Disinflation, Equity Valuation, and Investor Rationality

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Introduction

Until the early 1960s, economists largely ignored the effect of inflation on the prices of corporate equities. Since revenues and costs were thought to be proportionately affected by changes in the price level, profits would expand so as to keep pace with inflation. As residual claims to the earnings of corporations, equities were seen as partial, if not complete, hedges against the effects of inflation.

In the late 1960s and early 1970s, this notion was shattered. Despite a 95.2 percent rise in the consumer price index (CPI) from the end of 1966 to the end of 1977, the Standard & Poor's Stock Index rose only 2.4 percent. The 52.5 percent decline in the real value of equities over this period led to the development of many theories to explain the relationship between equity prices and inflation.

Among the most widely received theories was one offered by Franco Modigliani and Richard Cohn (1979). They claimed that investors make valuation errors by ignoring the gains debtors experience from inflation and therefore use the wrong measure of profits in pricing equities. Since inflation implies that the principal of the loan will be paid back in "cheaper" dollars, lenders require an inflation premium in the coupon on the loan. This suggests that a part of the firm's debt service is used to maintain the real value of the firm's debt and should not be treated as an expense. Traditional accounting measures, however, treat the entire debt service as an expense. Modigliani and Cohn claimed that the measure of "true profits" consistent with rational valuation would equal accounting profits, plus the portion of the interest expense attributable to inflation.

They reasoned that a more serious investor error involves the comparison of the discount rate for a pure equity stream with nominal, rather than real, interest rates. In figure 1 we present a time-series plot of the nominal interest rate on Aaa-rated corporate bonds and the earnings/price ratio of stocks in the Standard & Poor's Stock Index. At least since 1960, these two series track one another well. Because long-term nominal interest rates are thought to be largely determined by inflation expectations, this comparison by investors further erodes the level of stock prices in an inflationary environment.

Modigliani and Cohn showed that, in the absence of market imperfections, the real value of the firm should remain unaffected by anticipated inflation. Using a statistical model, they found that investors had indeed committed one or both forms of valuation error.

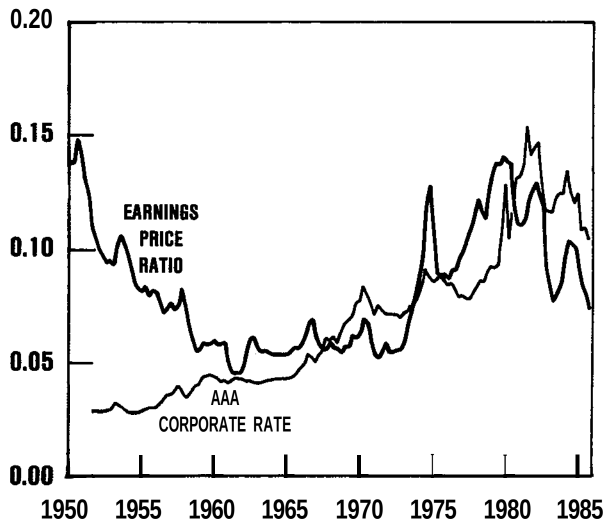
In this paper, we review the model introduced by Modigliani and Cohn and the alternative analyses of other investigators. We then evaluate those analyses by examining the behavior of the rate of return required on equities from 1953 to 1985. Surprisingly, we find little evidence of valuation errors. In particular, we note that when reported earnings are adjusted in the manner prescribed by Modigliani and Cohn, capitalization rates for equities appear to follow real interest rates, though they may also respond to factors related to aggregate risk.

I. A Fundamental Valuation Model

Fundamental equity valuation models assume that the goal of the firm's management is to maximize stockholders' wealth. Projects are accepted only if they increase the market value of the equity, that is, if the present discounted values of the expected net cash flows from new projects are positive. The market value of the firm's equity is found by discounting the cash flows distributed to stockholders at the rate stockholders could earn on alternative investment flows of equivalent risk.[1] The distribution to stockholders, or dividend, equals profits (revenue, less operating expenses and investment expenditures) minus interest payments on the firm's debt.

