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THE EFFECTS OF ECONOMIC UNCERTAINTY

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STOCK MARKET RETURNS AND INFLATION:
THE EFFECTS OF ECONOMIC UNCERTAINTY

by

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Finance Working Paper No. 157

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We have received many valuable comments from our colleagues; of course, we are responsible for any errors.
ABSTRACT

A well-documented but anomalous 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; and the apparent contradiction between previous empirical observations and financial theory can be explained if one controls for the degree of inflation uncertainty.
INTRODUCTION

A well-documented but anomalous finding from the U.S.\(^1\) and other\(^2\) 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.

This paper, in an attempt to resolve the apparent contradiction between financial theory and empirical findings, is motivated by earlier "macroeconomic" studies\(^4\) which recognize the adverse effect of inflation uncertainty on economic activity and by Malkiel [1979] and Friend [1982] who independently suggested that the real required returns for common stocks may have increased as a response to increased economic uncertainty, a concomitant of increased inflation uncertainty. The principal objective of this paper is to show that an increase in the real required return for common stocks did occur and is likely to be attributable to increased inflation uncertainty.

In brief, the empirical findings of this paper suggest that: (i) an increase in inflation uncertainty appears to be an important cause for the observed increase in the real required return for common stocks for the post-1960 period; (ii) the principal explanation for this finding appears to be the adverse effect of inflation uncertainty on anticipated pre-tax corporate profits (i.e., gross corporate
earnings); and (iii) the observed negative relationship between expected inflation and subsequently realized stock returns is likely to be a statistical artifact created by a structural relationship between the level of inflation and the degree of inflation uncertainty.

The presentation is divided into four sections. Section I reviews the previous literature. The theoretical model (Section II), an extension of earlier model by Friend, Landskroner and Losq [1976], analyzes the market equilibrium relationship for the real required return for common stocks in the presence of inflation uncertainty. Section III presents the data base, estimation procedure, and empirical findings. Section IV examines the implications and conclusions of these findings.

I. 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 of nominal gains and depreciation bases. According to their view, firms, reporting inflation generated book profits, are penalized by an increased tax burden. The immediate limitation of the pure "tax effect" hypothesis is its implicit assumption that corporations have no debt. If one assumes, as is the case empirically, that nominal interest rates respond "at most" point-for-point to changes in the inflation rate, then, because tax deductions are calculated for nominal interest payments, increased inflation will decrease the burden of real interest and principal payments to corporations. Then, the real net effect of inflation because of tax and debt effects is less clear. Even without debt, the
effect of nominal gain taxes may be less important than expected a priori 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]).

In contrast to the proponents of the tax effect hypothesis, Modigliani and Cohn [1979] allege that investors have systematic money illusion; investors do not recognize 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. Modigliani and Cohn's argument is perhaps supported by the inability of numerous studies to find empirical evidence for a wealth redistribution effect of unexpected inflation from bondholders to equity-owners (see, for example, French, Ruback and Schwert [1983] and the references therein).

Fama [1981] suggests that the observed negative relationships between stock returns and inflation are "spurious." According to Fama, increased inflation alters real variables such that the real return on capital is reduced; and, therefore, the observed negative relationships are generated by the real income "proxy effect" of inflation because stock prices are principally determined by expectations about future real activity. As proof for his position, Fama estimates a statistically insignificant relationship between expected inflation and subsequently realized stock returns, controlling for real activity. However, his "proxy effect" hypothesis is less than convincing because no strong argument is presented for existence of a negative relationship between real activity and the level of expected inflation.
Geske and Roll [1983] present an alternative view that the negative stock return-inflation relationship is not created by a "causal" effect of inflation on stock prices. They claim 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, a "reverse causality" from stock returns to inflation is logical. Of course, some feedback effect from the stock market to money supply is plausible. It is, also, possible that the observed negative relationship between expected inflation and subsequent stock returns may be a statistical artifact, created by a structural relationship between the level of inflation and the degree of inflation uncertainty. We argue below that this latter explanation seems more plausible than Geske and Roll's reverse causality interpretation.

Malkiel [1979] and Friend [1982] suggest independently that the risk premium for common stocks has increased as a response to increased economic uncertainty, presumably created by more inflation uncertainty. However, Pindyck [1984] contends a different view: even though an increased real required return for common stocks accounts for the decline in stock prices during the recent inflationary period, the impact of inflation uncertainty on the real required return for common stocks is likely to be negligible. But Pindyck's conclusion is based crucially on the assumption that real activity uncertainty is independent of inflation uncertainty. It is our contention that the relationships between inflation uncertainty and the real required return for common stocks have yet to be examined properly.
II. THEOREY 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: short-term nominal risk-free bonds (denoted by subscript o); and common stock (denoted by subscript s). Supply of these assets is fixed.

