estimates of the impact of sustained inflation than was present in the linear regressions. For fully-adjusted economic earnings, Equation 9 implies that a one percentage point increase in sustained inflation should be associated with a 20% drop in earnings. While linear and log fits will tend to give somewhat similar results when the time series involved are smooth, this similarity may vanish when the series are highly volatile. It is our judgement that the linear estimate of a 9-11% depressant effect on real economic earnings of a one percentage point increase in sustained inflation is much closer to the truth than the 20% implied by the log regression, although all of these estimates are subject to an uncomfortable margin of error. These effects are much higher than those implied by the earlier analyses of real dividends and real book earnings per share.

A corresponding regression for the cross-sectional Compustat data, which again incorporated the effect of five annual inflation lags, was estimated by a generalized least squares (gls) estimation procedure to eliminate some of the statistical deficiencies in ordinary least squares (Table 3). The gls procedure allows for cross-sectional heteroscedasticity and different autocorrelation coefficients for the disturbances in different industries. The earnings variable used is fully-adjusted economic earnings (corresponding to REPSCLC) per share, with weighting on the basis of number of standardized shares.[1]

The results again point to a substantial and statistically significant negative effect of inflation.[2] According to these results, a sustained 1% increase in the annual rate of inflation would be associated with about a 14% reduction in real economic earnings per share if all inflation adjustments are incorporated into the earnings data. This is higher than the corresponding estimate implied by the aggregate regressions. The discrepancy appears to result from sample differences and computational limitations described earlier.

No completely satisfactory explanation for the substantial negative relationship between inflation and economic profits has yet been offered, but it may be useful to summarize here some relevant considerations. The most commonly proffered explanation for the negative impact concerns the tax effect, by which is usually meant the additional tax burden imposed on the firm as a consequence of historical cost depreciation and FIFO inventory valuation. Offset against these penalties, however, are the deductibility of nominal interest payments and the progressive liberalization of permissible depreciation methods over the postwar period. Gonedes (1980) and Fama (1981) find the net effect negligible.

Even if the progressive liberalization of depreciation allowances is ignored, the implied negative impact of inflation should be manifest only at relatively moderate levels of inflation. As the inflation rate increases, the

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[1]Corresponding regressions excluding changes in the market value of debt from the inflation adjustments made and regressions with equal weights assigned to the data for each firm were also estimated but the results were not substantially different.

[2]Assessment of the impact of inflation is subject to the same uncertainties regarding transience and differential impacts of expected and unexpected inflation that characterized the book EPS and dividend analyses.

penalties of historical cost depreciation and FIFO inventory valuation reach limiting points, while the advantage conferred by deductibility of nominal interest payments rises linearly. A simulation analysis by Hasbrouck (1981) suggests that under reasonable parameter assumptions and the depreciation rules in effect prior to 1981, the level of sustained inflation at which the net tax burden would be equal to that with no inflation is probably about twenty percent per year.

Part of the negative impact of inflation upon economic profits may arise from a negative relationship between inflation and the level of economic activity.[1] This is suggested by the aggregate regressions in Table 4, in which those regressions which introduce industrial production as an additional variable have somewhat smaller estimated inflation coefficients.

Another avenue of explanation concerns factor prices. There is some evidence that compensation of employees as a share of total cost and profit of nonfinancial corporations increased slightly in the inflationary period of the

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[1] Fama (1981) has argued that the negative relationship between contemporaneous inflation and anticipated economic activity together with the positive relationship between market returns and anticipated economic activity largely account for the negative relationship between inflation and market returns. However, it is difficult to see how this type of argument could explain our finding of a negative relationship between inflation and economic profits. One limitation of the Fama analysis is that even the expected inflation effects on market returns disappear only when the growth rate of the monetary base is added as an additional explanatory variable and that the monetary base may act as a better proxy for expected inflation than the actual measure used. A second limitation is that even with the monetary base added the unexpected inflation effects are still significant in the monthly and quarterly regressions though not in the annual regressions. A third limitation is that Fama does not present sufficient data to substantiate his claim that "In the annual stock return regressions unexpected inflation also loses its explanatory power when placed in competition with future real activity" (p. 563). In the one relevant regression he presents in which economic activity is included but the monetary base is not, both expected and unexpected inflation rate effects are negative, with the first significant at the .95 level and the second conforming to a .8 level.

1970's.[1] There is also evidence that some effect of inflation on corporate earnings is attributable to the higher rise in the cost of goods which are purchased abroad, such as petroleum and other raw materials, than in those purchased domestically, which if true would imply that part of the inflation effect is attributable to the source of inflationary pressure during this period.[2] Of course much of these effects operating through the cost of goods might, like tax effects, ultimately be expected to be reflected in selling price.

Finally, it has been suggested that the negative inflation impact may reflect the additional regulatory burden imposed by government over a period coinciding with higher inflation. While this might help explain the negative relationship in the 1970's, it would not explain similar relationships between inflation and market returns in earlier periods or other countries. Moreover, among the motor vehicle, chemical and petroleum industrial groups, which have probably been most affected by adverse regulation, only the motor vehicle industry seems to have suffered a larger-than-average negative impact of inflation upon economic profits.

It may be recalled our analysis indicated that inflation has a more substantial negative effect on real economic earnings than on real dividends or real book earnings. This implies that dividends are not depressed by inflation as much as economic earnings. There are several tenable explanations of this result including the possibility that management consciously attempts to maintain their dividend payout when stock prices are depressed by inflation or that management gears its dividend payout in some

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[1] Economic Report of the President, U. S. Government Printing Office, January, 1981, p. 247.

[2] See Kravis and Lipsey (1982).

part, and perhaps more, to book than to economic earnings. These differential effects may also reflect errors in the measurement of economic earnings, including possible overstatement of the changes in plant and equipment prices due to inadequate representation of quality improvements in the capital goods price indexes. Measurement error is of course much less of a problem for book earnings and especially dividends.

Since we are interested for purposes of the following section in obtaining insights into how anticipated inflation affects required returns, it is necessary to estimate the effect of anticipated inflation on the level of real economic earnings per share expected in the future. Perhaps the best available approach to this problem is to assume that the sustained effect of inflation on actual real economic earnings estimated above on the basis of up to five-year time lags represents an adequate approximation to the effect of anticipated inflation on expected real economic earnings. However, another possible approach can be based on the assumption, admittedly dubious, that investors are able to forecast correctly the level of real economic earnings for up to five years in the future. The results of such an analysis, not presented for brevity, again indicate that expected inflation at a point in time is significantly negatively correlated with real economic earnings but suggest that the earlier results upon whch we are subsequently relying (Tables 3 and 4) may overstate the effect of anticipated inflation on expected real economic earnings.

