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Stock Market Returns and Inflation:
The Effects of Economic Uncertainty

Yoon Dokko

Robert H. Edelstein

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March, 1985

Stock Market Returns and Inflation:
The Effects of Economic Uncertainty

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ABSTRACT

A well-documented but anomolous finding from the U.S. and other stock markets is the negative relationship between aggregate stock returns and inflation. This finding is contrary to traditional thought that non-monetary assets, such as common stock (equity), are hedges against inflation. The empirical results of this paper suggest that the market risk premium for common stock has increased over the last three decades as a response to increased inflation uncertainty. Hence, the apparent contradiction between previous empirical analyses and financial theory can be explained if one controls for the degree of inflation uncertainty; in that case, the level of inflation, ceteris paribus, does not appear to affect the expected real returns on common stock equity.

INTRODUCTION

A well-documented but anomalous finding from the U.S.¹ and other² stock markets is the negative relationship between aggregate stock returns and inflation.³ This finding is contrary to traditional thought that non-monetary assets, such as common stock (equity), are hedges against inflation. As a result, over the last several years, a large quantum of academic research energy has been directed to the examination of this issue. Despite this effort, however, little agreement has emerged about why and how inflation affects stock prices.

In essence, Malkiel [1979] and Friend [1982] independently suggest that the market risk premium for common stocks (hereafter referred to as the risk premium) may have increased because of increased inflation uncertainty.⁴ The principal objective of this paper is to examine this hypothesis.

As a first step, a formal portfolio theory model is developed to explain the inter-relationships among the real required returns on stock equity, real asset returns uncertainty, and inflation uncertainty. The empirical model is derived from the theory. In brief, the empirical findings from the model suggest that: (i) the adverse impact of inflation uncertainty on corporate net operating income appears to be the "principal" cause for the observed increase in the real required return for common stocks over the last three decades, resulting in relatively depressed stock prices; (ii) the observed negative relationships among expected inflation and subsequently realized stock returns are statistical artifacts created by a structural relationship between the level of inflation and the degree of inflation uncertainty; (iii) the magnitude of the effect of nominal capital gain taxes on stock prices

(suggested by, among others, Feldstein [1980]) is likely to be overstated; and (iv) the lack of prior empirical support for the nominal contracting hypothesis apparently is the result of ignoring the adverse effect of uncertain inflation on corporate net operating income (which tends to offset capital gains on debt).

Our presentation is divided into four sections. Section I reviews the previous literature. Section II develops the theoretical model to show the market equilibrium relationship between the required return for common stocks and inflation uncertainty. Section III presents the data base, estimation procedures, and empirical findings. Finally, implications of these findings are discussed in Section IV.

1. THE PRIOR LITERATURE IN PERSPECTIVE

Feldstein [1980] and Summers [1981], among others, have attributed the decline in real stock prices during recent inflationary periods to the failure of corporate income tax indexation: firms which report inflation generated book profits are penalized by an increased tax burden. The immediate limitation of the "tax effect" hypothesis is its implicit assumption that corporations have no debt. Empirical studies, ante-dating the work of Irving Fisher, have confirmed that short term nominal interest rates respond "at most" point-for-point to changes in the inflation rate. This implies, because tax deductions are calculated for nominal interest payments, a decrease in the burden of real interest and principal payments to corporations. Then, the real net effect of inflation on taxes and debt is less clear. Even without introducing debt, the tax gains-depreciation effect hypothesis may be less important than expected on a priori grounds because the U.S. tax system permits the use of counter-inflation tax accounting methods, which implicitly may act as a substitute for indexation (Gonedes [1981]).⁵

In contrast to the proponents of the tax effect hypothesis, Modigliani and Cohn [1979] allege that investors have systematic money illusion; investors do not realize capital gains on debt, or mistakenly use the nominal required rate of return to discount the real cash flows, thereby explaining the observed decline in stock prices during inflationary periods. Because there is ample evidence for the "rationality" of stock price determination, most economists are likely to reject the irrational behavior hypothesis; particularly if the observed negative relationships between stock returns and inflation could be explained without the assumption of "irrational" behavior. Nevertheless, the theory of money illusion or the irrational

behavior hypothesis has a long and even respectable history, perhaps ante-dating Keynes [1936] who viewed the stock price as "the outcome of mass psychology of a large number of ignorant individuals (p. 154)." Moreover, in spite of numerous studies about the nominal contracting hypothesis since the 1950's, convincing evidence has yet to be presented for the theoretically anticipated wealth redistribution effect of unexpected inflation among creditors and debtors. Our findings do explain why previous tests for the nominal contracting hypothesis may have failed.

Geske and Roll [1983] present an unconventional view that the negative stock return-inflation relationship is not created by a "causative" effect of inflation on stock prices. They argue that a decrease in stock prices, in an efficient stock market, signals an increase in the government's monetized debt and its consequence, inflation; and, therefore, they claim that a "reverse causality" from stock returns to inflation is logical. Of course, some feedback effect from the stock market to money supply is plausible.⁶ As will be demonstrated later in this paper, the observed negative relationship between expected inflation and subsequent stock returns is a statistical artifact, created by a structural relationship between the level of inflation and the degree of inflation uncertainty. Hence, Geske and Roll's reverse causality position seems less than convincing.

