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

by

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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 predicted 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 the 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] In this analysis, expected cash flow and required rate of return can be measured either in nominal or real terms so long as both are measured on the same basis.

In attempting to reconcile these findings with the previously observed negative correlation between realized real stock market returns and the rate of even expected inflation, we find that at least part of this otherwise puzzling correlation is due to the effect on stock prices of changes in expected inflation whose effect in previous analyses was generally confounded with that of the level of expected inflation. Two other factors probably contributing to the remaining though generally not statistically significant negative correlation between real realized market returns and measures of expected inflation are the inadequacies of realized returns as a proxy for *ex ante* expected returns, and the statistical difficulty in distinguishing satisfactorily between expected and unexpected inflation. The empirical analysis in this paper supporting these conclusions will consist of four sections examining the impact of inflation upon (a) stock returns (Part 2); (b) dividends and book earnings per share (Part 3); (c) economic earnings per share (Part 4); and (d) the required rates of return on stock (Part 5). Where theory suggests the relevance of such distinctions, attempts are made to distinguish between expected inflation, unexpected inflation, and changes in expected inflation. 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 final section will summarize the major findings of this study (Part 7).

2. Inflation and Stock Market Returns

The historical correlation between real stock market returns and contemporaneous and lagged inflation is presented for monthly, quarterly and annual data in Tables 1, 2 and 3. Inflation is measured by changes in the Consumer Price Index, and real stock returns are obtained as the sum of dividend yields and capital gains on the Standard and Poor's Composite Index of Common Stocks minus the contemporaneous inflation rate. Many of the results presented are similar to those published in earlier studies, but others are new.

For the post-World War II period and for the 1926-1978 period as a whole, the correlation between realized real returns and contemporaneous inflation has tended to be negative, usually significantly so. This is surprising since close to a zero correlation would be expected under the assumptions of traditional theory.[1] The negative correlation for the post-World War II period appears to characterize both expected and unexpected inflation. Traditional theory would suggest that expected inflation should have no impact on the realized return and unexpected inflation should impact the return only to the extent that the firm's actual and, more importantly, anticipated earnings are affected by this variable. Alternative specifications of the regressions on monthly, quarterly and annual data in the post-World War II period employ two measures of expected inflation, one based on an autoregressive forecasting model and the other using Treasury bills with maturities corresponding to return horizons (except for annual data, in which an annualized quarterly rate was used). Regardless of which measure of expectations is used in the regression specification, the results indicate a negative and generally significant impact of both expected and unexpected inflation. The negative impact of expected inflation is particularly troublesome, although this may simply reflect the inadequacy of realized

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[1] In attempting to assess the impact of inflation upon real returns in the 1926-1978 period, the results may be colored by the fact that this period includes deflationary intervals as well as inflationary ones, and the effect of price changes on stock returns may well be asymmetric.

returns as a proxy for *ex ante* expected returns, especially if the distribution of returns is non-stationary.

It should be noted that adding a small number of lagged inflation rates to the contemporaneous inflation does not change the negative impact of sustained inflation on real stock returns. In the regressions of Table 1, some specifications include three months of lagged inflation rates, and although this tends to lessen the size of the contemporaneous inflation coefficient, the impact of sustained inflation as measured by the sum of all the inflation coefficients is still usually negative, particularly in the postwar period. In the quarterly and annual regressions, three lagged quarters and three lagged years of inflation are included respectively, and as with the monthly data, the negative impact of inflation upon real returns remains.

An issue we have not considered in our investigation of the statistical relationship between real stock returns and inflation is whether the existence of a negative correlation is due to the effect of inflation on the level of real economic activity and the effect of any such change in real activity on corporate real earnings and perhaps even on the real discount rate or whether it is due to other factors. The rate of change in the Federal Reserve Board Total Index of Industrial Production was introduced into some of the specifications in Tables 1, 2 and 3, where the period over which this rate was computed and the number of leads included was determined by the quality of the resulting fit. The contemporaneous rate of change was found to be a significant determinant of real market returns only in the annual regressions. Regardless of time period considered, the previously observed negative correlation between real returns and inflation for the 1926-1978 period as a whole is largely independent of any effect inflation may have had on the level of real economic activity. However, holding real economic activity constant does reduce the estimated effect of inflation and expected inflation on real returns especially in the post-World War II years. This is particularly true in the annual data, where inclusion of economic activity depresses the impact of expected inflation to the point of marginal statistical significance.