5. Required Return and Inflation

Since no reliable information on the required market rates of return on common stock exists, we shall attempt to roughly estimate the effect of inflation on required returns implied by the effect of inflation on expected cash flows and stock prices.

In both stock valuation models described in Section 2, the primary factor causing the drop in stock prices is the inflation-induced decrease in cash flows measured by X, maintaining the assumption that the real growth rate g is unaffected by inflation except transitionally, and that the impact on X of an increase in inflation is realized as an instantaneous drop in its current value. Despite the obvious importance of this consideration, however, the reduction in stock prices is clearly greater than the decrease in real dividends and book earnings and probably greater than the decrease in real economic earnings. Therefore, an explanation of the relationship between stock values and inflation may depend in part on the behavior of the required rate of return.

In the first valuation expression, which assumed indefinite deferral of capital gains taxes, it has already been pointed out in Section 2 that the direct inflation and tax effects appear to work in a perverse direction. This suggests that the empirical findings can only be reconciled by some combination of an inflation-induced decline in expected earnings and dividends and an inflation-induced increase in the real before-tax required rate of return. Even if we adopt the extreme position that the depressant effects of inflation upon economic earnings and stock price have been equal and that only economic earnings matter, the impacts of the direct inflation and tax effects must still be offset by an increase in the real before-tax discount rate assuming, in the absence of contradictory evidence, that g does not change as a result of a change in steady-state inflation. In the second valuation model, which assumed annual payment of capital gains taxes, only if the decline in stock prices exceeds the decline in earnings is an increase in the real required rate of return suggested. There would appear to be only two possible theoretical explanations for such an increase, an indirect tax effect and an increase in uncertainty of equity returns.[1,2]

Since taxes are levied on nominal gains, investors may "demand" a higher before-tax real rate of return in order to maintain their after-tax real return. Empirical and theoretical studies of the Fisher Effect on risk-free assets suggest that the expected real before-tax risk-free rate of return is either unaffected or depressed by an increase in expected inflation.[3] Yet another indirect tax effect is implicit in the uncertainty model as a result of the introduction of risk. Under an uncertainty model, higher tax rates reduce the variance as well as the level of after-tax return to the investor. As a result of this uncertainty, as implied by the capital asset pricing theory discussed in Section 6, the required risk premium might be expected to be decreased by higher personal tax rates. Consequently, it does not appear that the effect of inflation upon personal taxes can be used to explain the empirical evidence.

Since personal tax considerations are not useful in explaining the rise in the required rate of return suggested by the empirical evidence, we believe this rise to be attributable to a real or perceived increase in the riskiness of investment in common stocks. We shall briefly review here not only the connection between risk and the level of inflation, but also that between risk and change in the level. The latter relationship is important in determining

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[1]It should be noted that the effect of inflation on the propensity to save does not seem to help explain the apparent increase in the real required rate of return on stock, since empirical studies generally point to a rise in the propensity to save associated with uncertain inflation. See Howard (1978) and Juster and Wachtel (1972).

[2]This increased uncertainty of real return might reflect unexpected shifts in relative prices among countries and within the country and any rise in the relative importance of debt.

[3]See Gibson (1970) and (1972), Fama (1975), and Levy and Makin (1979).

whether the inflation-induced increase in risk is a necessary and permanent consequence of higher sustained levels of inflation, or a transitional phenomenon.

The differentiation between transitional and sustained effects is not one that lends itself easily to empirical resolution. Over the post-World War II period, there is strong correlation between the level and first difference of inflation, rendering statistical differentiation of the two difficult. In addition, inflation-related uncertainties may be dichotomized according to whether or not they derive from greater uncertainty in policy variables. Uncertainties stemming from policy may be a necessary consequence of neither the level nor the change in the rate of inflation, despite the fact that a strong statistical relationship may exist. For these reasons, our classification of these relationships as causal or coincidental must rest largely on the underlying theory.

Of central importance here is the connection between the level and uncertainty of inflation, or alternatively, between expected inflation and the variance of unexpected inflation. Empirical studies by Logue and Willet (1976) and Foster (1978) have found a strong relationship between the level and variability of inflation, but of course not all of this variability may be unanticipated. Additional support comes from cross-sectional survey data. In his reworking of the Livingston survey data, Carlson (1977) suggests a relationship between level of inflation and dispersion of expectations across respondents.

The underlying causes of the level-variability or level-uncertainty relationships are unclear. Logue and Willet attribute this behavior to the greater instability of monetary policy which has been associated with the inflation of recent experience. If the increase in the uncertainty about unexpected inflation derives from this source, then output will probably be affected as well. Barro (1976) has shown that theoretically the variance of output may be partially dependent on the variance of the money supply. This risk will be non-diversifiable, and hence will increase the risk premium, although since the rate of growth in the monetary base is a policy variable, this source of inflation-related uncertainty could perhaps be reduced.

The increase in the variance of unanticipated inflation directly affects the required rate of return on stocks as a whole, as will be shown in Section 6. In addition, however, the increase in variance will impact returns in certain firm- and industry-specific ways. If firms engage in nominal contracting, increased uncertainty about inflation will result in increased uncertainty in the firm's earnings. Another firm-specific risk derives from relative price differentials. Vining and Elwertowski (1976) have empirically established that under high inflation there is a greater dispersion of the specific price indices composing the overall index.[1] That this may result from the greater variance in unanticipated inflation is demonstated in a theoretical model by Parks (1978). To the extent that this variability in relative prices is unforeseen, it will cause greater uncertainty in the firm's spread between input and output prices and consequently greater uncertainty in the firm's earnings. Although these specific risks are, in theory at least, diversifiable, such risks may be important in determining required risk premiums since investors do not hold well-diversified portfolios.

These causal relationships may be summarized as follows. Increased uncertainty about the growth of the monetary base will result in increased uncertainty of outpt and inflation. In addition an increase in the variance

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[1]A thorough discussion of the nature and sources of relative price variability is given in Fischer (1982).

of inflation may, totally apart from its source, be associated with greater risk from price dispersion. A further source of uncertainty lies in exogenous shocks, such as the jumps in relative energy prices. It is our belief that such factors have caused an increase in the risk relevant to stock valuation coincident with the increase in inflation in the past decade, and we turn now to the empirical evidence in support of this position.