The inflation rate, \( \pi \), is decomposed into expected and unexpected inflation rates:

\[
\pi = E[\pi] + \pi^u
\]  

(1)

where \( E \) is the expectation operator; and \( \pi^u \) is the unexpected inflation rate that is normally distributed with mean, zero and variance, \( \sigma_\pi^2 \).

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:

\[
r_o = (1-t_p)R_o - E[\pi] - \pi^u
\]  

(2)

where \( t_p \) is the personal income tax rate.

The real rate of return on the firm's asset, \( r_a \), is also decomposed into:

\[
r_a = E[r_a] + r^u_a
\]  

(3-a)
where \( r^u_a \) is the unexpected real rate of asset return, which is assumed to be generated by equation (3-b): \(^{10}\)
\[
  r^u_a = b_a \pi^u + x_a; \quad b_a = \text{COV}(r^u_a, \pi^u) / \sigma^2\pi
\]  
(3-b)
where \( x_a \) is the residual of the simple regression equation (3-b), that is, \( \text{COV}(\pi^u, x_a) = 0 \), having variance \( \sigma^2_x \). Relative price changes (i.e., non-neutrality of inflation) are implicitly taken into account by the magnitude of \( b_a \) (i.e., the interrelationship between the real asset return and unexpected inflation).

Given the after-tax real interest rate (equation 2), the firm's real asset return generating function (equations 3), and the values of the firm's asset \( (V) \), debt \( (D) \) and equity \( (S) \) at the beginning of the period, the firm's after tax income will be \( (1-t_c)r^a_V - r^o_oD \) if the firm does not pay taxes on nominal capital gains; where \( t_c \) is the corporate income tax rate. Under current tax laws, the firm pays taxes on transactions where there are nominal capital asset gains, \( \pi V \), i.e., pseudo profits. Using the notation \( g_c \) for the corporate capital gain tax rate, corporate income available to shareholders is \( (1-t_c)r^a_V - r^o_oD - g_c \pi V \). Investors also pay taxes on nominal capital gains on equity investment, \( \pi S \). Using separate notations for the personal income tax rate \( (t_p) \) and the personal capital gain tax rate \( (g_p) \), after personal tax income to shareholders becomes \( (1-t_p)(1-t_c)r^a_V - r^o_oD - g_c \pi V - g_p \pi S \). \(^{11}\) Therefore, the real rate of return on equity, \( r_S \), is:
\[ r_s = (1-t_p)(1-t_c)E[r_a]V/S - E[r_o]D/S - g_cE[\pi]V/S - g_pE[\pi] \\
+ (1-t_p)(1-t_c)b_a V/S + D/S - g_c V/S - g_p\pi^u \\
+ (1-t_p)(1-t_c)x_a V/S \\
= E[r_s] + b_s\pi^u + x_s \]  

where \( x_s \) is the unexpected real equity return independent of unexpected inflation, having mean, 0, and variance, \( \sigma^2_s = \{(1-t_p)(1-t_c)(V/S)\}^2 \sigma^2_x \), that is, the risk of common stock when there is no uncertain inflation; \( b_s \) measures the relationship between the real stock return and unexpected inflation, that is, \( \text{COV}(r_s, \pi^u) / \sigma^2_\pi \); and \( b_s \) is jointly determined by the relationship between the asset return and unexpected inflation (\( b_a \)), the capital structure, and tax rates:

\[ b_s = \theta_p \theta_c b_a V/S + D/S - g_c V/S - g_p \]  

where \( \theta_p = 1-t_p \); and \( \theta_c = 1-t_c \).

II.2. Portfolio Equilibrium Adjustments

Given an information set about the changes in the price level and real returns on equity and bonds, investors would be expected to re-adjust their asset portfolios. The investor's objective is:

\[ \max_{\alpha^k_s} E[U(w^k + \alpha^k_s(r_s - r_o))] \]  

where \( U \) is the individual's utility function; \( w^k \) is the initial wealth of investor \( k \) at the beginning of the period; and \( \alpha^k_s \) is the fraction
of initial wealth invested in equity. The optimality condition becomes:

$$E[r_s - r_o] = c^k \cdot \text{COV}(r_o, r_s - r_o) + \alpha_s^k \cdot \text{VAR}(r_s - r_o)$$ \quad (7)

where $c^k$ is the Pratt-Arrow measure of relative risk aversion. From equations (2) and (4), \(\text{COV}(r_o, r_s - r_o) = -(1+b_s)\sigma^2_{\pi}\); and \(\text{VAR}(r_s - r_o) = (\sigma^2_s + (1+b_s)^2\sigma^2_{\pi})\). Equation (7) is rearranged to be:

$$E[r_s - r_o] = c^k \{-(1+b_s)\sigma^2_{\pi} + \alpha_s^k \cdot [\sigma^2_s + (1+b_s)^2\sigma^2_{\pi}]\}$$ \quad (8)

To get the market equilibrium condition, let $\delta^k = \omega^k/\Sigma \omega^k$ and $\lambda = (\sum\delta^k)^{-1}$. By multiplying both sides of equation (8) by $\lambda^k/c^k$; and aggregating over $k$:

$$E[r_s - r_o] = -\lambda(1+b_s)\sigma^2_{\pi} + \lambda\alpha_s^2 + (1+b_s)^2\sigma^2_{\pi} \cdot \sigma_s^2$$

$$= \lambda \alpha_s \sigma^2_s + \lambda[(1+b_s)^2\alpha_s^2 - (1+b_s)]\sigma^2_{\pi}$$ \quad (9)

where $\lambda$ is viewed as the market price of risk; and $\alpha_s$ ($=S/V$) is the proportion of total value of common stocks to total value of all assets.