The effect of inflation in this period seems to be further mitigated when a linear time trend is included in the specifications, possibly reflecting a secular decline in the real required return. In particular we note that when time is included in the annual specifications (Equation 12 in Table 3), the coefficients of expected inflation are pushed quite close to zero.[1]

Among the various sample periods considered in the monthly, quarterly and annual real stock return regressions, the negative influence of inflation is most manifest in the postwar period, which has been characterized by high inflation rates, but also by the transition to higher inflation rates. This suggests that some of the effect of inflation upon stock returns may be of a transitional nature, and the regression specifications should be modified accordingly. For example, if an increase in inflation is believed detrimental to subsequent stock returns, such an increase will depress both the current price and hence the current market return of the stock. With respect to the stock return regressions, the possibility exists that the negative effect of expected and unexpected inflation may be a consequence of their action as proxies for shifts in long-run inflationary expectations.

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[1]The negative correlation between contemporaneous inflation and returns was also obtained when a more comprehensive value-weighted index of all stocks or an estimate of the value of all marketable wealth (from the MPS econometric model) was substituted for the S&P index used here. However, these analyses using broader market indices are subject to a much greater margin of error.

In an attempt to capture these transitional effects in the return regressions, the first difference in the S&P muncicipal bond yield (ΔSPMUNIBY) was included in alternative forms of the specifications for the 1947-1978 period in the monthly, quarterly and annual regressions.[1,2] The effects of this inclusion are most striking in the monthly and quarterly regressions (equations 13-16 in Tables 1 and 2). The coefficient of ΔSPMUNIBY is always significantly negative, and the inclusion tends to depress the coefficient of expected inflation relative to the specifications in which ΔSPMUNIBY is omitted. In the monthly and quarterly regressions, the inclusion depresses the magnitude of the coefficient of expected inflation, and this coefficient though still negative is not statistically significant when changes in industrial production and time are included in the specification.

The effect of changes in the expected long-run inflation rate on real market returns is not apparent in the annual regressions (Equations 13-16 in Table 3). The effects of expected inflation on real market returns are not consistent, but in those specifications where time is included, these coefficients are not significantly negative even in the absence of ΔSPMUNIBY. One possible reason for the difficulty of the annual fits is collinearity between ΔSPMUNIBY and unexpected inflation. This pairwise correlation is much more pronounced in the annual data than in the monthly or quarterly. Thus, it

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[1]Substantially similar results were obtained when the first difference of the rate on newly-issued AA utility bonds was used as the proxy for changes in the long-run expected inflation.

[2]Fama and Schwert (1977) introduced changes in the short-term treasury bill rate as a proxy for changes in expected inflation, but the validity of this variable as a proxy for changes in long-term inflationary expectations is contingent on their assumption that inflation follows a random walk. Use of changes in the long-term rate avoids the need for this assumption.

may be that unexpected inflation whose coefficient remains highly significant is a better proxy in the annual data for shifts in the long-run expectations than ΔSPMUNIBY.

To summarize the analysis to this point, it is our judgement that changes in the expected level of long-run inflation explain at least part of the negative impact of the level of expected inflation on real returns found in earlier studies. Although this conflicts with the traditional view that real stock prices should be invariant to inflation, it is a position supported by the empirical evidence to be presented in later sections. On the other hand, assuming that the expected real rate of return is not systematically affected by inflation, the negative impact of expected inflation upon real realized returns highlighted in earlier studies is inconsistent with rational asset pricing, and may therefore be a spurious statistical artifact.

A further interesting aspect of the behavior of market returns and inflation concerns the risk premium. The expected real return on the market represents the sum of the expected real return on the nominally risk-free asset plus an expected risk premium, and a corresponding relationship exists for realized returns as well. To the extent that the difference between realized returns on the market and the risk-free asset is an adequate proxy for the expected risk premium, investigation of the inflation impact on the former should yield insight into the differential impact of inflation upon stocks *vis a vis* risk-free assets. Analysis of the impact of inflation upon the risk premium is all the more important because the impact of inflation upon the real expected rate of return on the nominally risk-free asset is still an unresolved issue. Table 4 contains monthly, quarterly and annual regressions in which the dependent variable is the realized return differential, computed as the stock return over the period minus the return on a Treasury bill of identical horizon purchased at the beginning of the period. The impact of expected inflation upon the return differential is generally less negative than the impact on realized real returns, and in many cases comes quite close to zero.

The negative correlation between market realized rates of return and inflation discussed above is a reflection of a negative correlation between inflation and stock prices. The regressions of stock prices on inflation presented in Table 5 indicate that a one percentage point (100 basis points) change in the sustained annual rate of inflation over the post-World War II period is associated with anywhere from a 10% to 19% decrease in stock prices. Both linear and logarithmic regressions (Equations 1 and 2) suggest that a one percentage point increase in sustained inflation is associated with a decline in real equity values of approximately 19%. The percent difference regressions, which are the least satisfactory in view of the extremely high standard errors, point to a 10% effect.

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. 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

[1]Clearly, this is a simplifying assumption.