The uncertainty that is of primary importance on theoretical grounds is that which is real and nondiversifiable, i.e., market-wide. To the extent that market imperfections lead investors to hold undiversified portfolios, however, certain firm- and security-specific uncertainty may be relevant as well. Since equities are marketable assets, any increase in risk should be apparent in the uncertainty of market returns. Of course since market values reflect the characteristics of the underlying earnings flows, increased market risk should reflect increased risk in those flows. Thus, the empirical analysis of uncertainty should examine that present in market returns and cash flows, and that which is both diversifiable and nondiversifiable.

Since nondiversifiable market risk is primary, our empirical analysis will concentrate upon it, and the results of tests on the other types of risk will be brought in as evidence of secondary import. Due to its explicit role in the subsequent analysis, our desired measure of the former is the variance of the real market returns. As a proxy for this, we shall use the variance of real return on the S&P composite index. Furthermore, since investors' ex ante estimates of this variable are generally unobservable, we are limited to inferences based on ex post variability. Two approaches will be employed, a rolling-variance analysis and one based on a heteroscedasticity analysis of linear return functions.

The former is conceptually the simplest. For a given month, an estimate of the real return variance was computed as the sample variance of real market returns in the twelve preceding months. This series was regressed against the average inflation rate over the same twelve months, over the period 1947-1977 and a statistically significant correlation coefficient (corrected for degrees of freedom) of .19 was obtained.[1] Statistical significance of the inflation variable persisted when various proxies for expected inflation were used and also when the specification was expanded to include a linear time trend, or a rolling-variance estimate of industrial production.

Despite the appeal of simplicity, there are certain problems with this type of analysis. The variance estimates are not serially independent, and even more serious, the method relies on the assumption that over the twelve month estimation period, returns are identically distributed, even though the final conclusion of the analysis suggests that this is almost certainly not the case. For these reasons, a more sophisticated analysis was employed. It was assumed that investors formed expectations of the real return based on some stable linear forecasting rule, a regression which could be estimated over the sample period. The residuals from this regression would then constitute the unexpected real return and an analysis of the unexpected return variance could then be performed as a test for heteroscedasticity.

A representative analysis of this type is described in Table 5. The real return-generating equation is estimated over the post-war sample period with the future change in industrial production (as a proxy for expected economic activity) and a time trend as explanatory variables. Two types of heteroscedasticity analysis were performed. In the first, due to Glesjer

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[1] Hasbrouck (1981) _op. cit._

(1969), the absolute values of the residuals were regressed against variables suspected of affecting the residual variance. Glesjer's Monte Carlo simulations of this technique suggested that the usual t-tests for significance were approximately correct. On this basis, actual contemporaneous inflation is a marginally significant determinant of return variance. When average inflation or a proxy for expected inflation is used, however, the level of significance is much higher, probably a consequence of the fact that these series are much smoother than the monthly inflation series.

Another test for heteroscedasticity has been recently suggested by Breusch and Pagan (1979). Although somewhat more complicated than the Glesjer analysis (details are summarized in the notes to Table 5), it has the advantage that the limiting distribution of the test statistic can be formally shown to be distributed as a χ^2 variate. Table 5 reports Breusch-Pagan analyses parallel in form to the Glesjer tests, and the results are similar, strongly suggesting a significantly positive link between inflation and the variance of the residuals in the return-generating equation. These results were found to be robust in use of a variety of return-generating equations and heteroscedasticity specifications.[1]

We turn now to the analysis of firm-specific market risk. A rolling-variance test of the sort described above was performed for each of 404 NYSE stocks from the Rodney White Center data base for which complete data were available for the 1947-1978 period. When the variance estimates were regressed against inflation, the coefficients in 93% of the regressions were positive. Based on a computation of binominal probabilities, the null

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[1]Hasbrouck (1981) op. cit.

hypothesis of equally-probable signs for this coefficient may be rejected with a degree of confidence well in excess of .999, assuming independence.

The performance of analyses similar to the above on earnings data is complicated by measurement error problems and more limited data. For reasons of brevity, we shall limit our reporting of the results to noting that a significant link between inflation and earnings variance was found, but the strength of the relationship was less than that observed in the analysis of market returns.

While there are statistical limitations in all the analyses carried out in this section, the consistency of the results appears to provide strong evidence that inflation has increased the riskiness of investment in common stocks.[1] We shall in the next section attempt to determine whether capital asset pricing theory can be used to cast any light on the quantitative relationship between both risk and personal taxation and the required rate of return for risky assets as a whole. It should be noted that such a theory may be questioned for a number of reasons, including its failure to incorporate the effect on required returns of company-specific risks.

6. Required Return and Capital Asset Pricing Theory

To analyze the theoretical relationship between the required rate of return on risky assets as a whole and inflation under capital asset pricing theory, we shall start with a simple transformation of the aggregate equilibrium relationship between the relative demand for risky assets and the market price of risk under uncertain inflation developed by Friend, Landskroner and Losq (1976):

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[1]Some of the uncertainties reflected in the market-variance and inflation relationship may be associated with the transition to higher rates of inflation. Once these higher rates become the established norm, it is possible that these uncertainties would diminish.

$$(1) \qquad E(r_m) = r_f + \sigma_{m\pi} + \alpha C(1-t)\left[(1-h)\,\sigma_m^2 + \frac{h}{\alpha}\,\sigma_{mh} - \frac{\sigma_{m\pi}}{\alpha(1-t)}\right]$$

where $E(r_m)$ is the expected or required nominal rate of return on the market portfolio of all risky, marketable assets, r_f is the risk-free nominal rate of return, $\sigma_{m\pi}$ is the covariance between the market return and the rate of inflation, α is the ratio of the value of risky to all marketable assets, C is the market's Pratt-Arrow measure of relative risk aversion, t is the effective tax rate on investor income, h is the ratio of human wealth to total wealth (both human and non-human or marketable), σ_m^2 is the variance of return on the market portfolio and σ_{mh} is the covariance between the market return and the return on aggregate human wealth. The assumptions necessary for the derivation of (1) include, in addition to those normally required for the development of the CAPM, arithmetic Wiener processes for r_m, inflation and the return on human wealth; constant relative risk aversion; and taxes which represent the same proportion of income regardless of the level of net worth.[1]

Equation (1) can be converted into a useful equilibrium demand relationship expressed in terms of real rather than nominal returns by substituting the assumption of arithmetic Wiener processes for real returns (ρ_m and ρ_f) on the market portfolio and on the nominally risk-free asset rather than for nominal returns and by the additional assumption

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[1]The constant relative risk aversion assumption is based on empirical analysis of the available data (see Friend and Blume (1975)). The constant proportionality tax assumption is, of course, a crude approximation which has been introduced in (1) for analytical convenience. However, it is possible to obtain a relationship similar to, though somewhat more complex than, (1) by making the alternative assumption that the tax rate is a function of the level of net worth but not of its composition (Friend and Blume (1975)).

that $\sigma_{mh} = 0$.[1] This relationship can be written as[2]

$$(2) \qquad E(\rho_m) = E(\rho_f) + C[a\ \sigma^2_{\rho_m} - (1-a)\ \sigma^2_\pi - (1-2a)\ \sigma_{\rho_m \pi}].$$

where $a = \alpha(1-t)(1-h)$.