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 (10):

$$E[R_s - R_o] = \frac{\lambda\alpha_s}{1-\tau_p} \sigma^2_s + \frac{\lambda}{1-\tau_p} \{(1+b_s)^2\alpha_s^2 - (1+b_s)]\sigma^2_{\pi}$$

$$= \beta_1 \sigma^2_s + \beta_2 \sigma^2_{\pi}$$ \quad (10)
where $R_s$ and $R_o$ are nominal returns on equity and bonds, respectively, before personal taxes; and $\tau_p$ is the overall effective personal income tax rate. Because of potential estimation problems, the current analysis examines the impact of inflation uncertainty on the expected risk premium (equation 10) rather than the value of the required return for common stocks. Of course, an increase in the expected risk premium is a sufficient condition for an increase in the real required return for common stocks.

III. The Empirical Analysis

III.1. Data Base

The source for the inflation and the risk premium data is the Livingston expectations surveys. For each semi-annual survey, individual respondents generated six-month forward forecasts for the Consumer Price Index and the stock market S&P 500 index. From these "level" predictions, the forecasted arithmetic average "rates" of inflation and the stock price changes can be computed; and interpreted as the market consensus for expected inflation rate and the expected stock market return, respectively.

The risk premium, $E^\hat{\gamma}[\Delta P_s/P_s - TB6]$, is obtained by subtracting the six-month Treasury bill rate (at the beginning of the survey month), TB6, from the expected stock market return, $E^\gamma[\Delta P_s/P_s]$.

The key estimated empirical relationships in the study depend upon the use of an appropriate surrogate measure for inflation uncertainty, $\sigma^2_s$. Unfortunately, for multifaceted reasons, no single surrogate measure is universally accepted as superior. Hence, alternative
widely-used surrogates for inflation uncertainty are employed for the analysis of the observed relationships between stock returns and inflation (see footnote 3). This approach, also, tests how robust the findings are with respect to variable specification.

Following other studies,\(^1\)! the cross-sectional variance of inflation forecasts, \(\sigma_t^2\), is used as a principal proxy for the measure of inflation uncertainty. In addition, two other proxies for inflation uncertainty are also used: (a) the inflation forecast errors from previous predictions, \(\text{FECPI}_t\), and (b) expected inflation rates, \(\hat{E}_t^\pi\).\(^2\)

Finally, the measure of real stock market uncertainty, \(\sigma_s^2\), is proxied by the variance of the "orthogonalized" part of the monthly realized real stock return (S&P 500) to the estimated monthly unexpected inflation rate from the six month sample period prior to each of the Livingston surveys, \(V_t(rs)\).\(^3\)

---

Insert Figure 1
---


Given the data base for the risk premium and the measures for inflation and real uncertainty, the empirical model analog for equation (10), the principal empirical-theoretical testing equation, will be equations (11):

\[
E_t^2[\Delta P_{s/P_s} - \text{TB6}] = c_0 + c_1V_t^2 + c_2V_t(rs) \tag{11-a}
\]

\[
E_t^2[\Delta P_{s/P_s} - \text{TB6}] = c_0 + c_1\text{FECPI}_{t-2} + c_2\text{FECPI}_{t-3} + c_3V_t(rs) \tag{11-b}
\]

\[
E_t^2[\Delta P_{s/P_s} - \text{TB6}] = c_0 + c_1\hat{E}_t^\pi + c_2V_t(rs) \tag{11-c}
\]
where $E$ is the expectation operator; its superscript "t" denotes Livingston forecasts; the subscript $t$ represents the month of the Livingston survey; the dependent variable is the risk premium; $V$ is the variance operator; $V(E^{t}[\pi])$ is the cross-sectional variance of the forecasted inflation rate; $^{21}$ FECPI is the forecast error of the inflation prediction (note that only observed forecast errors at the time of the survey $^{22}$ are present in equation 11-b; $E^{t}_{t}[\pi]$ is the expected inflation rate; and $V_{t}(rs)$ is the variance of monthly real stock returns (for the six month sample period prior to each of the surveys at time $t$) orthogonal to the estimated unanticipated inflation rate. Note that the intercept term is introduced into the regressions because the expected dividend yield is excluded from the dependent variable (see footnote 16).