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

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,[1] taxes drop out of the price expression:

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

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, assuming 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,

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[1]Again, this is a simplifying assumption.

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.

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.

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,

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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).

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 Index of Common Stocks 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 6.[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 6, 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

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[1]Quarterly regressions were also computed and gave similar qualitative results though the estimated overall impact of inflation (as measured by the sum of the current and lagged inflation coefficients) was even more variable among the relationships with different lag structures. Linear regressions implied almost the same inflation effects as the corresponding log regressions.

[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.

inflation is probably attributable to the general stickiness in dividend payout.[1,2]

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 6. 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

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[1]Using second and third degree Almon lags to avoid the problem of multicollinearity among the current and lagged inflation terms in Table 7 pointed to a depressant effect on dividends of about 2% associated with a sustained one percentage point rate of inflation.

[2]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.

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.

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.[3] 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

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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%.

[3]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.

trend.[1] 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.[2] 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 the weighted and unweighted regressions gave similar results, only the former are presented in Table 7. 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. 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%. There is no evidence from this analysis of a significant adverse impact of inflation on real book earnings as a whole to support the conclusion from the aggregate time series data.

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[1]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 7.

[2]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.

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 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. The increase in the number of independent observations will permit us in a subsequent analysis to attempt to isolate the direct inflation effect on economic earnings after controlling for level of output, quantity of physical assets, leverage factors and secular trends, while the use of firm and industry data in that analysis will also provide the advantage of dealing with more homogeneous production processes.

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

$$E'_t = E_t + [D_t - D'_t] + [(I^r_t - I^r_{t-1}) - (I^b_t - I^b_{t-1}) - \pi^i_t I^r_{t-1}]$$

$$+ (\pi^k_t - \pi_t) K_{t-1} + (\pi^i_t - \pi_t) I^r_{t-1}$$

$$+ \pi_t NFL_{t-1} - (B_t - B_{t-1})$$

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 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 of volatility of this correction, as well as its "one-time" nature. The first measure is similar to

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

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 8 corresponding to the three measures of economic profits. Another group of real economic earnings regressions is presented in Table 7 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 8) 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 7). 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]

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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.

The results again point to a substantial and statistically significant negative effect of inflation.[1] 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 coresponding 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 (1980) 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 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)

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[1]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.

suggests that under reasonable parameter assumptions, the level of sustained inflation at which the net tax burden is equal to that with no inflation may be 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 8, 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 1970's.[2] We also suspect 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. 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

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[1] Fama (1980) has argued that the negative relationship between contemporaneous inflation and anticipated economic activity largely accounts for the relationship between inflation and market returns.

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

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 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, unreported 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 7 and 8) 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 and g. 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. Actually, if we use our empirical results in conjunction with either of the two valuation models to examine the first year's impact of inflation on the variables determining stock prices, the significant increase in the first year's real dividends and earnings (economic as well as book) associated with a significant decline in stock prices points to an appreciable increase in the real required rate of return unless there is a marked decline in the expected real growth rate (g). However, we are also interested in the implications for the required rate of return of a change in the level of sustained or steady-state inflation which according to our empirical results is associated with a substantial decrease in real dividends and earnings as well as in stock prices.

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 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

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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.

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. 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. On the other hand, effective corporate tax rates may have increased, assuming that the inflation rates of recent experience have not been sufficient to push the gain from nominal interest deductions beyond the loss arising from historical cost depreciation and FIFO inventory valuation.

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 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-sectonal survey data. In his reworking of the Livingston 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 is 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, in theory and in the long run, be eliminated.

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. 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 casual relationship may be summarized as follows. Increased uncertainty about the rate of growth of the monetary base will result in increased uncertainty of output and inflation. An increase in the variance of unanticipated inflation may, in addition, be associated with greater risk from price dispersion. A further source of recent uncertainty lies in exogenous shocks, such as the jumps in petroleum prices. To determine whether or not an increase in riskiness is apparent in earnings and market returns, we carried out four different types of analyses.

First, for the 1947-1976 period, we regressed real monthly realized stock returns on percentage change in industrial production over the next six and twelve months and a time trend and then regressed each of the absolute values of the residuals and ratios of the squares of the residuals to the mean square error on measures of inflation and also on two expected inflation variables, one estimated from an autoregressive model, the other from 90-day Treasury bill rates. All of the inflation effects were positive and generally significant, but for brevity only representative results are presented in Table 9.