Malkiel [1979] and Friend [1982], working in tangentially related subject areas, independently suggest a much more plausible explanation for the observed negative relationship between stock returns and inflation:⁷ they surmise that the risk premium for common stocks has increased as a response to inflation uncertainty. However, empirical evidence for impacts of inflation uncertainty on the risk premium has yet to be presented.

II. THEORY AND MODEL

II.1. Portfolio Choice under Uncertain Price Changes

The economy is described as:

Assumption 1: Individuals (denoted by superscript k) are standard Sharpe-Lintner CAPM investors.

Assumption 2: There is only one firm which issues two assets: (i) short-term nominally risk-free bonds (denoted by subscript o); and (ii) common stock (denoted by subscript s). Supply of these assets is fixed.

Assumption 3: Real rates of return and the rate of price changes follow continuous-time stochastic (Wiener) processes, which are time-homogeneous Markov processes.

The instantaneous rate of the price change,⁸ π , is described by a Wiener process:

$$(1) \quad \pi dt = E[\pi]dt + \sigma_{\pi} y_{\pi} \sqrt{dt}$$

where E is the expectation operator; σ_{π} is the standard deviation of the Wiener process of price change, that is, σ_{π} represents inflation uncertainty;⁹ y_{π} is, by construction, a standardized normal random variable which is identically and independently distributed over time; $E[y_{\pi}] = 0$ and $E[y_{\pi}^2] = 1$; and dt is an infinitesimal time period.

It is further assumed that the nominal interest rate before taxes, R_o , is known at the beginning of the period. Since taxes are calculated for nominal interest payments, the net real interest rate after personal income taxes, r_o , is defined as:¹⁰

$$(2) \quad r_o dt = (1-t_p)R_o dt - \pi dt + \sigma_{\pi}^2 dt$$

where t_p is the personal income tax rate.¹¹

Changes in price uncertainty may cause a change in the firm's production function, or a shift in demand for its output. Uncertainty about the future, induced by uncertainty about price changes, is likely to change the firm's investment decision. Similarly, consumers may alter consumption-saving decisions because of perceived changes in price uncertainty. Finally, because the asset return generating function should be viewed as a reduced form of the production and demand functions, a two-factor return generating process for the firm's asset real return, r_a , is assumed to be:

$$(3) \quad r_a dt = E[r_a]dt + \sigma_a y_a \sqrt{d\bar{t}} + b_a \sigma_{\pi} y_{\pi} \sqrt{d\bar{t}}$$

where $\sigma_a y_a$ represents the stochastic component of the asset return which is independent of uncertain price changes, that is $E[y_a y_{\pi}] = 0$ by construction; and $b_a = \text{cov}(r_a, \pi) / \sigma_{\pi}^2$, that is, b_a measures the degree of responsiveness of the real asset return with respect to uncertain price changes.

Given the firm's asset return generating function (3), and the values of the firm's asset (V), debt (D) and equity (S) at the beginning of the period, the real rate of return on the firm's equity after personal taxes, r_s , can be expressed as (see Appendix A):

$$(4) \quad r_s dt = E[r_s]dt + \sigma_s y_s \sqrt{d\bar{t}} + b_s \sigma_{\pi} y_{\pi} \sqrt{d\bar{t}}$$

where $\sigma_s = (1-t_p)(1-t_c)\sigma_a V/S$, that is, σ_s represents the real rate of

return risk for common stock which is independent of uncertain price changes; and b_s measures the degree of responsiveness of the real stock return with respect to uncertain price changes, that is, $\text{cov}(r_s, \pi) / \sigma_\pi^2$. Using separate notation for personal capital gain tax rate, g_p , and the corporate capital gain tax rate, g_c , b_s will be (see Appendix A):

$$(5) \quad b_s = \theta_p \theta_c b_a V/S + \theta_p D/S - \theta_p g_c V/S - g_p$$

where $\theta_p = 1 - t_p$; and $\theta_c = 1 - t_c$. Equation (5) illustrates that b_s is jointly determined by the relationship between the asset return and uncertain price changes (b_a), the capital structure, and tax rates.

11.2. Portfolio Equilibrium Adjustments

For any information set about the changes in the price level and real returns on equity and bonds, investors would be expected to readjust their asset portfolios. The investor's objective is:

$$(6) \quad \max_{\alpha_s^k} E\{U(W^k + W^k[r_o dt + \alpha_s^k(r_s - r_o)dt])\}$$

where U is the individual's utility function; W^k is the initial wealth of investor k at the beginning of the period; and α_s^k is the fraction of initial wealth invested in equity. The optimality condition becomes:¹²

$$(7) \quad U'(W^k) E[(r_s - r_o)dt] +$$

$$U''(W^k) W^k E\{[r_o dt + \alpha_s^k(r_s - r_o)dt] (r_s - r_o)dt\} = 0$$

Since $E[r_0 dt(r_s - r_0) dt] = \text{cov}(r_0, r_s - r_0)dt = -(1 + b_s) \sigma_\pi^2$, and $E[\{(r_s - r_0)dt\}^2] = \text{var}(r_s - r_0)dt = (\sigma_s^2 + (1 + b_s)^2 \sigma_\pi^2)dt$, (7) is rearranged to be:

$$(8) \quad E[r_s - r_0] = c^k \{-(1 + b_s) \sigma_\pi^2 + \alpha_s^k (\sigma_s^2 + (1 + b_s)^2 \sigma_\pi^2)\}$$

where $c^k = -U''(W^k)W^k/U'(W^k)$, i.e., the Pratt-Arrow measure of relative risk aversion; and dt is eliminated because it appears in both sides of equation (8). To get the market equilibrium condition, let $y^k = W^k/\bar{W}^k$ and $-\lambda = (\sum \frac{y^k}{c^k})^{-1}$. By multiplying both sides of equation (8) by $\lambda y^k/c^k$;

and aggregating over k :

$$(9) \quad E[r_s - r_0] = -\lambda(1+b_s) \sigma_\pi^2 + \lambda\{\sigma_s^2 + (1+b_s)^2 \sigma_\pi^2\}\alpha_s$$

where λ is viewed as the market price of risk; and α_s is the proportion of total value of common stocks to total value of all assets.

In order to facilitate the derivation of an empirically testable model, it is subsumed that the net supply of bonds is zero, that is, $\alpha_s = 1$. Then, equation (9) becomes:

$$(10) \quad E[r_s - r_0] = \lambda \{\sigma_s^2 + (b_s^2 + b_s) \sigma_\pi^2\}$$

Equation (10) illustrates that the risk premium increases when σ_π^2 increases if b_s is less than -1 or greater than 0. Given the linear relationship between real stock returns and uncertain price changes in equation (4), if b_s is greater than zero, common stocks are not protected against

unexpected "deflation," and, therefore, the risk premium increases when σ_{π}^2 increases. The risk premium decreases when σ_{π}^2 increases if b_s is between -1 and 0. The result is not "bizarre" because the risk premium is expressed vis-a-vis bonds, and the degree bonds hedge against unexpected price changes, $\text{cov}(r_o, \pi)/\sigma_{\pi}^2$, is exactly -1. It has been well-documented empirically elsewhere that b_s is negative; this analysis examines whether the observed negative relationships among stock returns and inflation are interrelated to the effect of "inflation uncertainty" on the expected risk premium for common stocks and, if so, why.

Since r_s and r_o are after personal income taxes, and pre-tax data is observed, the empirical model is modified to be equation (11):

$$(11) \quad E[R_s - R_o] = \frac{\lambda}{1 - \tau_p} \sigma_s^2 + \frac{\lambda}{1 - \tau_p} (b_s^2 + b_s) \sigma_{\pi}^2$$

$$= \beta_1 \sigma_s^2 + \beta_2 \sigma_{\pi}^2$$

where R_s and R_o are nominal returns on equity and bonds, respectively, before personal taxes; and τ_p is the overall effective personal income tax rate.^{13, 14}

III. THE EMPIRICAL MODEL

III.1. Data Base¹⁵

Expected rates of inflation and stock market returns are estimated using the Livingston expectations data, which is perhaps the richest source of ex-ante information for major economic variables. Individual respondents generated six-month forward forecasts for rates of inflation and stock

returns, for each of the semi-annual surveys. The risk premium and inflation uncertainty measures are estimated as follows:

- (i) For each survey, the arithmetic averages of forecasted stock returns and inflation rates, respectively, represent the market consensus of expected stock market return and expected inflation rate. The risk premium (PREM) is obtained by subtracting the six-month Treasury bill rate (at the beginning of the survey month) from the expected stock market return.
- (ii) Since the measure of inflation uncertainty, σ_{π}^2 , is not directly observed, three alternative surrogates are used: (a) the cross-sectional variances of individual forecasted inflation rates, $V(LE_t\pi)$; ¹⁶ (b) the inflation forecast errors from previous predictions, FECPI;¹⁷ and (c) expected inflation rates, $LE_t\pi$. ¹⁸

Finally, σ_s^2 , the variance for asset uncertainty, independent of price changes, is estimated from the variance of the monthly realized real stock return on the S&P 500 for the six month sample period prior to each of the surveys, $V_t(RS)$. ¹⁹

III.2. Inflation Uncertainty and the Risk Premium: Empirical Findings

Given the data base for the risk premium, inflation uncertainty and the variance of real stock returns, the empirical model analog for equation (11), the principal empirical-theoretical testing equation, will be equations (12):

$$(12-a) \quad PREM_t = a_0 + a_1 V(LE_t\pi) + a_2 V_t(RS)$$

$$(12-b) \quad PREM_t = a_0 + a_1 FECPI_{t-2} + a_2 FECPI_{t-3} + a_3 V_t(RS)$$

$$(12-c) \quad PREM_t = a_0 + a_1 LE_t\pi + a_2 V_t(RS)$$

where the subscript t represents "at the time of the Livingston semi-annual survey"; $PREM$ is the risk premium; $V(LE_t\pi)$ is the cross-sectional variance of the forecasted inflation rate;²⁰ $FECPI$ is the forecast error of the inflation prediction (note that only observed forecast errors at the time of the survey²¹ are present in (12-b)); $LE_t\pi$ is the expected inflation rate; and $V_t(RS)$ is the variance of monthly real stock return (for the six month sample period prior to each of the surveys at the time t) orthogonalized to the estimated unanticipated inflation rate.