The regression results for equation (11), reported in Table 1, $^{23}$ show that the risk premium increases when inflation uncertainty increases, resulting in relatively depressed stock prices during the recent inflationary period. These results are consistent across regressions, and robust with respect to various measures of inflation uncertainty.

For Table 1, the dividend yield implied by the negative sign for the intercept ($c_{0}$) is 3 to 4 percent on an annualized basis; Ibbotson and Sinquefield's [1982, p. 18] estimate of the annual average dividend yield for the corresponding period is 3.8 percent. The coefficient estimate for $V_{t}(rs)$, which may be interpreted as the market price of risk, $^{24}$ is also positive throughout the regressions. The positive, statistically significant coefficients for the inflation prediction forecast error variables are consistent with the hypothesis that investors have adaptive expectations.
In order to control for the possibility of temporal trends in equations (11), a time trend variable (TIME: 1955.06 = 0.01, etc.) has been introduced into the regressions. The regression results, after controlling for the possible time effect, are virtually unchanged.26

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INSERT TABLE 1
---

The findings in Table 1 strongly suggest that overall increases in economic uncertainty, both inflationary and real, have caused an increase in the real required returns for common stocks during the recent inflationary period. However, Poterba and Summers [1984] suggest that if the volatility of stock returns is not serially correlated, an increase in uncertainty is not likely to cause an increase in the real required return for equity. Following their suggestions, the autocorrelations of the uncertainty measures in this paper were examined (see, also, footnote 25). The results, reported in Table 2, show that only inflation uncertainty measures are significantly autocorreleated. This finding implies that an increase in inflation uncertainty is likely to be an important cause for the observed increase in the real required return for common stocks. This finding contrasts with Pindyck's [1984] claim: "any increase in the variance of inflation would have had a negligible direct effect on the variance of the net real return on equity (p. 340)," even though he attributes the decline in stock prices during the recent inflationary period to the increased variance of equity returns.

---

INSERT TABLE 2 HERE
---
Ceteris paribus, increasing risk over time, created by unanticipated events, tends to depress stock prices ex post, and thereby leads 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 Table 1, equations 11) implies a negative ex post relationship between the realized stock return and the change in inflation uncertainty. (This argument is expanded below in Sections III.3 and III.4). This implication is confirmed econometrically by the OLS regression, equation 12:

$$RS_t = 0.069 - 0.061 \Delta \log V(E_t^{2/\pi}) - 0.043 \Delta \log V_t(\text{rs})$$  
(4.793)(-2.121)  
(-3.166)

$$\text{Adj. } R^2 = 0.279, \ F = 8.729, \ DW = 2.235 \ (1960.06-80.06) \quad (12)$$

where $RS_t$ is the semi-annual log realized real return on the S&P 500 at the time of the survey; and $\Delta \log V(E_t^{2/\pi})$ and $\Delta \log V_t(\text{rs})$ are measures for the change in inflation uncertainty and real uncertainty, respectively. This finding also confirms the claimed "consistency" between the Livingston ex ante data and the market ex post data.


Portfolio choice theory indicates that the level of expected inflation itself, 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 (13), controlling for real and inflation uncertainty, confirm the anticipated results: expected inflation itself has no consequential impact on the risk premium. That is, an observable positive relationship between the ex ante risk premium and the level of expected inflation is "spurious" because of the uncertainty proxy effect of the inflation level. Furthermore, if one assumes that a change in the level of expected inflation reflects a change in inflation uncertainty, the results contained in equations (13) explain why ex post realized stock returns are negatively related to changes in the level of expected inflation.

\[
E_t^e \left[ \frac{\Delta P_s}{P_s} - \text{TB6} \right] = -0.012 - 0.949 E_t^e [\pi] + 5.906 V(E_t^e \pi) + 5.518 V_t^e (rs)
\]

\[
\begin{align*}
(-2.048) & \quad (-1.688) & \quad (2.943) & \quad (2.265) \\
\text{Adj. } R^2 = 0.505, & \quad F = 14.581, & \quad DW = 1.836 (1960.06-80.06) & \quad (13-a)
\end{align*}
\]

\[
E_t^e \left[ \frac{\Delta P_s}{P_s} - \text{TB6} \right] = -0.013 - 0.044 E_t^e [\pi] + 0.935 \text{FECPI}_{t-2}
\]

\[
\begin{align*}
(-3.304) & \quad (-0.143) & \quad (2.326) \\
+ 0.797 \text{FECPI}_{t-3} + 5.873 V_t^e (rs)
\end{align*}
\]

\[
\begin{align*}
(2.167) & \quad (2.471) \\
\text{Adj. } R^2 = 0.504, & \quad F = 11.156, & \quad DW = 1.774 (1960.06 - 80.06) & \quad (13-b)
\end{align*}
\]

III.4. Expected Inflation and Ex Post Stock Returns: Empirical Findings

The observed negative relationship between expected inflation at the beginning of the period and subsequently realized (ex post) stock
returns is averred to be "the most anomalous of the negative stock return-inflation relations (Fama [1981, p. 560])."