A question which arises is the extent to which the inflation-related increase in risk is transitional. Unfortunately, an attempt to empirically resolve this issue was not successful because of the statistical correlation between the levels and first differences of inflation. A second question arises here concerning the exact nature of the inflation-related uncertainty. In Section 2, it was demonstrated that the first differences of the municipal bond yield, a proxy for change in the long-run expected rate of inflation, was a significant determinant of monthly returns. It is therefore plausible that the increase in market return variability associated with inflation simply reflects increased volatility of expectations. To test this hypothesis, a further analysis was performed. Real market returns were first regressed agaist time, economic activity and also the first difference of the municipal bond yield. The residuals from this regression were then analyzed in a manner identical to that used in Table 9. Relative to the analysis performed with the first difference of the municipal bond yield omitted, the impact of the level of inflation upon risk was slightly lower, but still significant.

Second, we carried out similar analyses for the 1947-1978 period substituting quarterly real book earnings per share in the S & P Composite Index for monthly realized stock returns. We again obtained strong inflation effects on the residuals of the first-stage earnings regressions.[1]

So far,we have essentially used only the return variance (or similar measure of dispersion) of a proxy for the market portfolio of all risky assets as a basis for measuring the impact of inflation on corporate risk. While this is consistent with the implications of the capital asset pricing model (CAPM), several recent studies have indicated that unique or company-specific as well as common market risks influence the required return and pricing of individual risky assets.[2] As a result, two other types of regression analyses have been carried out to examine the relationship between inflation and the level of company-specific risks.

Thus, for the 1947-1978 period, we selected all 404 NYSE common stocks for which complete data were available for the entire period from the Rodney White Center data base, computed real realized monthly market rates of return, and then regressed the variance, σ_{it}^2, of these real returns for security i in year t on the rate of inflation in that same year. The inflation coefficients in 93 percent of the 404 regressions were positive: 66 percent had t-statistics over 1.5 and 50 percent over 2.0. Pooling these individual stock data in an additive linear model in which the impact of inflation was assumed identical for all stocks, although the intercepts were permitted to differ, yielded an inflation coefficient (of .065) with a t-statistic of 13.9.

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[1]Due to the numerical approximations used to obtain economic EPS, there is a strong possibility that the variance of the measurement error is correlated with inflation, obscuring the true risk-inflation relationship. In light of this consideration, heteroscedasticity analyses were not performed on our economic EPS series.

[2]E.g., Friend, Westerfield and Granito (1978) and Friend and Westerfield (1981).

Finally, we carried out a test of the effect of inflation on our ability to forecast real book earnings per share for the 251 Compustat companies for which we had the required annual data for the period 1958-1977.[1] For this test we first estimated expected real earnings per share for any year in the 1963-1977 period, and then regressed the weighted average of the squared forecasting errors for the individual company stocks for each year on the level of inflation for that year. The results of this analysis are uniform in indicating statistically significant effects of inflation in making more difficult the forecasting of real earnings per share.

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.[2] We shall in the next section attempt to determine whether modern ccpital asset pricing theory can be used to cast any light on the quantitative reltionship 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 is deficient 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 modern capital asset pricing theory, we shall start with a simple transformation of the aggregate

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[1]The basis for selection of these companies was similar to that discussed earlier.

[2]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.

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):

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

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

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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)).

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

$$(2) \quad E(\rho_m) = E(\rho_f) + C[a\,\sigma_m^2 - (1-a)\,\sigma_\pi^2 - (1-2a)\,\sigma_{\rho_m \pi}].$$

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

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

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

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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, $\sigma_m^2 = \sigma_{\rho_m}^2 + \sigma_\pi^2 + 2\sigma_{\rho_m \pi}$ and $\sigma_{m\pi} = \sigma_\pi^2 + \sigma_{\rho_m \pi}$.

[3]See Hasbrouck (1981).

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 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 close to zero to 10%. This increase might be compared wth 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 recent months. 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

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[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.

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 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 10% rate of inflation would reduce a by at most .06 (from .252 to .191). In contrast, a 10% increase in the expected annual rate of inflation would result in an increase of .0012 in σ_m^2 from .0010 in the absence of inflation to .0022.[2] With C=6, $E(\rho_m) - E(\rho_f)$ would be increased from .0015 on a monthly basis (in the absence of inflation) to somewhere between .0028 and .0036 (with 10% annual inflation), or from 1.8% (1.8 percentage points) to between 2.8% and 3.4% on an annual basis.[3]

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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 9) 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).

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 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.

Assume $t = .15$, $(1-h) = .35$, $\alpha = 0$, and a market price of risk of 2, which imply that $C = 7.5$. 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 P/E multiple to drop by 22% in the first model, and by 35% in the second model. We have used in this example a real growth rate g which probably errs on the low side, an expected real return on the nominally-risk free asset, ρ_f, which probably errs on the high side, and a market price of risk which probably errs on the low side. Making any of these changes increases the inflation impact.