To obtain analytical insights into how $E(\rho_m)$ is affected by expected inflation, i.e., to determine $\frac{d\ E(\rho_m)}{dE(\pi)}$, it is necessary to integrate supply considerations with the demand relationship presented in Equation (2), but the resulting model is too complex to reach a tractable solution unless some completely unrealistic simplifying assumptions are made.[3] As a result, we shall use a more convenient form of Equation (2) where the expression in brackets is expressed in nominal terms

$$(3) \qquad E(\rho_m) = E(\rho_f) + C\ [a\ \sigma^2_m - \sigma_{m\pi}],$$

C has been estimated at about 2 by Friend and Blume (1975) using a model in which investment decisions are not affected by human wealth. However, using their data and a model that incorporates human wealth, which corresponds to Equations (1)-(3), the estimate of C becomes roughly 6, based on a value of .9

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[1]The assumption that $\sigma_{mh} = 0$ is based on the empirical evidence (Fama and Schwert (1977). The assumption of Wiener processes for real returns is approximately equivalent to the corresponding assumption for nominal returns. The real-nominal Wiener process correspondence can be made exact if geometric processes are employed.

[2]In deriving this equation from (1), it should be noted that ρ_m is defined as $\frac{r_m - \pi}{1 + \pi}$ and that, under the assumptions made, $\sigma^2_m = \sigma^2_{\rho_m} + \sigma^2_\pi + 2\sigma_{\rho_m \pi}$ and $\sigma_{m\pi} = \sigma^2_\pi + \sigma_{\rho_m \pi}$.

[3]See Hasbrouck (1981).

for α,[1] .8 for (1-t) and .35 for (1-h).[2] The base estimate for h is derived from the data tape associated with the MPS model by applying an assumed capitalization rate of 10% to real wages and salaries to obtain the real value of human wealth, while the base estimate of (1-t) is estimated as the ratio of disposable income to personal disposable income from the same source reduced by 10% to approximate the weighted harmonic mean of (1-t) for individual investors which theory suggests is the more appropriate value to use.[3]

We shall make two estimates of how $C\alpha\sigma_m^2$ and therefore $E(\rho_m)$ are likely to be affected by an increase in the annual rate of inflation from 3% to 10%. This increase might be compared with the rise in the actual rate of inflation as measured by the CPI from 2.8% as an average for 1965-1967, before the break in the stock market and the subsequent onset of inflationary pressures, to 9.6% for 1976-1979, and to a higher figure in 1980-81. The two estimates of the change in $C\alpha\sigma_m^2$ differ only in their estimates of the change in $a = \alpha(1-t)(1-h)$ associated with a 10% rate of inflation. The first estimate assumes that the average values of α, (1-t) and (1-h) over the 1947-1978 period (.9, .8 and .35 respectively) would not be changed significantly by the increase in inflation. The second estimate assumes that α, (1-t) and (1-h) would each be decreased by .05, which seems larger than the likely

[1]See Friend and Blume (1975).

[2]It should be noted that the base estimate of C(1-h) is the same regardless of whether the model incorporating a C value of 2 or that of 6 is used, so that the estimate of $E(\rho_m)$ is unaffected by the choice of model under the other assumptions made.

[3]See Friend and Blume (1975) both for the theoretical justification of the weighted harmonic mean and for the empirical basis of the 10% adjustment factor.

effect of a 10% rate of inflation on these three parameters.[1] It should be noted that these values of α, (1-t) and (1-h) are based on data for households only. The inclusion of institutional investors would not affect α very much but would substantially increase both (1-t) as a result of their close to tax-free status and (1-h) since h=0 for institutions. As a result, our estimates of a and the change in a tend to understate somewhat both the required real risk differential and the change in the differential associated with inflation.

Thus, we estimate that the effect of a shift in the rate of inflation from 3% to 10% would reduce a by at most .06 (from .252 to .191). In contrast, the shift would be associated with an increase in σ_m^2 from .0013 to .0022.[2] With C=6, $E(\rho_m) - E(\rho_f)$ would be increased from .0020 on a monthly basis with a 3% inflation to somewhere between .0025 and .0033 (with 10% annual inflation), or from 2.4% (2.4 percentage points) to between 3.0% and 4.0% on an annual basis.[3]

The consequences of these parameter shifts for stock prices may be illustrated using the valuation models developed in Section 2. The expected real rate of return is given in (3) and for simplication purposes we will

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[1]The effect of inflation on (1-t) and (1-h) are estimated by regressing each of them on the rate of inflation over the 1947-1978 period.

[2]The estimated impact of inflation upon σ_m^2 was obtained from a heteroscedasticity analysis (similar to that presented in Table 5) on nominal monthly returns. There is, however, very little difference between real and nominal market return variances since monthly inflation uncertainty is small.

[3]The effect of inflation on α cannot be estimated in the same fashion since comparable annual data do not exist. In any case, it is clear that we have over-estimated the depressant effect of inflation on a. These estimated real risk differentials seem lower than the estimates implied by realized nominal rates of return since the turn of the century (see Friend and Blume (1975) and Ibbotson and Sinquefeld (1977)). This might reflect an understatement of the estimates of C or σ_m^2 (the latter in the absence of inflation).

let $\sigma_{m\pi} = 0$ though the empirical evidence suggests a small negative covariance between realized market returns and the unexpected rate of inflation. The two price expressions, which followed from the assumption of indefinite deferral of capital gains taxes and regular payment of capital gain taxes, become

$$P = \frac{X(1-t)}{[E(\rho_f) + Ca\sigma_m^2](1-t) - g - \pi t} \text{ and } P' = \frac{X}{E(\rho_f) + Ca\sigma_m^2 - g}$$

Using parameter estimates previously discussed, it is possible to compute the derived impact of inflation upon prices, although the analysis remains highly sensitive to parameter values.

As noted in the earlier development, the impact of inflation to be assessed here should be viewed in a comparative statics sense. The cash flows in particular exhibit an adjustment to changes in inflation that is distributed over time. We ignore these transitional effects, assuming for convenience that the impact of inflation is instantaneously felt and subsequent real growth is at the constant rate g, which is unaffected by the rate of inflation.