In the previous section, it was shown that the ex ante relationship is likely to be spurious because of a possible structural relationship between the level of inflation and the degree of inflation uncertainty. Likewise, the ex post relationship also can be explained by the same type of structural relationship.

The hypothesized structural relationship between the level of inflation and the degree of inflation uncertainty, $\rho$, can be represented by equation (14-a):

$$E_t \pi = \rho(\pi_t \sigma_t^2) \sigma_{\pi \pi_t}^2; \; \rho > 0$$

(14-a)

where $\rho$ is assumed to be monotonically non-decreasing function of the inflation level. Equation (14-a) is predicated on prior empirical work that suggests that inflation uncertainty begins to increase 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 (14-b) represents the dynamic relationship between the level of inflation and the degree of inflation uncertainty,

$$E_t \pi < \rho_t \text{ if } E_t \pi > h$$
$$E_t \pi > \rho_t \text{ if } E_t \pi < h$$

(14-b)
where the dot over the variable denotes the rate of its change; and \( h \) is the threshold level of inflation. The relationship between inflation uncertainty and stock returns can be expressed as equation (14-c).

\[
RS_t = \xi \cdot (\sigma_{\pi, t}^2 - \sigma_{\pi, t-1}^2); \quad \xi < 0.
\]  

(14-c)

By substituting equation (14-a) into equation (14-c) and factoring out expected inflation at time \( t-1 \), equation (14-d) is created.

\[
RS_t = \xi [(E_{t-1}^{\pi} - \hat{\pi}_t)/\rho_t]E_t^{\pi} = \xi \delta_t E_t^{\pi}
\]  

(14-d)

where the terms in the bracket are replaced by \( \delta_t \).

Given the hypothesized relationship of equation (14-b), \( \delta_t \) 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 (14-d), should be (given a negative \( \xi \)) 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, 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 3. In
general, the results suggest that the negative estimated coefficient
for expected inflation disappears when the sample period is charac-
terized by relatively high and unstable inflation.

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INSERT TABLE 3 HERE
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In order to investigate the relationship of the magnitude of the
estimated coefficient for expected inflation with the level of and the
instability of inflation, the regression coefficient estimate, COEF
(the estimated coefficient from Table 3 of the monthly Treasury Bill
rate for the simple real stock regression, $R_s_t = a + COEF \times TB_l_{t-1}$),
is regressed on the measures for the level of and instability of infla-
tion. The empirical results for these analyses are shown as equations
(15). The subscript $j$ in equations (15) denote the sample period $^27$ 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. The findings contained in equations (15) are consistent
with the earlier interpretation of the results in Table 3; and lend
support to the position that the observed negative relationships be-
tween expected inflation and subsequent stock returns are statistical
artifacts $^28$

\[
COEF_j = -17.523 + 781.892 AVINF_j + 13.050 VARINF_j \\
(-7.881) \quad (3.442) \quad (1.636)
\]

\[
\text{Adj. } R^2 = 0.333, \quad F = 7.495 \quad \text{(15-a)}
\]
\[ \text{COEF}_j = -20.203 + 19.638 \ \text{AVDINF}_j \]
\[ (-8.961) (2.562) \]
\[ \text{Adj. } R^2 = 0.176, \ F = 6.562 \quad (15-b) \]

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. 29

The positive relationship between the risk premium and inflation uncertainty implies that \( b_s \) is less than \(-1\), assuming \( a_s = S/V = 2/3 \) (see equation 9). In section II, \( b_s \) is expressed as \( \theta_p \theta_c b_a V/S + D/S - g_c V/S \) \( -g_p \); and thereby \( b_a \) is less than \((-2 + 3\theta_p g_c + 2g_p - \theta_c)/3\theta_p \theta_c \). Therefore, if pseudo nominal capital gains are completely taxed, \( (g_p = t_p \text{ and } g_c = t_c) \), \( b_a \) is approximately less than \(-1.5 \) (assuming that \( \theta_p = .75 \text{ and } \theta_c = .5 \)). In the other extreme case where nominal capital gains are not taxed at all \( (g_c = g_p = 0) \), \( b_a \) is less than \(-2.0 \).

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 profit or net operating income is likely to be a principal cause for the depressant effect of inflation on stock prices. 30 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 expectations about pre-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 of inflation uncertainty on real economic activity has been well recognized in macroeconomic studies. As would be expected from this paper's result, a 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. This behavior of corporate managers in the volatile inflationary environment is justified by Vining and Elwertowski's [1976] empirical work about changes in individual prices and general inflation. 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.