The above analysis assumes that (1-t) and (1-h) remain fixed. A time-series analysis of the impact of inflation upon these parameters suggests that an increase of seven percentage points in the sustained inflation rate should be associated with a .01 drop in (1-t) and a .02 drop in (1-h). These parameter shifts suggest a decrease in the P/E multiple of 13% in the first valuation model and a decrease of 30% in the second. The margin of error in these estimations is high, however, and the declines in the parameters may be even larger. If (1-t) and (1-h) drop by .03 and .05, respectively, the first valuation model suggests an increase of 13%, and the second would suggest a decrease of 23%, in the P/E multiple.

Thus, these results obtained from the implementation of our theoretical model are sufficiently sensitive 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

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[1]In constrast 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 argument does not require an interjection of investor irrationality to explain a downturn in stock prices, we do 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.

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

7. 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 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.

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 admit to changes in price-earnings multiples ranging from substantially negative to

[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, which has a lower required rate of return than equity totally apart from the corporate tax effect, 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.

slightly positive. On the basis of our empirical analysis, the increase in price-earnings multiples associated with a one percentage point of 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 returns seems smaller than generally suggested in 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. We have deferred to a subsequent study the implications of the structure of the corporate balance sheet (i.e., the comparative importance of plant and equipment, inventories, cash, net receivables, short-term and long-run debt) as well as the level of output and relative price shifts for the impact of inflation on earnings, dividends, required returns and stock prices.

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Table 1.

Inflation and NYSE Returns, Monthly.

EQ	PERIOD	DEP VAR	CONST	ΔSPMUNIBY[T]	DP[T]	DP[T-1]	DP[T-2]	DP[T-3]	DX[T+12]	DX[T+6]	EDP1MTB[T-1]	TIME[T]	UDP1MTB[T]	SUM	R2C	DW
1.	1926.02-1978.12	RRM[T]	0.009 (3.5)		-0.941 (-2.4)									-0.941 (-2.4)	0.009	1.796
2.	1926.02-1978.12	RRM[T]	0.010 (3.9)		-0.529 (-1.2)	-0.309 (-0.6)	-0.490 (-1.0)	-0.258 (-0.6)						-1.587 (-3.1)	0.015	1.804
3.	1926.02-1977.12	RRM[T]	0.006 (1.1)		-0.533 (-1.2)	-0.278 (-0.6)	-0.482 (-1.0)	-0.225 (-0.5)	0.083 (2.9)	0.121 (4.2)		0.000 (-0.1)		-1.518 (-2.7)	0.062	1.875
4.	1947.01-1978.12	RRM[T]	0.012 (4.9)		-1.906 (-3.9)									-1.906 (-3.9)	0.038	1.983
5.	1947.01-1978.12	RRM[T]	0.014 (5.0)		-1.469 (-2.6)	-0.557 (-1.0)	0.124 (0.2)	-0.668 (-1.2)						-2.571 (-3.9)	0.046	1.976
6.	1947.01-1978.06	RRM[T]	0.008 (2.4)		-1.350 (-2.5)	-0.411 (-0.7)	0.257 (0.5)	-0.401 (-0.8)		0.196 (4.5)				-1.905 (-2.3)	0.095	2.081
7.	1947.01-1978.12	RRM[T]	0.019 (2.1)		-1.416 (-2.5)	-0.511 (-0.9)	0.155 (0.3)	-0.648 (-1.2)				-0.001 (-0.6)		-2.421 (-3.4)	0.046	1.977
8.	1947.01-1978.06	RRM[T]	0.017 (1.9)		-1.246 (-2.3)	-0.322 (-0.6)	0.316 (0.6)	-0.362 (-0.7)		0.200 (4.6)		-0.002 (-1.1)		-1.614 (-2.2)	0.099	2.088
9.	1947.01-1977.11	RRM[T]	0.015 (5.1)								-2.870 (-4.1)		-1.629 (-3.0)		0.051	2.015
10.	1947.01-1977.11	RRM[T]	0.007 (2.3)							0.197 (4.5)	-1.901 (-2.7)		-1.533 (-2.9)		0.099	2.112
11.	1947.01-1977.11	RRM[T]	0.023 (2.6)								-2.648 (-3.6)	-0.002 (-1.0)	-1.529 (-2.8)		0.053	2.019
12.	1947.01-1977.11	RRM[T]	0.018 (2.0)							0.200 (4.5)	-1.608 (-2.2)	-0.002 (-1.3)	-1.407 (-2.6)		0.103	2.120
13.	1947.02-1977.11	RRM[T]	0.015 (5.3)	-3.327 (-6.1)							-2.651 (-3.8)		-1.263 (-2.4)		0.140	2.022
14.	1947.02-1977.11	RRM[T]	0.008 (2.5)	-3.094 (-6.1)						0.183 (4.3)	-1.694 (-2.4)		-1.223 (-2.3)		0.181	2.117
15.	1947.02-1977.11	RRM[T]	0.024 (2.8)	-3.421 (-6.1)							-2.353 (-3.2)	-0.002 (-1.2)	-1.168 (-2.2)		0.143	2.029
16.	1947.02-1977.11	RRM[T]	0.020 (2.3)	-3.205 (-6.1)						0.188 (4.4)	-1.293 (-1.7)	-0.003 (-1.5)	-1.104 (-2.1)		0.185	2.130

DP Monthly inflation in CPI.