The regression results for equations (12), reported in Table 1, show that the risk premium increases when inflation uncertainty increases.²² These results are consistent across regressions, and robust with respect to various measures of inflation uncertainty. The coefficients for the various measures of inflation uncertainty are significantly positive even when controlling for uncertainty about real activity ($V_t(RS)$). This implies that increased inflation uncertainty has informational content (i.e., bad news) for the stock market. Also, the coefficients of $V_t(RS)$ are statistically significantly positive throughout the regressions, which is consistent with the assumption of risk averse behavior.²³ The positive, statistically significant coefficients for the inflation prediction forecast errors variables are consistent with the hypothesis that investors have adaptive expectations. In order to control for the possibility of temporal trends in equations (12), a time trend variable ($TIME: 1960.06 = 0.01$, etc.) has been introduced into the regressions. The regression results, after controlling for the possible time effect, are virtually unchanged.

Insert Table 1 here

Ceteris paribus, increasing risk over time is created by unanticipated events, which tend to depress stock prices ex post, and thereby lead to lower ex post realized rates of return for investors. Hence, the positive ex ante relationship between the risk premium and inflation uncertainty (i.e., results found for equations 12a and 12b in Table 1) implies a negative ex post relationship between the realized stock return (RS_t) and the change in inflation uncertainty. (This argument is expanded below in Section III.3.) This implication is confirmed econometrically by the OLS regression, equation 13:

$$(13) \quad RS_t = 0.069 - 0.061 \Delta \log V(LE_t \pi) - 0.043 \Delta \log V_t(RS)$$

$$(4.793) \quad (-2.121) \quad (-3.166)$$

Adj $R^2 = 0.279$, $F = 8.729$, $DW = 2.235$ (1960.06-80.06)

where RS_t is the semi-annual log realized real return on the S&P 500 at the time of the survey; and $\Delta \log V(LE_t \pi)$ and $\Delta \log V_t(RS)$ are measures for the change in inflation uncertainty and real activity uncertainty, respectively.

III.3. Expected Inflation and Stock Returns: Empirical Findings

The portfolio choice theory, developed above, indicates that the level of expected inflation, ceteris paribus, should not affect investor's decision-making; and thereby the risk premium should be statistically unrelated to the level of expected inflation. If it were plausible to assume that the level of expected inflation is a good measure of (or highly correlated with) inflation uncertainty, then, a positive empirical relationship between the risk premium and expected level of inflation might occur. In order to obtain the "true" relationship of statistical insignificance between the risk premium and

the level of expected inflation, the analysis must control for inflation uncertainty.

Equations (14), controlling for inflation and non-price stock market uncertainty, confirm the anticipated results. Furthermore, if one assumes that a change in the level of expected inflation reflects a change in inflation uncertainty, the results contained in equations (14) explain why ex post realized stock returns are negatively related to changes in the expected level of inflation.

$$(14-a) \quad \text{PREM}_t = -0.012 - 0.949 \text{LE}_t\pi + 5.906 \text{V}(\text{LE}_t\pi) + 5.518 \text{V}_t(\text{RS})$$

$$\quad \quad \quad (-2.048) \quad (-1.688) \quad \quad (2.943) \quad \quad (2.265)$$

Adj R² = 0.505, F = 14.581, DW = 1.836 (1960.06-80.06)

$$(14-b) \quad \text{PREM}_t = -0.018 - 0.044 \text{LE}_t\pi + 0.935 \text{FECPI}_{t-2}$$

$$\quad \quad \quad (-3.304) \quad (-0.143) \quad \quad (2.326)$$

$$\quad \quad \quad + 0.797 \text{FECPI}_{t-3} + 5.873 \text{V}_t(\text{RS})$$

$$\quad \quad \quad (2.167) \quad \quad (2.471)$$

Adj R² = 0.504, F = 11.156, DW = 1.774 (1960.06 - 80.06)

As demonstrated in Table 1, equations 12-c, there exists an observable positive relationship between the ex ante risk premium and the level of ex ante expected inflation. The ex ante relation is consistent with the observed negative relationship between ex ante expected inflation and subsequently (ex post) realized returns. The consistency emanates from and is likely to be explained by a "structural" relationship between the level of inflation and the degree of inflation uncertainty. The hypothesized structural relationship between the level of inflation and the degree of

inflation uncertainty can be represented by equation (15-a):

$$(15-a) \quad E_t \pi = \rho(\pi_t) \sigma_{\pi,t}^2; \quad \rho > 0$$

$E_t \pi$ is expected inflation. ρ is assumed to be a monotonically non-decreasing function of the inflation level, once the rate of inflation rises above some threshold (e.g., 2-4 percent according to Logue and Willet [1976] and Hafer and Heyne-Hafer [1981]). In other words, when the inflation level is relatively high, the degree of inflation uncertainty tends to be more closely associated with the inflation level and vice versa. Then, equation (15-b) represents the dynamic relationship between the level of inflation and the degree of inflation uncertainty,

$$(15-b) \quad \dot{E}_t \pi < \dot{\rho}_t \quad \text{if } E_t \pi > \delta$$

$$\dot{E}_t \pi \geq \dot{\rho}_t \quad \text{if } E_t \pi \leq \delta$$

where a dot over the variable denotes the rate of its change; and δ is the threshold level of expected inflation. The relationship between inflation uncertainty and stock returns can be expressed as equation (15-c).