The implied inflation impacts on the price-earnings multiples (P/X or P'/X) derived from the above valuation models are highly sensitive to parameter choice. Assume as before that C=6, (1-t)=.8, (1-h)=.35, α=.9 (implying a=.252), and that the increase in risk (σ_m^2) associated with a rise in inflation from 3% to 10% is as described above. If in addition $E(\rho_f)$=.02 and g=.01, on an annual basis, the effect of going from a 3% to 10% sustained inflation would be to cause the price-earnings multiple in the first model (P/X) to increase by 7% and that of the second model (P'/X) to drop by 33%. A slightly smaller value for $E(\rho_f)$ and a slightly larger value for g would, however, increase the absolute values of these magnitudes. The source of the surprising direction of the inflation impact in the first model stems from the $-\pi t$ term which dominates the effect of the rise in σ_m^2 in the denominator, a consequence of the tax-deferral feature.

Thus, these results obtained from the implementation of our theoretical model are sufficiently sensitive to model specification (and to the values of the parameters assumed) that the only strong conclusion that can be drawn is that our earlier empirical findings are not clearly inconsistent with the results of our theoretical analysis.[1]

Two further comments should be made about our implementation of the CAPM. First, it implies an effect of inflation on the required rate of return and hence on stock prices which is towards the lower end of the range implied by our earlier empirical analysis. Second, the personal income tax effect of change in the inflation rate on required real market (before-tax) returns seems completely unimportant and of negative rather than positive sign. In the theoretical framework we have used in this section of the paper, it is the impact of inflation on the variance of market return and hence on the required real rate which helps account for the perverse effect of inflation on stock prices.

However, we suspect that part of the increase in the required real return has little to do with the version of the CAPM developed in this section,

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[1] In contrast to the analysis presented here, Modigliani and Cohn conclude that the negative impact of inflation on stock prices reflects investor irrationality. Asserting that real economic earnings have not been adversely affected by inflation, they conclude that the downturn in stock prices during the recent inflationary period is attributable either to an understatement of real economic earnings or an overstatement of the real required rate of return. The understatement of real economic earnings in their view reflected investors' lack of understanding of the favorable implications of inflation on the real burden of debt while the overstatement of the real required rate of return reflected a confusion between nominal and real return. While our analysis does not require an interjection of investor irrationality to explain a downturn in stock prices, we would not find it implausible that investors took a prolonged period of time to assess and respond to the impact of inflation on real economic earnings and the relevant discount factor.

reflecting instead the increase in unique (as distinguished from market) risks associated with inflation.[1]

7. Inflation and Realized Stock Market Returns.

We now turn to a discussion of the implications of the preceding analysis for the problem of stock returns. Much research, cited in the introduction, has focused on this problem, and the consensus finding has been a negative relationship between realized returns and both realized and expected inflation. The negative impact of expected inflation in particular is held to be a particularly troublesome result, seeming to violate rational asset pricing under the assumption that the expected real return is constant. We shall now reexamine this relationship in light of our valuation model.

To recap some of the findings of earlier sections, an increase in inflation was found to be associated with a drop in earnings (distributed over time) and a rise in the level of risk. In the last section, simple valuation models were used to obtain in a comparative statics framework an inflation-elasticity of real stock values. The implications of this for realized returns are the following: first, a rise in the long-run expected rate of inflation should be associated with a drop in stock values, and hence, a one-time capital loss. It is emphasized that the inflation expectations horizon relevant here is the horizon of the stock valuation model, which is indisputably long run. The second prediction of our analysis is a positive association between the risk premium and expected inflation.

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[1]While the analysis of this section has been directed toward establishing an inflation-related increase in the real required return on equity, we note that the effect on the average cost of capital is more problematic. If leverage increased as a result of inflation, a rise in the weight of debt might more than offset the increase in the cost of equity, resulting in a net decrease in the real overall cost of capital, even if the real cost of debt were to increase.

To test the validity of these conjectures, realized real market returns were regressed against a set of variables which included expected and unexpected inflation, changes in expected inflation, and economic activity. The results are presented in Table 6. The measure of expected inflation used was the Treasury bill yield less an average real return on similar Treasury bills over the previous six periods. The proxy for economic activity used was the rate of change in the Federal Reserve Board index of industrial production. The first difference in the S&P average municipal bond yield was taken as a proxy for changes in the long-run inflation rate. When this last variable was included in monthly and quarterly regressions, the sign was negative and significant, as predicted by our analysis. Its role in annual return regressions, however, was close to zero. Inclusion of this variable tended to mitigate, but not eliminate, the negative impact of the level of expected inflation. The remaining effects of the level of expected inflation may reflect measurement error, including a possible confounding of level and changes in the expected inflation measures in our analysis.

To test the impact of expected inflation on the risk premium, regressions were run in which the dependent variable was the realized risk premium, measured as the actual market return less the return over the period of a Treasury bill (of compatible maturity) purchased at the beginning of the period. This variable was then regressed against the set of explanatory variables used above and the results are reported in Table 7. For the monthly, quarterly and annual regressions, the coefficient of expected inflation is negative, but insignificantly so. When a time trend is included in the specifications, the coefficient of expected inflation becomes insignificantly positive in the quarterly and annual regressions. These results do not indicate any clear relationship between realized risk premia and expected inflation, which may indicate that realized risk premia are grossly inadequate proxies for expected or required premia, or that the changes in required premia associated with changes in expected inflation are quite small.

8. Conclusion

Inflation has depressed not only stock prices and realized real market rate of return on stock, but also real dividends and earnings per share. However, while the decline in real dividends and in real book earnings per share historically associated with a one percentage point increase in sustained inflation appears to be of the same general order of magnitude, roughly about 5%, the decline seems to be somewhat more than double for real economic earnings per share. There is also strong evidence, although it is not conclusive, that inflation increases the uncertainty of real return on stock investment which would be expected to be associated with a significant increase in the risk premium and therefore probably with the required rate of return on stock.

The implications of our theoretical model for the effects of inflation on price-earnings multiples are, however, less clear. The analysis is highly sensitive to tax assumptions and parameter choice, and the computations point to changes in price-earnings multiples ranging from substantially negative to slightly positive. On the basis of our empirical analysis, the increase in price-earnings multiples associated with a one percentage point increase in sustained inflation was in the range of 0 to 5 percent, which is well within the range suggested by the theoretical analysis.

The negative impact of the level of expected inflation on realized stock returns seems smaller than suggested in most of the previous literature, once changes in expected inflation are incorporated into the analysis of market returns, and may simply reflect remaining statistical limitations of this analysis.