RRM Real return on S&P 500. (Dividend yield plus capital gains minus DP.)

EDP1MTB Expected value of DP next period based on one-month Treasury bill yields.

UDP1MTB Unexpected inflation using the T-bill expectations proxy.

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

DX 6-month rate of change in the Federal Reserve Board total industrial production index.

ΔSPMUNIBY First difference of the end-of-period S&P municipal bond yield.

SUM Sum of the DP coefficients.

R2C R^2 corrected for degrees of freedom.

DW Durbin-Watson statistic.

T-statistics are in parentheses.

Table 2.

Inflation and NYSE Returns, Quarterly.

EQU	PERIOD	DEP VAR	CONST	ΔSPMUNIBY[T]	DP[T]	DP[T-1]	DP[T-2]	DP[T-3]	DX[T+2]	DX[T+4]	DX[T+6]	EDP1QTB[T-1]	TIME[T]	UDP1QTB[T]	SUM	R2C	DW
1.	1926.1-1978.4	RRM[T]	0.029 (3.0)		-0.902 (-1.5)										-0.902 (-1.5)	0.011	2.213
2.	1926.1-1978.4	RRM[T]	0.033 (3.3)		-0.192 (-0.3)	-0.996 (-1.3)	-0.559 (-0.7)	0.146 (0.2)							-1.602 (-2.1)	0.027	2.243
3.	1926.1-1977.4	RRM[T]	0.028 (1.4)		-0.142 (-0.2)	-0.891 (-1.2)	-0.578 (-0.8)	0.052 (0.1)	0.058 (0.5)	0.307 (2.9)			-0.004 (-0.2)		-1.560 (-1.8)	0.070	2.257
4.	1947.1-1978.4	RRM[T]	0.042 (4.8)		-2.474 (-3.7)										-2.474 (-3.7)	0.096	1.803
5.	1947.1-1978.4	RRM[T]	0.043 (4.4)		-2.185 (-2.5)	-0.613 (-0.7)	0.459 (0.6)	-0.254 (-0.4)							-2.592 (-3.3)	0.097	1.735
6.	1947.1-1977.2	RRM[T]	0.049 (4.6)		-2.674 (-3.0)	-0.818 (-0.9)	0.649 (0.9)	-0.124 (-0.2)			-0.153 (-1.0)				-2.367 (-3.7)	0.126	1.819
7.	1947.1-1978.4	RRM[T]	0.053 (1.8)		-2.087 (-2.3)	-0.572 (-0.6)	0.450 (0.6)	-0.272 (-0.4)					-0.007 (-0.4)		-2.481 (-3.0)	0.098	1.785
8.	1947.1-1977.2	RRM[T]	0.060 (2.0)		-2.567 (-2.7)	-0.778 (-0.8)	0.631 (0.8)	-0.144 (-0.2)			-0.150 (-1.0)		-0.008 (-0.4)		-2.858 (-3.4)	0.126	1.819
9.	1950.4-1977.4	RRM[T]	0.047 (4.3)									-3.394 (-3.5)		-5.157 (-4.3)		0.177	1.903
10.	1950.4-1977.2	RRM[T]	0.049 (4.2)								-0.100 (-0.6)	-3.224 (-3.3)		-5.425 (-4.4)		0.181	1.903
11.	1950.4-1977.4	RRM[T]	0.050 (1.3)									-3.337 (-2.8)	-0.002 (-0.1)	-5.125 (-4.0)		0.175	1.902
12.	1950.4-1977.2	RRM[T]	0.044 (1.1)								-0.100 (-0.6)	-3.307 (-2.8)	0.003 (0.1)	-5.473 (-4.2)		0.179	1.905
13.	1950.4-1977.4	RRM[T]	0.046 (4.4)	-7.463 (-3.3)								-2.974 (-3.2)		-4.103 (-3.4)		0.249	1.888
14.	1950.4-1977.2	RRM[T]	0.048 (4.3)	-7.585 (-3.3)							-0.117 (-0.7)	-2.736 (-2.9)		-4.367 (-3.6)		0.255	1.906
15.	1950.4-1977.4	RRM[T]	0.072 (1.9)	-7.755 (-3.3)								-2.500 (-2.2)	-0.018 (-0.7)	-3.833 (-3.0)		0.250	1.839
16.	1950.4-1977.2	RRM[T]	0.067 (1.7)	-7.798 (-3.3)							-0.116 (-0.7)	-2.468 (-2.1)	-0.013 (-0.5)	-4.132 (-3.1)		0.254	1.904

DP — Quarterly inflation in CPI.