Finally, this paper's findings suggest that the "irrational behavior" hypothesis in Modigliani and Cohn [1979] may not be
supportable; rather, 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. 32
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. See Lucas [1973], Barro [1978], Friedman [1977], and Cukierman and Wachtel [1979], among others. The adverse effect of uncertain inflation is perhaps best summarized by Friedman's Nobel Laureate Lecture: inflation uncertainty reduces the efficiency of the price system because "the harder it becomes to extract the signal about relative prices from the absolute prices (p. 467)," the greater inflation uncertainty is.

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. More seriously, Fama [1981] himself presents non-spurious negative relationships between unexpected inflation and stock returns in spite of controlling for real activity variables. This finding alone contradicts his proxy effect hypothesis. Also, Ram and Spencer [1983], in response to Fama, showed even positive relationships between real activity measures and inflation. Standard textbook IS-LM analysis suggests that increased inflation, ceteris paribus, is consistent with increased real output.

7. For example, Rogalski and Vinso [1977] showed a "bi-directional" causality between stock returns and money supply.

8. See Dokko and Edelstein [1985].

9. The personal income tax rate across individuals is assumed to be constant.

10. 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 consunmation-saving decisions because of perceived changes in price uncertainty. The asset return generating function should be viewed as a reduced form of the production and demand functions; and, thus, a two-factor return generating process for the firm's asset real return is assumed.

11. For analytic convenience, a 100% dividend payout ratio is implicitly assumed. Consideration of retained earnings (and, thus, "real" capital gains due to growth opportunity) is eliminated in order to focus on the effect of "pseudo" profit taxes ($g \pi V$ and $g \pi s$) on the stock price.

12. The marginal utility of end-of-period wealth, in the first-order condition for (6), is expanded in a Taylor series about the mean of end-of-period 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 (10) can be used to derive the "generalized" Fisher equation for nominal stock returns which has $E[R]$ as the dependent variable. Empirically, it is difficult to estimate the generalized Fisher equation because the real interest rate may not be constant over time (for example, see Startz [1981]) or may be correlated with inflation (for example, see Mundell [1963] and Sargent [1972]). Therefore, the Fisher equation for stock returns should be estimated as part of a set of structural equations (e.g., in a macroeconomic model, see Levi and Makin [1978]).

15. There has been some controversy about the usefulness of the Livingston data. However, the recent work by Brown and Maital [1981], explicitly recognizing the survey's structural break around 1960, supports the rationality of the survey participants' forecasts of inflation and stock market returns for the post-1960 period. Therefore, the ex ante surveys seem to be more reasonable than ex post data series "constructed" upon a rationality assumption. Moreover, the Livingston surveys seem to be appropriate to represent the overall market; according to Ahlers [1977], the institutions with which the respondents were affiliated have accounted for more than sixty percent of all stock market exchange trading during the late 1960's and through the early 1970's. Details about the Livingston data base and estimation procedure can be obtained by contacting the authors.

16. The survey participants provide only the predicted level of the stock market price index at the end of the forecasting horizon. As will be seen later, the exclusion of the dividend yield from the dependent variable is inconsequential to the results about the effect of inflation uncertainty on the risk premium.
17. Cukierman and Wachtel [1979] present formal proof that the cross-sectional variance measure is closely related to 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.

18. When prior forecast errors are realized (ex post), it seems intuitively appealing that ceteris paribus the future should appear relatively more uncertain. Considering the asymmetry in psychology of inflation, one should distinguish between inflation uncertainty and deflation uncertainty. Hence, the absolute values of forecast errors appear to be an inappropriate proxy for "inflation" uncertainty.

19. The use of expected inflation as a proxy of inflation uncertainty might occur when, as discussed in Section II, the level of expected inflation is highly intercorrelated with factors affecting unexpected inflation. In particular, there appears to exist a structural relationship between the level of inflation and the degree of inflation uncertainty; so one needs to separate inflation uncertainty out of expected inflation when examining the effects of the interrelated factors (e.g., the real interest rate). For empirical findings about the 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], and Holland [1984]. Holland [1984] provides a concise survey of most of these studies. 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.

20. The monthly unexpected inflation rate was estimated by the residual, \( \pi^u \), of the following regression for the 1951.12 - 80.05 period:

\[
\pi_j = \alpha_0 + \sum_{i=1}^{12} a_{1i} \pi_{j-i} + \sum_{i=1}^{6} a_{2i} GMB_{j-i} + \sum_{i=1}^{3} a_{3i} RS_{j-i} + a_{4} TBL_{j-1} + \pi^u_j
\]

where \( \pi \) is the monthly CPI inflation rate; GMB is the monthly growth rate of the monetary base (source: Federal Reserve Bank of St. Louis); RS is the monthly realized real return for S&P 500; TBL is the one month Treasury-bill rate. After monthly unexpected inflation rate were estimated, RS is regressed on the corresponding
\[ \pi^u: \quad RS_j = b_0 + b_1 \pi_j^u + x_j. \] The variance of \( x \) is used as a proxy for \( \sigma_s^2 \). For \( \sigma_s^2 \), other alternatives (such as cross-sectional variances of Livingston forecasts for stock market returns and growth rates of the industrial production index) were also used. But these alternative measures for real uncertainty were completely dominated by inflation uncertainty measures.