$$(15-c) \quad RS_t = \xi (\sigma_{\pi,t}^2 - \sigma_{\pi,t-1}^2); \quad \xi < 0.$$

By substituting equation (15-a) into equation (15-c), and factoring out expected inflation at time t-1, equation (15-d) is created.

$$\begin{aligned}
 (15-d) \quad RS_t &= \xi [(\dot{E}_t \pi - \dot{\rho}_t) / \rho_t] E_{t-1} \pi \\
 &= \xi \gamma_t E_{t-1} \pi
 \end{aligned}$$

Given the hypothesized relationship of equation (15-b), γ_t is likely to be negative when the inflation level is relatively high (i.e., above the threshold level), and vice versa. This implies that the magnitude of the coefficient of the level of expected inflation in the stock return regression, such as equation (15-d), should be (given a negative ξ) more negative when the inflation level is relatively low and stable. It is also possible for this coefficient to be positive when the inflation level is relatively high and unstable. In either case, given the theory, the coefficient of expected inflation in the stock return regression is a statistical artifact created by a structural relationship between the level of inflation and the degree of inflation uncertainty.

The relationships for monthly, quarterly, and semi-annual ex post real stock returns with the corresponding ex ante expected inflation measures (at the beginning of the period) are examined in Table 2. In general, the results suggest that the negative estimated coefficient for expected inflation disappears when the sample period is characterized by relatively high and unstable inflation.

Insert Table 2 here

In order to investigate the relationship between the magnitude of the estimated coefficient for expected inflation with the level of and the instability of inflation, the value of the estimated coefficients (COEF is the

estimated coefficient of the monthly Treasury Bill rate for the simple real stock regression, $RS_t = a + \text{COEF} * TB_{t-1}$) is regressed on measures of the level and instability of inflation. The empirical results for these analyses are shown as equations (16). The subscript J in equations (16) denote the sample period²⁴ for the stock return regression; AVINF and VARINF are, respectively, the average and the variance of the percentage monthly inflation rate for the corresponding sample period; and AVDINF is the average of the change in the percentage monthly inflation rate for the corresponding sample period. These findings are consistent with the results in Table 2 and lend support to the position that the observed negative relationships²⁵ between expected inflation and subsequent stock returns are statistical artifacts.

$$(16-a) \quad \text{COEF}_J = -17.523 + 781.892 \text{ AVINF}_J + 13.050 \text{ VARINF}_J$$

$$\quad \quad \quad (-7.881) \quad (3.442) \quad (1.636)$$

$$\quad \quad \quad \text{Adj } R^2 = 0.333, \quad F = 7.495$$

$$(16-b) \quad \text{COEF}_J = -20.203 + 19.638 \text{ AVDINF}_J$$

$$\quad \quad \quad (-6.961) \quad (2.562)$$

$$\quad \quad \quad \text{Adj } R^2 = 0.176, \quad F = 6.562$$

IV. IMPLICATIONS AND CONCLUSIONS

This paper has demonstrated that the risk premium for common stocks increases when inflation uncertainty increases, and common stocks are not, even vis-a-vis bonds, hedges against uncertain inflation. This finding contrasts with a belief by some economists that bond investment is riskier

with respect to inflation than equity investment.²⁶

In Section II, b_s is expressed as $\theta_p \theta_c b_a V/S + \theta_p D/S - \theta_p g_c V/S - g_p$. For simplicity, it was assumed that the net supply of debt is zero. Then, b_s equals $\theta_p \theta_c b_a - \theta_p g_c - g_p$. The positive relationship between the risk premium and inflation uncertainty implies that b_s is less than -1, and thereby b_a (the degree of responsiveness of before tax profits with respect to unexpected inflation) is less than $(-1 + \theta_p g_c + g_p)/\theta_p \theta_c$. Therefore, if nominal capital gains are completely taxed ($g_c^- = t_c$ and $g_p = t_p$), b_a is also less than -1. In the other extreme case where nominal capital gains are not taxed at all ($g_c = g_p = 0$), b_a is less than $-1/\theta_p \theta_c$ or -2.67 (assuming that $\theta_p = 0.75$ and $\theta_c = 0.5$).

These results imply that b_a must be sufficiently negative, regardless of a nominal capital gain tax, if the risk premium is positively related with inflation uncertainty. In other words, the adverse effect of uncertain inflation on before tax profits is likely to be a principal cause for the depressant effect of inflation on stock prices.²⁷ This finding contrasts with Feldstein's [1981] argument that an important depressant effect of inflation on share prices results from nominal capital gain taxes and the "historic cost" methods of depreciation; not particularly from the decline in before tax profits. Therefore, this paper's findings indicate that prior claims about the importance of the tax system for determining stock values (relative to uncertain inflation effects) may have been overstated.