Following Modigliani and Miller (1958), we make assumptions sufficient to derive an expression for the value of the firm's equity: a) capital markets are frictionless, that is, participants can borrow or lend at the riskless rate of interest and there are no taxes; b) the social costs of bankruptcy are zero; c) all firms are in the same risk class; and d) equity and default-free debt are the only types of claims on firms.

EARNINGS/PRICE RATIO FOR THE S&P STOCK INDEX AND MOODY'S Aaa-CORPORATE RATE



SOURCE: Moody's Investors Service; and Standard & Poor's Corp.

FIGURE 1

The value of an unlevered (all equity) firm at date t, $V^u(t)$, with expected adjusted profits X is found by discounting the firm's expected available net cash flow at the rate that is appropriate for the firm's risk class (ρ).[2] Viewing the firm as an ongoing concern with a perpetual income stream X, its value is given by:

(1) $V^u(t) = X/\rho$

Note that if the adjusted profits of the firm are expected to grow continually at a rate g, the firm's value can be represented as:

(2) $V^u(t) = X/(\rho - g)$

Given the above assumptions, Modigliani and Miller go on to show that a firm's value is independent of its capital structure. That is, rational investors will ignore the effects of the firm's borrowing and base their valuation on the firm's cash flow from operations. The levered firm's total market value, $Vl(t)$, is defined as the sum of the market values of equity, $S(t)$, and debt, $D(t)$:

(3) $V^l(t) = S(t) + D(t)$

The adjusted profits available for distribution to the stockholders of a levered firm differ from an unlevered firm's adjusted profits at date t, $X(t)$, by the firm's interest expense, $rD(t)$. The expected rate of return to the levered firm's stockholders, i, is simply:

(4) $i = [X(t) - rD(t)]/S(t)$

Combining equations (1) and (3), Modigliani and Miller's Proposition 1 states that:

(5) $X(t) = \rho[V^l(t)] = \rho[S(t) + D(t)]$

Substituting (5) into (4) and allowing for earn. ings growth at rate g gives:

(6) $i = \rho + (\rho - r)d - g,$

where $d = D(t)/S(t)$, is the firm's debt-equity ratio. The value of the equity of a levered firm can then be found by discounting the income stream available to stockholders at the appropriate rate (given by equation [6]). That is:

(7) $S(t) = [X(t) - rD(t)]/[\rho + (p-r)d - g]$

Following Modigliani and Cohn, suppose that at time $t = 0$ there is no inflation and that immediately thereafter fully anticipated inflation begins at the rate p and continues forever. Adjusted prof-

1 This should be distinguished from the so-called book value of equity. found by subtracting the book value of liabilities from the book value of assets.

2 'Adjusted profits' refer to after-tax reported profits adjusted for the effects of inflation on inventory valuation and the value of actual depreciation deductions. In the NIPA these adjustments are referred to as 'IVA' and 'CCadj,' respectively. They are based on corporate tax records and assumptions about asset lives and replacement costs. For a discussion of the NIPA adjustment, see Grimm (1982). A problem with applying this adjustment to the S&P reported earnings index is that the NIPA profits measure is based on "book" profits which vary somewhat from reported earnings, especially after 1981.

its will rise continuously at the rate of inflation so that at any date t, the unlevered firm's profits, $X(t)$ will equal $X(0)e^{pt}$. From equation (1), the value of the unlevered firm at date t, $V^u(t)$, equals $V^u(0)e^{pt}$. In other words, the realvalue of the unlevered firm will not be affected by fully anticipated inflation. Rationally priced equity claims on such a firm are complete inflation hedges.

Conventional accounting measures of a levered firm's profits are distorted by inflation. Accounting profits equal operating income, minus nominal debt expense. Assume that the nominal interest rate (R) is approximately equal to the sum of the real interest rate (r) and the expected inflation rate (p) and that the firm's debt remains fixed in real terms ($D[t]$ equals $D[0]e^{pt}$).[3] Also assume that the firm's debt is structured so that it always pays the current rate of interest. The levered firm's accounting profits, Π, can then be written as:

$$\begin{aligned} \Pi(t) &= X(t) - RD(t) \\ (8) \quad &= [X(t) - (r+p)D(t)] \\ &= [X(0) - rD(0)]e^{pt} - pD(0)e^{pt} \end{aligned}$$