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Table 1.

Stock Prices and Inflation, Annual, 1946-1978.

Equ.	Dependent Var.	Const.	DP[T]	DP[T-1]	DP[T-2]	DP[T-3]	DP[T-4]	DP[T-5]	TIME[T]	SUM	R2C	DW	RHO
1.	RSPXEND[T]	-37.80 (-1.3)	-454.53 (-4.6)	-201.63 (-3.8)	-197.06 (-3.4)	-221.04 (-3.9)	-30.87 (-0.6)	-1.35 (0.0)	334.90 (4.3)	-1106.47 (-4.9)	0.674	2.022	0.721
2.	LOG RSPXEND[T]	2.34 (6.8)	-7.65 (-5.2)	-3.46 (-4.6)	-3.71 (-4.6)	-3.91 (-5.0)	-0.43 (-0.6)	-0.21 (-0.3)	5.87 (6.3)	-19.38 (-6.6)	0.701	1.869	0.658

Equ.	Dependent Var.	Const.	ΔDP[T]	ΔDP[T-1]	ΔDP[T-2]	ΔDP[T-3]	ΔDP[T-4]	ΔDP[T-5]	SUM	R2C	DW
3.	PΔRSPXEND[T]	0.038 (1.4)	-3.942 (-4.2)	-2.633 (-2.6)	-1.972 (-1.8)	-2.318 (-2.1)	0.025 (0.0)	0.571 (0.6)	-10.268 (-2.3)	0.342	2.042

RSPXEND — S&P Composite Index deflated by CPI (end-of-year values). Average value over 1946-78 period is 59.6.

DP — Annual inflation in CPI.

TIME — Time trend. Initialized to .01 in 1946 and incremented by .01 in each year thereafter.

ΔDP — First difference in DP.

PΔRSPXEND — Proportional first difference in RSPXEND.

Equations 1 and 2 were estimated using a first-order Cochrane-Orcutt autocorrelation correction. RHO is the estimated autocorrelation coefficient.

SUM — Sum of the inflation coefficients (DP or ΔDP). R2C is R^2 corrected for degrees of freedom. T-statistics are given in parentheses. DW is the Durbin-Watson statistic.

Table 2.

Dividends Per Share, Book Earnings Per Share

and Inflation, Annual, 1952-1978

Equ.	Dependent Var.	Const.	DP[T]	DP[T-1]	DP[T-2]	DP[T-3]	DP[T-4]	DP[T-5]	LOGXIPT[T]	TIME[T]	XIPTAVG[T]	SUM	R2C	DW	RHO	RHO2
1.	LOG RSPDIVS[T]	0.350 (3.4)	-0.625 (-1.1)	-2.196 (-4.0)	-2.052 (-2.9)	-1.982 (-3.5)	-1.090 (-2.5)	-1.071 (-2.4)		3.855 (5.6)		-9.017 (-5.0)	0.656	0.900	0.701	
2.	LOG RSPDIVS[T]	0.602 (6.1)	-0.028 (-0.1)	-1.648 (-3.9)	-1.342 (-2.5)	-1.054 (-1.9)	-0.436 (-1.2)	-0.517 (-1.7)		2.152 (3.2)		-5.024 (-2.4)	0.612	1.375	1.517	-0.696
3.	REPS[T]	1.766 (1.7)	13.947 (2.3)	-26.222 (-4.5)	5.091 (0.7)	-14.475 (-2.4)	3.384 (0.7)	-4.957 (-1.0)		17.619 (2.5)		-23.232 (-1.2)	0.622	2.004	0.692	
4.	REPS[T]	1.393 (1.8)	4.435 (0.7)	-16.274 (-3.3)	1.740 (0.3)	-11.715 (-2.4)	2.002 (0.5)	-3.456 (-0.9)			0.044 (3.8)	-23.268 (-1.8)	0.636	1.711	0.665	
5.	LOG REPS[T]	0.983 (5.5)	2.580 (1.8)	-5.140 (-3.7)	1.010 (0.6)	-2.816 (-2.0)	0.762 (0.7)	-0.732 (-0.7)		3.353 (2.6)		-4.336 (-1.2)	0.609	1.936	0.605	
6.	LOG REPS[T]	-3.092 (-2.4)	0.197 (0.1)	-3.181 (-3.0)	-0.132 (-0.1)	-2.695 (-2.5)	0.602 (0.8)	-0.998 (-1.1)	1.073 (3.6)			-6.207 (-2.1)	0.632	1.783	0.817	

RSPDIVS — Dividends per share for S&P Composite Index, deflated by CPI.

REPS — Earnings per share for S&P Composite Index, deflated by CPI.

DP — Inflation in CPI.

XIPTAVG — Average value of Federal Reserve Board total industrial production index.

LOGXIPT — Logarithm of XIPTAVG.

TIME — Time trend. Initialized to .01 in 1946 and incremented by .01 in each year thereafter.

All equations except 2 are fitted with a first-order Cochrane-Orcutt correction, with RHO being the estimated autocorrelation coefficient. Equation 2 is fitted with a second-order correction, with RHO and RHO2 as the estimated coefficients.

Table 3.