21. Since \( \nu(\pi^2) \) is a relatively small number, it has been scaled multiplying by 100.

22. Let the subscript \( t-1 \), for example, represent the December 1980 survey. \( FECP_{t-1} \) 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.

23. Evidence of the rationality and the informational efficiency of the Livingston survey data for the post-1960 period (Brown and Maital [1981]) indicate a potential structural break in the Livingston data around 1960. Therefore, the regression results for the estimated equations 11, Table 1 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.

24. Assuming that \( \alpha_\pi = 2/3 \) and \( \tau_H = 0.3 \). The coefficient estimate of \( \nu(\pi^2) \), from 5.7 to 8.9, is consistent with Friend and Hasbrouck's [1982b] and Pindyck's [1984] estimate which is about 6.

25. \[ \nu(\pi^2) = c_0 + 0.12 \text{ TIME}_t \quad (5.41) \]
   \[ \nu(\pi^2) = c_0 + 0.08 \text{ TIME}_t \quad (15.18) \]
   \[ \nu(\pi^2) = c_0 + 0.003 \text{ TIME}_t \quad (2.04) \]

   where \( t \)-statistics are in parentheses and \( \text{TIME} \) is the time trend variable (e.g., 1955.06 = .01, etc.)

26. When \( \text{TIME} \) is present into the regression, the intercept term has no implication.

27. 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.

28. Geske and Roll [1983] suggest 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.

29. 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.

30. 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). But Pindyck suggests that the effect of inflation uncertainty on the gross return on capital is negligible; and that volatility of inflation "makes bonds relatively riskier, and should therefore increase share values (p. 336)." But Pindyck's suggestion is also a tautological result from the assumption that the variance of the real return on capital is independent of the variance of inflation (see his equation 5).

31. See, also, Parks [1978].

32. In accordance with our findings, changes in inflation uncertainty may affect the value of the firm (equity plus debt) through two interrelated effects: (i) expected pre-tax corporate profits decline and (ii) the real required rate of return increases. The impact of these effects on nominal corporate debt depends upon the change in the real required rate of return. Even if the real value of corporate debt were to decline, thereby increasing the capitalized value of equity of the firm ceteris paribus, the effects of changes in corporate pre-tax profits and/or the real required rate of return could offset the net debt effect. Also, see Bokko [1985].
REFERENCES


### Table 1
Relationships Between the Risk Premium and Inflation Uncertainty, June 1960 Through June 1980

<table>
<thead>
<tr>
<th>Equation</th>
<th>Eq.</th>
<th>( c_0 )</th>
<th>( c_1 )</th>
<th>( c_2 )</th>
<th>( c_3 )</th>
<th>Adj R²</th>
<th>F</th>
<th>DW</th>
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<tbody>
<tr>
<td>11-a-1*</td>
<td></td>
<td>-0.016</td>
<td>4.242</td>
<td>--</td>
<td>--</td>
<td>0.331</td>
<td>20.277</td>
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<td></td>
<td></td>
<td>(-2.774)</td>
<td>(4.503)</td>
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<td></td>
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<td></td>
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<tr>
<td>11-a-2</td>
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<td>-0.019</td>
<td>2.852</td>
<td>6.642</td>
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<td>0.480</td>
<td>19.497</td>
<td>1.765</td>
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<tr>
<td></td>
<td></td>
<td>(-4.296)</td>
<td>(3.205)</td>
<td>(2.768)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>11-a-3</td>
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<td>-0.002</td>
<td>4.428</td>
<td>5.691</td>
<td>-0.693</td>
<td>0.502</td>
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<td>1.876</td>
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<tr>
<td></td>
<td></td>
<td>(-0.135)</td>
<td>(3.402)</td>
<td>(2.351)</td>
<td>(-1.630)</td>
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</table>

<table>
<thead>
<tr>
<th>Equation</th>
<th>Eq.</th>
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<th>( c_1 )</th>
<th>( c_2 )</th>
<th>( c_3 )</th>
<th>( c_4 )</th>
<th>Adj R²</th>
<th>F</th>
<th>DW</th>
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<tbody>
<tr>
<td>11-b-1</td>
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<td>-0.015</td>
<td>1.304</td>
<td>0.974</td>
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<td>--</td>
<td>0.450</td>
<td>17.377</td>
<td>1.837</td>
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<td></td>
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<td>(-3.511)</td>
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<td>(2.861)</td>
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<td></td>
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<tr>
<td>11-b-2</td>
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<td>0.908</td>
<td>0.775</td>
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<td>--</td>
<td>0.480</td>
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<td>1.776</td>
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<tr>
<td></td>
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<td>(2.588)</td>
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<td>(2.501)</td>
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<td>0.505</td>
<td>11.200</td>
<td>1.780</td>
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<td></td>
<td></td>
<td>(-1.564)</td>
<td>(2.534)</td>
<td>(2.323)</td>
<td>(2.470)</td>
<td>(-0.317)</td>
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</table>