The firm's accounting profits have been expressed in this form to illustrate the following essential points. 1) The portion of reported interest expense attributable to inflation, $pD(0)e^{pt}$, should be added back to accounting profits to yield "true" profits. 2) At high enough inflation rates, accounting profits may become negative.[4]

True profits, Π^*, will therefore increase at the fully anticipated inflation rate. That is:

$$\begin{aligned} \Pi^*(t) &= \Pi(t) + pD(0)e^{pt} \\ (9) \quad &= [X(0) - rD(0)]e^{pt} \end{aligned}$$

Substituting the levered firm's true profit stream Π^*, into equation (7), we have:

$$(10) \quad S(t) = \Pi^*(t)/[\rho + (\rho - r)d - g]$$

Equation (10) therefore indicates that the *real* value of a firm's equity is unaffected by inflation. Now substituting for accounting profits and rearranging, equation (10) becomes:

$$(11) \quad [\Pi(t) + pD(t)]/S(t) = \rho + (\rho - r)d - g$$

This expression reduces to:

$$(12) \quad \Pi(t)/S(t) = \rho + (\rho - r)d - pd - g,$$

or,

$$(13) \quad S(t) = \Pi(t)/[\rho + (\rho - r)d - pd - g]$$

Equation (13) shows that, although the real value of a firm's equity should be unaffected by inflation, accounting earnings must be adjusted for inflation's effect.

Modigliani and Cohn hypothesized that investors failed to incorporate inflation in their valuations of equities. They tested this hypothesis by regressing a measure of stock prices on variables that enter either the numerator or the denominator on the right-hand side of expression (13). Their estimate of the coefficient on inflation implied systematic misvaluation. In our attempts to replicate the results of Modigliani and Cohn, however, we found that the results were sensitive to assumptions regarding lag distributions used to construct proxies for ex-ante, or expected, values of key variables. In addition, our attempts to replicate the results of Modigliani and Cohn yielded a coefficient on inflation that differed from their estimate (see Appendix). Rather than update their empirical work, we take a different approach to evaluating the performance of Modigliani and Cohn's model.[5]

We utilize observable, ex-post observations on each of the relevant variables to simulate the model, calculating implied values for p, the required real rate of return of a pure equity stream. To the extent that our measures of greflect expectations, our estimate of ρ is an *ex-ante* required rate of return on a pure equity stream. Consequently, p is analogous to a real interest rate, adjusted for the risk in equity and the fact that the security is a perpetuity.

By focusing on the time-series values of ρ, implied by the model rather than the predicted equity values, we avoid much of the controversy surrounding equity valuation having to

3 If, as finance theory suggests, investors are concerned with after-tax real rates of return, then one could replace $R=r+p$ with $R^*=R(1-\tau)=r+p$, where τ is the marginal tax rate on interest income. Clearly, fixing r implies that the change in R* due to a change in p is not 1 for 1. This relates to Hendershott's (1981) argument discussed below.

4 An additional factor that is thought to offset the inflation-induced gain from debt service, $pD(0)e^{pt}$, is the possible increase in the firm's pension obligations. This argument requires that inflation be unanticipated and is relevant only for defined-benefitpension plans (currently comprising roughly 75 percent of all pension assets). A defined-benefit pension is one in which contributions are determined by the benefits they will eventually yield. The obligation of the firm to restore underfunded pensions, however, rests in part on the nature of the firm's contract with labor. Feldstein and Morck (1983) find that the stock market appears to react favorably to firms with overfunded pensions and negatively to underfunded pensions. They note, however, that most large, well-managed firms have traditionally had overfunded pensions.

5 An empirical update of Modigliani and Cohn is presented by Townsend (1986).

do with the appropriate form of the discount rate.[6] The advantage of this approach is that we are able to see how ρ varies over time and, in particular, if it is correlated with inflation or real interest rates. This does not contradict the assumption that at any point in time, all variables in the denominator of (13) are expected to remain constant forever. While Modigliani and Cohn assumed that ρ is not affected by inflation, the theories discussed below allow ρ to be related to many factors, including the rate of inflation.