Panel EPS Regressions, Annual, 1958-1977

	Book EPS				Economic EPS			
Industry	(1) Weight	(2) Avg. EPS	(3) Constant	(4) Time	(5) Weight	(6) Avg. EPS	(7) Constant	(8) Time
Food	0.053	14.91	8.38	0.666	0.053	10.54	6.07	0.787
			(5.3)	(3.6)			(1.7)	(2.4)
Textiles	0.011	8.33	9.03	0.036	0.011	4.49	7.56	0.108
			(3.9)	(0.2)			(3.9)	(0.5)
Lumber and Wood	0.011	20.03	4.49	1.508	0.010	20.53	7.00	1.669
			(0.8)	(3.3)			(0.6)	(1.6)
Paper	0.035	11.84	7.96	0.427	0.037	7.82	6.73	0.497
			(1.7)	(1.2)			(2.2)	(1.8)
Chemicals	0.132	15.68	15.65	0.383	0.119	12.49	14.03	0.260
			(4.8)	(1.3)			(7.6)	(1.3)
Petroleum	0.310	15.32	9.66	0.604	0.309	10.04	7.71	0.616
			(6.4)	(3.3)			(4.6)	(3.1)
Rubber and Plastics	0.024	14.39	13.40	0.188	0.022	10.72	13.09	0.184
			(7.6)	(1.0)			(4.6)	(0.7)
Stone, Clay, etc.	0.035	11.99	10.81	0.167	0.036	8.41	9.59	0.275
			(5.2)	(0.8)			(5.3)	(1.3)
Ferrous Metals	0.107	7.64	8.97	-0.062	0.129	3.34	4.59	0.266
			(3.6)	(-0.3)			(3.0)	(1.4)
Nonferrous Metals	0.035	9.93	9.61	0.120	0.046	6.49	6.01	0.[illegible]
			(3.9)	(0.5)			(2.0)	(1.6)
Machinery	0.066	36.08	3.65	2.457	0.060	19.11	11.06	1.162
			(0.9)	(7.3)			(3.9)	(4.3)
Electrical Machinery	0.049	19.72	13.79	0.640	0.045	16.02	14.33	0.555
			(4.3)	(2.2)			(4.8)	(2.0)
Motor Veh. and Parts	0.139	20.69	22.05	0.057	0.125	13.43	23.42	-0.466
			(3.4)	(0.1)			(3.2)	(-0.8)
Pooled Coefficient Estimates		DP_t	79.45				136.75	
			(4.5)				(5.5)	
		DP_{t-1}	-71.98				-91.16	
			(-4.2)				(-3.4)	
		DP_{t-2}	17.87				-5.87	
			(0.8)				(-0.2)	
		DP_{t-3}	-24.08				-88.52	
			(-1.1)				(-2.7)	
		DP_{t-4}	-18.79				3.62	
			(-0.8)				(0.2)	
		DP_{t-5}	-18.67				-105.25	
			(-0.7)				(-2.9)	
		SUM	-36.20				-145.43	
			(-1.0)				(-3.9)	
		R2C	0.902				0.801	
		Avg. EPS over all industries	16.20				10.49	

Table 3 presents panel estimations on book and economic earnings per share, the latter reflecting all inflation adjustments. These figures are standardized as described in the text and then deflated by the GNP deflator.

The statistical model is

$$\frac{EPS_{it}}{PGNP_t} = a_i + b_i \, TIME_t + \sum_{i=0}^{5} c_i \, DP_{t-i} + e_{it}$$

for t = 1958; ..., 1977
and i = 1, ..., 13 industries

where

EPS_{it}	Earnings per share (either book or economic), standardized, for industry i in year t.
$PGNP_t$	GNP deflator.
$TIME_t$	Initialized to 1 in 1958 and incremented by 1 each year thereafter.
DP_t	Inflation measured by PGNP.

The residuals were assumed autocorrelated:

$$e_{it} = \rho e_{it-1} + \upsilon_{it}$$

$$\text{where Var } (\upsilon_{it}) = \sigma_i^2$$

Observations were weighted by the relative number of standardized shares in each industry and these weights are given in columns (1) and (5). The regression was estimated using a GLS procedure. The intercept terms are given in columns (3) and (7); time trend coefficients in (4) and (8). Beneath these are the inflation coefficients, and their sums.

Table 4.
Economic Earnings per Share and Inflation, Annual, 1955-1977

Equ.	Dependent Var.	Const.	DP[T]	DP[T-1]	DP[T-2]	DP[T-3]	DP[T-4]	DP[T-5]	LOGXIPTAVG[T]	TIME[T]	XIPTAVG[T]	SUM	R2C	DW	RHO
1.	REPSCLA[T]	-0.872	10.157	-17.869	-28.581	-1.341	-26.398	-15.422		39.054		-79.453	0.599	3.145	0.183
		(-1.9)	(1.8)	(-2.4)	(-3.0)	(-0.1)	(-2.8)	(-2.9)		(11.8)		(-8.0)			
2.	REPSCLA[T]	-1.168	-10.341	0.347	-31.769	4.295	-25.295	-3.088			0.089	-65.851	0.598	2.179	-0.244
		(-3.3)	(-1.5)	(0.0)	(-2.5)	(0.3)	(-2.0)	(-0.5)			(15.9)	(-10.3)			
3.	LOG REPSCLA[T]	-4.808	-1.706	0.364	-6.233	2.221	-5.301	0.467	1.495			-10.188	0.602	1.913	-0.221
		(-14.4)	(-1.4)	(0.2)	(-2.7)	(0.9)	(-2.3)	(0.4)	(18.7)			(-9.9)			
4.	REPSCLB[T]	-4.101	51.803	-22.273	-62.880	3.032	-18.775	-11.145		58.175		-60.237	0.593	2.439	0.329
		(-2.7)	(3.4)	(-1.2)	(-2.7)	(0.1)	(-0.8)	(-0.7)		(5.4)		(-1.9)			
5.	REPSCLB[T]	-3.810	35.578	-4.101	-58.205	5.796	-13.999	4.414			0.122	-30.517	0.596	2.269	-0.045
		(-3.9)	(2.2)	(-0.2)	(-2.2)	(0.2)	(-0.5)	(0.3)			(7.9)	(-1.7)			
6.	LOG REPSCLB[T]	-6.840	1.651	3.447	-12.805	6.074	-7.913	1.918	1.967			-7.628	0.584	2.673	0.128
		(-6.3)	(0.6)	(0.9)	(-2.9)	(1.3)	(-1.8)	(0.7)	(7.5)			(-2.2)			
7.	REPSCLC[T]	-2.478	118.355	-13.905	-185.467	122.273	-125.110	8.084		50.294		-75.770	0.579	2.304	-0.076
		(-1.6)	(4.5)	(-0.4)	(-3.7)	(2.4)	(-2.4)	(0.3)		(4.4)		(-2.2)			
8.	REPSCLC[T]	-3.265	92.783	1.752	-176.086	109.956	-103.929	11.801			0.121	-63.722	0.584	2.399	-0.172
		(-2.2)	(3.3)	(0.0)	(-3.6)	(2.2)	(-2.1)	(0.5)			(5.0)	(-2.3)			
9.	LOG REPSCLC[T]	-7.084	3.079	16.479	-50.435	29.663	-23.157	4.245	2.075			-20.127	0.529	2.388	-0.168
		(-3.3)	(0.4)	(1.6)	(-3.7)	(2.1)	(-1.7)	(0.6)	(4.0)			(-3.0)			

REPSCLA Earnings per share for S&P Composite Index, deflated by the CPI and scaled by the Cagan-Lipsey income figures to reflect inflation adjustments for inventory valuation, underdepreciation of physical capital and changes in purchasing power of net financial liabilities. Average value is $5.00.

REPSCLB As above, but adjustments reflect all inflation adjustments except changes in market value of debt. Average value is $6.73.

REPSCLC As above, but inclusive of all inflation adjustments. Average value is $6.86.