The adverse effect on before tax profits will be intensified if debt is present because it is "piled upon" the smaller equity base. Therefore, the findings may explain why previous tests for the nominal contracting hypothesis have failed to show the wealth redistribution effect of unexpected inflation between bondholders and shareholders. In particular, share-

holders' capital gains on debt are likely to be offset by this adverse effect on before tax profits, because inflation uncertainty increases the "business risk" and thereby the "financial risk" as the debt-to-equity ratio increases (Modigliani and Miller [1963]). In other words, inflation uncertainty implies an increase of "non-diversifiable" risk, which increases with the debt-to-equity ratio.

The economic implication of uncertainty about the future has been discussed long before by a classical work of Frank Knight [1921], and the adverse effect of inflation uncertainty on economic activity has been recognized in macroeconomic studies (for example, Lucas [1973], Barro [1976], Friedman [1977], and Cukierman and Wachtel [1979], among others). This adverse effect on real activity is perhaps best summarized by Friedman's Nobel Laureate Lecture: Greater inflation uncertainty shortens the average duration of contracts and reduces the efficiency of the price system in allocating resources, resulting in the lower growth rate of real output and a potential increase in the unemployment rate. The price system becomes less efficient because "the harder it becomes to extract the signal about relative prices from the absolute prices" (p. 467), the greater inflation uncertainty is.

Friedman's argument is well supported by Vining and Elwertowski's [1976] empirical work about the behavior of changes in individual prices and general inflation.²⁸ They found that high inflation tends to be associated with a greater dispersion of changes in relative prices, that is, a structural relationship exists between the instability of general inflation and the dispersion of relative price changes. Uncertainty about the future, associated with higher general inflation, arises from unpredictable changes in the relative price structure; and, consequently, a higher risk premium is

required for an investment project when the general inflation rate is high.

As would be expected from this paper's results, a recent survey of non-financial corporations listed on New York Stock Exchange, conducted by Blume, Friend and Westerfield [1981], found that inflation is considered to be one of the key factors depressing real plant and equipment expenditures; and the corporations attributed this adverse effect to increased uncertainty of sales, prices, wages, and the cost of financing as a consequence of inflation.

Finally, the findings indicate that the "irrational behavior" hypothesis cannot be supported. High inflation is associated with relatively low stock prices simply because risk averse investors require a higher discount rate adjusted for greater uncertainty about the future.

TABLE 1. EQUATIONS 12[†]RELATIONSHIPS BETWEEN THE RISK PREMIUM AND INFLATION
UNCERTAINTY, JUNE 1980 THROUGH JUNE 1980

Equation 12-a	$PREM_t = c_0 + c_1 V(LE_t\pi) + c_2 V_2(RS) + c_3 TIME_t$						
Eq.	c_1	c_2	c_3	Adj R ²	F	DW	
12-a-1*	4.242 (4.503)	--	--	0.331	20.277	1.681	
12-a-2	2.852 (3.205)	6.642 (2.768)	--	0.480	19.497	1.765	
12-a-3	4.428 (3.402)	5.691 (2.351)	-0.693 (-1.630)	0.502	14.450	1.876	
Equation 12-b	$PREM_t = c_0 + c_1 FECPI_{t-2} + c_2 FECPI_{t-3} + c_3 V_t(RS) + c_4 TIME_t$						
Eq.	c_1	c_2	c_3	c_4	Adj R ²	F	DW
12-b-1	1.304 (3.904)	0.974 (2.861)	--	--	0.450	17.377	1.837
12-b-2	0.908 (2.588)	0.775 (2.356)	5.862 (2.501)	--	0.517	15.272	1.776
12-b-3	0.944 (2.534)	0.805 (2.323)	5.862 (2.470)	-0.009 (-0.317)	0.505	11.200	1.780
Equation 12-c	$PREM_t = c_0 + c_1 LE_t\pi + c_2 V_t(RS) + c_3 TIME_t$						
Eq.	c_1	c_2	c_3	Adj R ²	F	DW	
12-c-1*	0.950 (2.580)	--	--	0.127	6.656	1.665	
12-c-2	0.542 (2.032)	8.902 (3.782)	--	0.405	14.599	1.745	
12-c-3	1.706 (2.461)	7.663 (3.211)	-0.131 (-1.810)	0.438	11.408	1.946	

† t-statistics are in parentheses below the estimated coefficients.

Equations followed by * indicate that the regression is adjusted for first-order autocorrelation (using the Cochrane-Orcutt method).