In order to isolate ρ we can rewrite equation (13) as:

$$(14) \quad \rho = \frac{\frac{\Pi(t)}{S(t)} + (r+p)d + g}{1 + d}$$

Using the definition of the nominal interest rate, *R*, we have:

$$(15) \quad \rho = \frac{\frac{\Pi(t)}{S(t)} + Rd + g}{1 + d}$$

Equation (15) shows the relation between the required real rate of return on a pure equity stream in a given risk class and mostly observable variables. The only unobservable variable is the expected growth rate of reported profits. The variable ρ may be viewed as a modified earnings/price ratio, adjusted for inflation, leverage, and earnings growth.

II. The Determinants of ρ

Below we discuss three theories of the determination of the cost of a pure equity stream. Two of the explanations given for the behavior of ρ focus on a risk premium, while the third considers the relation between ρ and the real rate of return on bonds.

In trying to explain the behavior of the stock market in the mid-1970s, Burton Malkiel (1979) adjusted corporate profits for inflation's effect on corporate debt and found them to be steady in low- and high-inflation periods. He argued that the decline in real stock prices was caused by an increase in the risk premium embodied in the rate of return required by stockholders. The increased risk premium was due to economic developments of the early 1970s that led to a departure from the relative stability of the 1960s. He reasoned that investors thought policymakers could no longer "fine tune away" economic fluctuations and that long-run planning involved greater uncertainty. Although profits rose with the price level, their dispersion across industries also rose, in turn raising business risk. The rising use of debt financing was another source of increased risk for the financial system. Finally, rising government regulation may have been perceived as reducing profitability.

As evidence supporting the perception of increased risk, Malkiel cites the rise in the "risk spread" between anticipated returns on equities and long-term government bonds, as well as between the yields on Baa-rated corporate bonds and government bonds. These widening spreads throughout the 1970s may suggest that investors believed the credit quality of firms was falling. According to Malkiel's findings, we would expect to see a path for ρ that starts out low in the '50s and '60s and then turns higher in the mid-to-late 1970s.

A related theory of the behavior of ρ involves the possibility of a disinflationary distress premium: real required rates of return on pure equity streams rise in a climate of disinflation. Firms may be under greater strain in a disinflationary environment as they are often unable to match declines in revenue with declines in expenses.[7] This is particularly evident following a period of prolonged high inflation. Extreme examples of the upheaval associated with disinflation can be found in the oil and steel industries. Further, corporate defaults have generally been higher in disinflationary periods than in inflationary periods.[8] This hypothesis implies that stockholders will require a premium whenever there are large reductions in inflation in order to compensate them for the increased credit risk. By this hypothesis, ρ should fall with increases in inflation and rise with disinflation.

Hendershott (1981) attributes the valuation error noted by Modigliani and Cohn solely to investors' comparisons of the expected real yield on equities, ρ, with the nominal yield on bonds. He claims that Modigliani and Cohn's

6 The emphasis on ρ is also justified by the implications of work done by Shiller (1981) and others on the volatility of dividends and stock prices. The literature on stock volatility suggests that profits have much lower variances than stock prices. Thus, variation in ρ and other factors influencing the rate at which profits are discounted could be expected to account for much of the variation in stock prices.

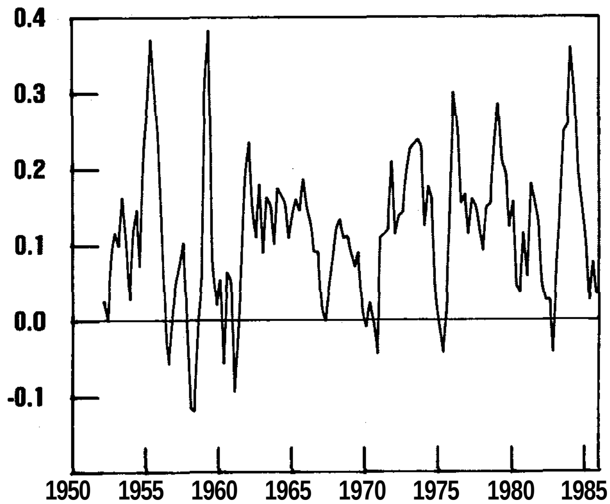
7 This may be due to the existence of fixed labor and supply contracts. A simple model introduced by Wadhwani (1986), on the other hand, suggests that the inflation premium in a levered firm's debt service causes nominal debt expense to increase proportionately more than nominal revenue during inflation, forcing the firm to report lower accounting profits. Conversely, this expense will decrease more than proportionately during disinflation, resulting in higher reported, or accounting, profits.