RRM — Real return on S&P 500. (Dividend yield plus capital gains minus DP.)

EDP1QTB — Expected value of DP next period based on one-quarter Treasury bill yields.

UDP1QTB — Unexpected inflation using the T-bill expectations proxy.

TIME — Initialized to .01 in 1924 I; incremented by .01 each quarter thereafter.

DX — 2-quarter rate of change in the Federal Reserve Board total industrial production index.

ΔSPMUNIBY — First difference of the end-of-period S&P municipal bond yield.

Table 3.

Inflation and NYSE Returns, Annual.

EQU	PERIOD	DEP VAR	CONST	ΔSPMUNIBY[T]	DP[T]	DP[T-1]	DP[T-2]	DP[T-3]	DX[T]	DX[T+1]	EDP1YTBQ[T-1]	TIME[T]	UDP1YTBQ[T]	SU4	R2C	DW
1.	1927-1978	RRM[T]	0.118		-1.131									-1.131	0.054	1.941
			(3.2)		(-1.7)									(-1.7)		
2.	1928-1978	RRM[T]	0.101		-1.374	0.599	-0.177	0.288						-0.664	0.051	1.978
			(2.5)		(-1.6)	(0.6)	(-0.2)	(0.3)						(-0.7)		
3.	1928-1977	RRM[T]	0.042		-2.594	1.165	-0.367	1.048	1.154	0.168		-0.005		-0.748	0.323	1.726
			(0.6)		(-3.2)	(1.2)	(-0.4)	(1.3)	(4.5)	(0.7)		(0.0)		(-0.7)		
4.	1947-1978	RRM[T]	0.201		-3.109									-3.109	0.254	2.323
			(4.3)		(-3.3)									(-3.3)		
5.	1947-1978	RRM[T]	0.183		-4.161	1.363	-0.679	0.767						-2.710	0.265	2.411
			(3.2)		(-3.2)	(1.2)	(-0.7)	(0.8)						(-2.1)		
6.	1947-1977	RRM[T]	0.025		-3.112	1.308	0.152	-0.512	1.691	1.213				-2.164	0.515	1.880
			(0.4)		(-2.5)	(1.3)	(0.2)	(-0.6)	(4.3)	(2.4)				(-2.0)		
7.	1947-1978	RRM[T]	0.155		-4.344	1.448	-0.731	0.776				0.033		-2.850	0.256	2.407
			(1.0)		(-2.7)	(1.1)	(-0.7)	(0.8)				(0.2)		(-1.9)		
8.	1947-1977	RRM[T]	0.093		-2.475	0.988	0.390	-0.680	1.711	1.337		-0.225		-1.777	0.493	1.928
			(0.8)		(-1.6)	(0.9)	(0.4)	(-0.7)	(4.3)	(2.4)		(-0.7)		(-1.5)		
9.	1951-1977	RRM[T]	0.180								-3.351		-7.265		0.430	2.498
			(3.5)								(-3.0)		(-4.2)			
10.	1951-1977	RRM[T]	-0.010						1.821	0.975	-1.342		-5.680		0.587	2.002
			(-0.2)						(3.8)	(2.2)	(-1.3)		(-3.8)			
11.	1951-1977	RRM[T]	0.025								-4.097	0.438	-8.267		0.426	2.472
			(0.1)								(-2.8)	(0.8)	(-3.9)			
12.	1951-1977	RRM[T]	0.155						2.102	1.177	-0.078	-0.557	-4.035		0.575	2.029
			(1.0)						(4.0)	(2.4)	(-0.1)	(-1.1)	(-2.0)			
13.	1951-1977	RRM[T]	0.180	-0.748							-3.312		-7.151		0.413	2.515
			(3.4)	(-0.2)							(-2.9)		(-3.7)			
14.	1951-1977	RRM[T]	-0.017	2.432					1.858	1.057	-1.420		-5.938		0.565	2.002
			(-0.3)	(0.6)					(3.8)	(2.2)	(-1.4)		(-3.8)			
15.	1951-1977	RRM[T]	-0.006	1.588							-4.332	0.527	-8.714		0.409	2.457
			(0.0)	(0.3)							(-2.6)	(0.8)	(-3.2)			
16.	1951-1977	RRM[T]	0.145	0.474					2.095	1.183	-0.156	-0.529	-4.224		0.548	2.027
			(0.8)	(0.1)					(3.8)	(2.4)	(-0.1)	(-0.9)	(-1.8)			

DP — Annual inflation in CPI.