DP Inflation in CPI.

XIPTAVG Annual average of Federal Reserve Board total industrial production index.

TIME Time trend. Initialized to .01 in 1946 and incremented by .01 in each year thereafter.

Table 5.

Inflation and Heteroscedasticity in Real Market Returns, Monthly, 1947-1977.

Return Generating Equation:

$$RRM(T) = \underset{(2.0)}{.01804} + \underset{(5.1)}{.21654}\, DX(T+6) + \underset{(1.7)}{.07264}\, DX(T+12) - \underset{(-2.1)}{.00394}\, TIME(T)$$

$R^2 = .090$; $DW = 2.11$; $MSE = .00144$.

Heteroscedasticity Tests:

Equ.	Dep. Var.	Const.	DP[T]	DPAVY[T]	EDP1MTB[T-1]	R2C	DW	B-P
1.	ARES[T]	0.028 (18.1)	0.529 (1.7)			0.008	1.910	
2.	ARES[T]	0.025 (13.8)		1.472 (3.5)		0.032	1.948	
3.	ARES[T]	0.025 (14.5)			1.381 (3.5)	0.032	1.947	
4.	G2[T]	0.867 (7.5)	42.750 (1.8)			0.009	1.789	5.615
5.	G2[T]	0.632 (4.7)		116.847 (3.6)		0.035	1.822	21.612
6.	G2[T]	0.663 (5.1)			107.490 (3.6)	0.033	1.825	20.803

RRM — Real monthly return on S&P composite index.

DX — Six-month rate-of-change in Federal Reserve Board total industrial production index.

TIME — Initialized to .01 in 1924.01; incremented by .01 each month thereafter.

DP — Monthly inflation in CPI.

DPAVY — (Geometric) average monthly inflation over last 12 months.

EDP1MTB — Expected inflation estimated on the basis of monthly T-bill yields.

B-P — Breusch-Pagan test statistic. See notes below.

Table 5 (continued).

ARES $|e_t|$ where e_t is the estimated residual from the return generating equation.

G2 e_t^2/MSE where MSE is the mean-square error from the return-generating equation.

See notes below.

<u>Note on the Heteroscedasticity Test Procedures.</u>

Tests were made for heteroscedasticity on the estimated residuals from the return generating equation, e_t. Regressions involving ARES follow the Glesjer method [15]. Regressions involving G2 follow the Breusch-Pagan method [2]. In the latter's framework, the heteroscedasticity is assumed to be of the form $Var(e_t) = Z_t a$ where Z_t is some matrix of exogenous variables (the first element of which is unity), and a is some coefficient vector. The Breusch-Pagan test statistic is one half the explained sum of squares in the regression $G2_t = Z_t a$. Under the null hypothesis of no heteroscedastic dependence, this statistic is assymptotically distributed as chi-squared with df = n-1 where n is the length of Z. In all specifications used here, n=2 (constant + inflation), so the appropriate distribution is chi-squared with df=1. The .95 confidence level is 3.84.

Table 6.

Realized Stock Returns

1. Monthly

$$RM_t = \underset{(2.5)}{.008} - \underset{(-2.4)}{1.694}\ EDP1MTB_{t-1} - \underset{(-2.3)}{1.233}\ UDP1MTB_t + \underset{(4.3)}{.183}\ DX_{t+6} - \underset{(-6.1)}{8.094}\ \Delta SPMUNIBY_t$$

$R^2C = .181;\quad DW = 2.117$

2. Quarterly

$$RM_t = \underset{(1.6)}{.018} - \underset{(-1.7)}{1.318}\ EDP1QTB_{t-1} - \underset{(-1.9)}{1.487}\ UDP1QTB_t + \underset{(4.7)}{.643}\ DX_{t+2} + \underset{(.2)}{.032}\ DX_{t+4} - \underset{(-3.6)}{7.341}\ \Delta SPMUNIBY_t$$

$R^2C = .337;\quad DW = 2.005$

3. Annual

$$RM_t = \underset{(-.3)}{-.017} - \underset{(-1.4)}{1.420}\ EDP1YTB_{t-1} - \underset{(-3.8)}{5.938}\ UDP1YTB_t + \underset{(3.8)}{1.858}\ DX_t + \underset{(2.2)}{1.057}\ DX_{t+1} + \underset{(.6)}{2.432}\ SPMUNIBY_t$$

$R^2C = .565;\quad DW = 2.002$

RM_t is the real return on stock computed as the return on the S&P Composite Index less actual inflation; EDP1MTB, EDP1QTB and EDP1YTB are expected inflation measures over the next month, quarter and year as discussed in the text; UDP1MTB, UDP1QTB and UDP1YTB are the corresponding measures of unexpected inflation; DX is the rate of change in the Federal Reserve Board index of industrial production; ΔSPMUNIBY is the first difference of the S&P average municipal bond yield. Monthly regression was estimated over 1947-1977; quarterly and annual regressions were estimated from 1951-1977.

Table 7

Realized Risk Differentials

1. Monthly

$$RD_t = \underset{(1.8)}{.006} - \underset{(-1.3)}{.952}\ EDP1MTB_{t-1} - \underset{(-.6)}{.290}\ UDP1MTB_t + \underset{(4.4)}{.187}\ DX_{t+6} - \underset{(-6.0)}{8.111}\ \Delta SPMUNIBY_t$$

$R^2C = .160$; $DW = 2.099$

2. Quarterly

$$RD_t = \underset{(1.3)}{.015} - \underset{(-1.1)}{1.070}\ EDP1QTB_{t-1} - \underset{(-1.5)}{1.539}\ UDP1QTB_t + \underset{(4.3)}{.656}\ DX_{t+2} - \underset{(-3.1)}{6.685}\ \Delta SPMUNIBY_t$$

$R^2C = .306$; $DW = 1.948$

3. Annual

$$RD_t = \underset{(-.6)}{-.042} - \underset{(-.9)}{.945}\ EDP1YTB_{t-1} - \underset{(-3.3)}{5.401}\ UDP1YTB_t + \underset{(3.7)}{1.865}\ DX_t + \underset{(2.2)}{1.071}\ DX_{t+1}$$
$$+ \underset{(.8)}{3.191}\ \Delta SPMUNIBY_t$$

$R^2C = .532$; $DW = 1.933$

RD_t is the realized return differential computed as the return on the S&P Composite Index less the return on a T-bill of compatible maturity purchased at the beginning of the period. Other variables are defined in the notes to Table 6. Monthly regressions were estimated from 1947-1977; quarterly and annual estimations were from 1951-1977.