<table>
<thead>
<tr>
<th>Equation</th>
<th>Eq.</th>
<th>( c_0 )</th>
<th>( c_1 )</th>
<th>( c_2 )</th>
<th>( c_3 )</th>
<th>Adj R²</th>
<th>F</th>
<th>DW</th>
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</thead>
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<tr>
<td>11-c-1*</td>
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<td>-0.016</td>
<td>0.950</td>
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<td>0.127</td>
<td>6.656</td>
<td>1.665</td>
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<td></td>
<td>(-1.815)</td>
<td>(2.580)</td>
<td></td>
<td></td>
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<tr>
<td>11-c-2</td>
<td></td>
<td>-0.021</td>
<td>0.542</td>
<td>8.902</td>
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<td>0.405</td>
<td>14.599</td>
<td>1.745</td>
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<tr>
<td></td>
<td></td>
<td>(-3.616)</td>
<td>(2.032)</td>
<td>(3.782)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>11-c-3</td>
<td></td>
<td>0.007</td>
<td>1.706</td>
<td>7.663</td>
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<td>0.438</td>
<td>11.408</td>
<td>1.946</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.429)</td>
<td>(2.461)</td>
<td>(3.211)</td>
<td>(-1.810)</td>
<td></td>
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</tr>
</tbody>
</table>

† 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

AUTOCORRELATION FUNCTIONS OF THE UNCERTAINTY MEASURES, JUNE 1960 TO JUNE 1980

<table>
<thead>
<tr>
<th>Variable</th>
<th>Order of Autocorrelation</th>
<th>Adjusted Box-Pierce Q-Statistic to lag 10†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>$V(E_t^2)$</td>
<td>0.760</td>
<td>0.573</td>
</tr>
<tr>
<td>FECPI</td>
<td>0.348</td>
<td>0.418</td>
</tr>
<tr>
<td>$E_t^2(\pi)$</td>
<td>0.855</td>
<td>0.719</td>
</tr>
<tr>
<td>$V_t(rs)$</td>
<td>0.057</td>
<td>0.064</td>
</tr>
</tbody>
</table>

†: To test the joint hypothesis that all of k auto-correlation coefficients are zero, Q-statistic introduced by Box and Pierce can be used. The Q-statistic is approximately distributed as chi-square with k degrees of freedom. The critical value of the chi-square distribution with 10 degrees of freedom is 4.865 at the conventional 10% significance level.
<table>
<thead>
<tr>
<th>Panel A. ( (R S_{t} = c_0 + c_1 E_{t-1}^{2} \pi_t) )</th>
<th>Panel B. ( (R S_{t} = c_0 + c_1 TB_{t-1}) )</th>
<th>Panel C. ( (R S_{t} = c_0 + c_1 TB_{t-1}^3) )</th>
<th>Panel D. ( (R S_{t} = c_0 + c_1 TB_{t-1}^2) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eq.</td>
<td>Period</td>
<td>( c_1 )</td>
<td>(t-stat)</td>
</tr>
<tr>
<td>1.</td>
<td>55.I-65.II</td>
<td>-18.57</td>
<td>(-2.30)</td>
</tr>
<tr>
<td>2.</td>
<td>66.I-73.II</td>
<td>-5.75</td>
<td>(-0.86)</td>
</tr>
<tr>
<td>3.</td>
<td>74.I-80.I</td>
<td>3.68</td>
<td>(0.73)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. ( (R S_{t} = c_0 + c_1 TB_{t-1}) )</th>
<th>Panel C. ( (R S_{t} = c_0 + c_1 TB_{t-1}^3) )</th>
<th>Panel D. ( (R S_{t} = c_0 + c_1 TB_{t-1}^2) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eq.</td>
<td>Period</td>
<td>( c_1 )</td>
</tr>
<tr>
<td>1.</td>
<td>59.I-65.II</td>
<td>-7.22</td>
</tr>
<tr>
<td>2.</td>
<td>66.I-73.II</td>
<td>-6.89</td>
</tr>
<tr>
<td>3.</td>
<td>74.I-80.I</td>
<td>0.37</td>
</tr>
</tbody>
</table>

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

\[ RS_t = \pi_t \] \#-month real return on the S&P 500.
\[ TB_t = \#-month Treasury-bill rate. \]
\[ \pi_t \] six-month Livingston expected inflation rate.
FIGURE 1

TIME-SERIES OF $\varepsilon^t[\Delta P_s/P_s - \text{TB6}]$ AND $V(\varepsilon^t)$

SURVEYS FROM JUNE 1955 TO JUNE 1980