RRM — Real return on S&P 500. (Dividend yield plus capital gains minus DP.)

EDP1YTBQ — Expected value of DP next period based on annualized 3-month Treasury bill yields.

UDP1YTBQ — Unexpected inflation using the T-bill expectations proxy.

TIME — Initialized to .01 in 1924; incremented by .01 each month thereafter.

DX — Annual rate of change in the Federal Reserve Board total industrial production index.

ΔSPMUNIBY — First difference of the end-of-period S&P municipal bond yield.

Table 4. Inflation and the Realized Risk Differential.

MONTHLY DATA.

EQU	PERIOD	DEP VAR	CONST	ΔSPMUNIBY[T]	DX[T+6]	EDP1MTB[T-1]	TIME[T]	UDP1MTB[T]	R2C	DW
1.	1947.01-1977.11	RD[T]	0.005		0.201	-1.128		-0.618	0.076	2.094
			(1.6)		(4.5)	(-1.6)		(-1.2)		
2.	1947.01-1977.11	RD[T]	0.021		0.206	-0.690	-0.004	-0.429	0.085	2.113
			(2.4)		(4.7)	(-0.9)	(-1.9)	(-0.8)		
3.	1947.02-1977.11	RD[T]	0.006	-8.111	0.187	-0.952		-0.290	0.160	2.099
			(1.8)	(-6.0)	(4.4)	(-1.3)		(-0.6)		
4.	1947.02-1977.11	RD[T]	0.023	-8.269	0.194	-0.383	-0.004	-0.120	0.170	2.125
			(2.7)	(-6.2)	(4.6)	(-0.5)	(-2.2)	(-0.2)		

QUARTERLY DATA.

EQU	PERIOD	DEP VAR	CONST	ΔSPMUNIBY[T]	DX[T+2]	EDP1QTB[T-1]	TIME[T]	UDP1QTB[T]	R2C	DW
5.	1950.1-1977.4	RD[T]	0.014		0.731	-1.300		-2.102	0.248	1.962
			(1.1)		(4.7)	(-1.3)		(-2.0)		
6.	1950.1-1977.4	RD[T]	0.080		0.800	0.300	-0.050	-1.614	0.272	2.022
			(2.3)		(5.1)	(0.2)	(-2.0)	(-1.5)		
7.	1950.1-1977.4	RD[T]	0.015	-6.685	0.656	-1.070		-1.539	0.306	1.948
			(1.3)	(-3.1)	(4.3)	(-1.1)		(-1.5)		
8.	1950.1-1977.4	RD[T]	0.093	-7.260	0.731	0.840	-0.060	-0.914	0.339	2.052
			(2.8)	(-3.5)	(4.9)	(0.7)	(-2.5)	(-0.9)		

ANNUAL DATA.

EQU	PERIOD	DEP VAR	CONST	ΔSPMUNIBY[T]	DX[T]	DX[T+1]	EDP1YTBQ[T-1]	TIME[T]	UDP1YTBQ[T]	R2C	DW
9.	1951-1977	RD[T]	-0.033		1.815	0.964	-0.843		-5.062	0.549	1.933
			(-0.5)		(3.7)	(2.1)	(-0.8)		(-3.3)		
10.	1951-1977	RD[T]	0.027		2.215	1.250	0.954	-0.791	-2.809	0.556	2.017
			(0.4)		(4.2)	(2.6)	(0.6)	(-1.6)	(-1.4)		
11.	1951-1977	RD[T]	-0.042	3.191	1.865	1.071	-0.945		-5.401	0.532	1.933
			(-0.6)	(0.8)	(3.7)	(2.2)	(-0.9)		(-3.3)		
12.	1951-1977	RD[T]	0.025	0.333	2.210	1.254	0.900	-0.772	-2.900	0.529	2.014
			(0.3)	(0.1)	(4.0)	(2.5)	(0.5)	(-1.4)	(-1.2)		

RD[T] RM [T] -RTB[T-1]

Where RM is the return on the S&P 500 and RTB [T-1] is the coupon yield on a Treasury bill at the end of the last period. The Treasury bill has a maturity equal to the time period considered.

DX [T] In the monthly and quarterly regressions DX [T] is the 6-month rate of change in the Federal Reserve Board total industrial production index. In the annual regressions, the rate is measured on an annual basis.

EDP1MTB
EDP1QTB
EDP1YTBQ Expected inflation. See notes to Tables 1, 2 and 3.

UDP1MTB
UDP1QTB
UDP1YTBQ Unexpected inflation. See notes to Tables 1, 2 and 3.

ΔSPMUNIBY First difference of S&P average municipal bond yield.

ΔSPMUNIBY First difference of S & P average municipal bond yield.

TIME See notes to Tables 1,2 and 3.