TABLE 2. THE RELATIONSHIP BETWEEN
EXPECTED INFLATION AND SUBSEQUENT STOCK RETURNS

$$RS_t = c_0 + c_1 E_{t-1} \pi_t$$

Eq.	Period	c_1	(t-stat)	Adj R ²	Eq.	Period	c_1	(t-stat)	Adj R ²
<u>Panel A.</u>					$(RS6_t = c_0 + c_1 LE_{t-1} \pi_t)$				
1.	55.1-65.11	-18.57	(-2.30)	0.17	4.	55.1-73.11	-6.26	(-2.63)	0.14
2.	66.1-73.11	-5.75	(-0.86)	-0.02	5.	66.1-80.1	0.81	(0.37)	-0.03
3.	74.1-80.1	3.68	(0.73)	-0.04	6.	55.1-80.1	-1.75	(-1.42)	0.02

<u>Panel B.</u>					$(RS6_t = c_0 + c_1 TB6_{t-1})$				
1.	59.1-65.11	-7.22	(-0.88)	-0.02	4.	59.1-73.11	-5.82	(-2.30)	0.13
2.	66.1-73.11	-6.89	(-1.41)	0.06	5.	66.1-80.1	-0.73	(-0.33)	-0.03
3.	74.1-80.1	0.37	(0.11)	-0.09	6.	59.1-80.1	-1.99	(-1.28)	0.02

Note: The six-month Treasury bill has been available since January 1959.

<u>Panel C.</u>					$(RS3_t = c_0 + c_1 TB3_{t-1})$				
1.	55.1-65.IV	-11.22	(-2.36)	0.10	4.	55.1-73.IV	-6.09	(-3.02)	0.10
2.	66.1-73.IV	-5.52	(-1.28)	0.02	5.	66.1-80.IV	0.62	(0.28)	-0.02
3.	74.1-80.IV	1.82	(0.52)	-0.03	6.	55.1-80.IV	-1.72	(-1.27)	0.01

<u>Panel D.</u>					$(RS1_t = c_0 + c_1 TB1_{t-1})$				
1.	55.01-65.12	-11.55	(-2.54)	0.04	4.	55.01-73.12	-6.39	(-3.43)	0.04
2.	66.01-73.12	-7.12	(-1.73)	0.02	5.	66.01-80.12	0.02	(0.01)	-0.01
3.	74.01-80.12	1.40	(0.45)	-0.01	6.	55.01-80.12	-2.07	(-1.67)	0.01

RS# = #-month real return on the S&P 500.

TB# = #-month Treasury-bill rate.

LE π = six-month Livingston expected inflation rate.

APPENDIX A
CASH FLOW TO SHAREHOLDERS

(1)	$(1 + \pi)r_a V$	Nominal Replacement Cost Income
(2)	$- R_0 D$	Interest Payment
(3)	$[(1) - (2)] + \pi V$	Taxable Income with Capital Gains
(4)	$-t_c [(1) - (2)] - g_c \pi V$	Corporate Taxes
(5)	$[(3) - (4)] - \pi V$	After Tax Nominal Income to S-H's
(6)	$(1 + \pi)V - D$	Liquidation (one period model)
(7)	$[(5) + (6)] - S$	Taxable Income to Shareholders
(8)	$= 0_c (1 + \pi)r_a V - (0_c R_0 - \pi)D - g_c \pi V + \pi S$ $- t_p [0_c (1 + \pi)r_a V - (0_c R_0 - \pi)D - g_c \pi V] - g_p \pi S$	with Personal Capital Gains Personal Taxes
(9)	$[(7) - (8)]$	Nominal Return After Personal Taxes

Notes:

r_a = real rate of return on total assets; π = inflation rate; R_0 = nominal interest rate before taxes; S = value of equity at the beginning; D = value of debt at the beginning; $V = D + S$; t_c = corporate income tax rate; $0_c = 1 - t_c$; g_c = corporate capital gain tax rate; t_p = personal income tax rate; $0_p = 1 - t_p$; g_p = personal capital gain tax rate.

FOOTNOTES

1. This finding has been well documented by a number of studies since the mid-1970's: Lintner [1975], Bodie [1976], Jaffe and Mandelker [1976], Nelson [1976], Fama and Schwert [1977], and Friend and Hasbrouck [1982], among others.
2. For examples, see Gultekin [1983] and Solnik [1983].
3. The negative relationship can be described in three different ways: realized aggregate stock market returns are negatively related to (i) expected inflation (at the beginning of the time period); (ii) changes in the expected inflation rate (during the time period); and (iii) lagged and contemporaneous unexpected inflation rates.
4. Pindyck [1984] examines a closely related issue about stock market share valuation, and finds that inflationary uncertainty is likely to have led to depressed real share prices.
5. In addition, fewer firms than might have been expected have actively changed from FIFO to LIFO. This suggests that the tax cost associated with the FIFO method is probably insignificant relative to the inventory management cost under LIFO method (see, Granof and Short [1984]). Also, note that the U.S. tax laws do not allow the use of different inventory valuation methods for financial and tax purposes.
6. For example, Rogalski and Vinso [1977] showed a "bi-directional" causality between stock returns and money supply.
7. The adverse impacts of inflation uncertainty on real economic activity have been well recognized in several macroeconomic studies; see Lucas [1973], Barro [1976], Friedman [1977], and Cukierman and Wachtel [1979], among others.
8. Inflation is assumed to be neutral to avoid the intricacies of relative price changes in the model derivation.
9. Uncertainty about inflation can be viewed as a dispersion measure of the distribution from which a point forecast (expected inflation) is drawn. Knight [1921] made a distinction between risk and uncertainty. Risk occurs when the future is unknown, but the probability distribution of future states is known. Uncertainty occurs when the probability distribution is itself unknown. However, modern portfolio theory draws no distinction between the two concepts. Risk and uncertainty are used interchangeably in this study.
10. The stochastic continuous-time version of the Fisher equation was originally derived by Fischer [1975].
11. The personal income tax rate across individuals is assumed to be constant.

12. The marginal utility of end-of-period wealth, the first-order condition for (6), is expanded in a Taylor series about initial wealth.
13. Note that r_s and r_o are after personal taxes. Since taxes are paid for nominal returns, $E[r_s] = E[(1 - \tau_p)R_s - \pi]$ and $E[r_o] = E[(1 - \tau_p)R_o - \pi]$.
14. Equation (11) may be transformed into the "generalized" Fisher equation for stock returns by solving for $E[R_s]$ as the dependent variable. The difficulty with the empirical test for the generalized Fisher equation would be that the real interest rate and the inflation level are likely to be intercorrelated (for example, see Mundell (1963) and Sargent (1972)); and, therefore, the Fisher equation for stock returns should be treated as a pseudo-reduced form of a set of structural equations in a macroeconomic model (Levi and Makin [1973]). For this reason the current analysis examines the impact of inflation uncertainty on the risk premium rather than the required return for common stocks.
15. Details about the data base and estimation procedures can be obtained by contacting the authors.
16. Cukierman and Wachtel [1979] present formal proof that the cross-sectional variance measure is closely related with inflation uncertainty within a rational expectations model; and Bomberger and Frazer [1981] present empirical evidence that the Livingston cross-sectional variance is an internally consistent measure of inflation uncertainty.
17. When prior forecast errors are realized (ex post), it seems intuitively appealing that ceteris paribus the future should appear relatively more uncertain.
18. There appears to exist a structural relationship between the level of inflation and the degree of inflation uncertainty. See Logue and Willet [1976], Jaffe and Kleiman [1977], Cukierman and Wachtel [1979], Taylor [1981], Fischer [1981], Frohman, Laney and Willet [1981], Hafer and Heyne-Hafer [1981], Pagan, Hall and Trivedi [1983], Holland [1984] and Pindyck [1984]. For the survey of most of these studies, see Holland. The current study finds a higher correlation between expected inflation and the cross-sectional variance of the forecasted inflation rate for the post-1966 period.
19. $V(RS)$ is computed from monthly realized real stock returns which are orthogonalized to the estimated monthly unexpected inflation rates because the risk of common stock, $y_s \sigma_s$, in equation (4) is independent of uncertain inflation, $y_\pi \sigma_\pi$.
20. Since $V(LE_t \pi)$ is a relatively small number, it has been scaled by multiplying by 100.

21. Let the subscript $t-1$, for example, represent the December 1980 survey. $FECPI_{t-1}$ is defined as the difference between the realized inflation rate from the beginning of January 1981 to the end of June 1981 and the expected inflation rate for the corresponding period at the December 1980 survey. It should be noted that this forecast error was not observed when the June 1981 survey (represented by the subscript t) was conducted in early June or late May of that year.
22. Evidence of the rationality and the informational efficiency in the Livingston survey data for the post-1960 period (Brown and Maital [1981]) indicates a potential structural break in the Livingston data around 1960. Therefore, the regression results for equations (12) were separated into two sub-periods: (i) June 1960 to June 1980; and (ii) June 1955 to June 1980. Since there is no qualitative difference in the results for these two sub-periods, only the results for the post-1960 period are reported to save space.
23. The magnitude of the coefficient estimate of $V(RS)$ can be interpreted as the market price of the risk. Note that the estimate of the market price of risk is quite stable across the regressions, which indicates the robustness of the empirical model.
24. The first sample period is 1950.01-54.12, the second one is 1951.01-55.12, ..., the last one is 1976.01-80.12: that is, 27 regression coefficients were obtained.
25. Geske and Roll suggest [1983] a "reverse causality" argument. They hypothesize that changes in the risk premium are probably inconsequential in explaining observed negative relationships between expected inflation and subsequent stock returns. They further argue that the large negative coefficient of expected inflation in the stock return regression (estimated from an earlier sample period by Fama and Schwert [1977]) "cannot be taken seriously as a causative value, since a rise in the Treasury-bill rate of only five percent ... [would imply] negative expected stock returns (p. 9)." Hence, they surmise a reverse causal relationship, and suggest that decreases in stock prices cause inflation through monetization of governmental debt. However, their hypothesis is inconsistent with the empirical results presented in Table 2; in particular, their analysis cannot account for either the changes in coefficient magnitudes or changes in coefficient signs over time. The "statistical artifact" argument seems to be a more plausible explanation.
26. For example, an earlier work by Gordon and Halpern [1976] claims that "an increase in the uncertainty of the inflation will result in a reduction of the expected risk premium" (p. 563). However, they considered the effect of inflation uncertainty only on the required rate of return for bonds, and their argument is a tautological result of the assumption that real returns on non-monetary assets are independent of inflation.
27. This result has been reported independently by Pindyck [1984] in a related but different context. He also claims that the decline in stock prices is attributed to an increase in uncertainty of the "gross" marginal return on capital (i.e., before tax profits).
28. See, also, Parks [1978].

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