8 Fons (1986) investigates the correlation between "unanticipated changes in the consumer price index and a measure of expected corporate default rates embodied in yield spreads. Though not statistically significant, the relationship between inflation surprises and an implied default premium on low-rated corporate debt is negative.

model implies that the after-tax real bond yield falls as a result of inflation, while nominal yields remain constant. Since bonds and equities are substitute assets, the fall in the after-tax real yield on debt would lower the rate of return required by stockholders. The decline in the required yield on equity offsets the overpayment of taxes resulting from the inflation-induced understatement of depreciation and inventory costs (see discussion of Feldstein [1980] below), or increased risk premia noted by Malkiel, leaving the nominal value of stocks essentially unchanged. Hendershott claimed that there were other factors responsible for the decline in the real value of equities. First, there was a decline in savings due to lower real after-tax yields. Second, there was a decrease in the productivity of new capital due to higher regulatory costs and higher energy prices. In addition, Hendershott felt that an increase in the realized rates of return on noncorporate assets, such as residential housing, may have induced investors to reduce their holdings of debt and equity.

By Hendershott's reasoning, ρ should decline in inflationary periods and rise with disinflation. Declines in productivity, however, would be reflected in a lower expected growth rate of earnings (g).

COMPUTED p SERIES WITH ONE-PERIOD ACTUAL EARNINGS GROWTH



SOURCE: Figures 2, 3, and 4 author's calculations.

FIGURE 2

III. Data & Methodology.

Quarterly observations for the period covering 1953 through 1985 on each of the following data series were used to construct estimates of ***p***: adjusted earnings per share, stock prices, nominal corporate interest rates, aggregate debt-equity ratios, and earnings growth. The values for stock prices and earnings were taken from the Standard & Poor's Index. The price index, based on as many as 500 different equities mostly traded on the New York Stock Exchange, is constructed in such a way that, when divided into the associated earnings index, the unwanted weighting factor cancels. The earnings-per-share index is constructed from the reported earnings over the past four quarters of the firms in the corresponding stock index. We adjust for inflation-caused inventory valuation and depreciation errors by multiplying the earnings index by the ratio of adjusted-to-reported after-tax profits found in the National Income and Product Accounts (NIPA) (see footnote 2).

The interest rate on corporate borrowings is measured as Moody's cross-sectional average yield on single A-rated bonds. This rating corresponded to the average quality rating (in terms of par value) of all publicly traded corporate debt as of December 1985. As was previously discussed, the nominal interest rate embodies inflation expectations. In using this measure, we avoid the problems encountered by Modigliani and Cohn in constructing an econometric proxy for expected inflation.

The debt-equity ratio for nonfinancial corporations, *d*, was constructed from two sources. Data covering 1953 to 1961 was taken from Von Furstenberg (1977), in which the market value of debt is inferred from a present value relation. The 1961 to 1985 series for the market values of corporate debt and equity were constructed by the Board of Governors of the Federal Reserve System. In this case, the market value of debt is found by pricing all mortgages and long-term bonds at the average price of bonds traded on the New York Stock Exchange, ignoring such nontraded items as deferred taxes, leases, and pension obligations. An attempt was made in the estimation of the market value of equity (the listed values on all exchanges, times the number of corresponding shares outstanding) to avoid the double counting of firm ownership through stock holdings.

The computation of p involves assumptions about the process generating the parameter *g*. One extreme is to let g assume its realized value equal to the annualized growth rate of four-quarter reported earnings for each period. The volatile behavior of g and p when ***g*** is measured this way can be seen in figure 2. We feel that such erratic movement in g is unreasonable since, in theory, g is the expected perpetual growth rate of earnings. Presumably this precludes g from being negative.

An alternative way to measure g is to utilize a time-series model to construct an in-sample one-period-ahead forecast of earnings growth. We modeled the quarterly growth of four-quarter earnings as following an ARMA(1,1) process. Using the forecast for g at each date in the calculation of p yields the time-series plot of p presented in figure **3.** This series is only slightly less volatile than the series constructed from actual growth rates.

COMPUTEO p SERIES WITH ARMA(1,1) EARNING GROWTH

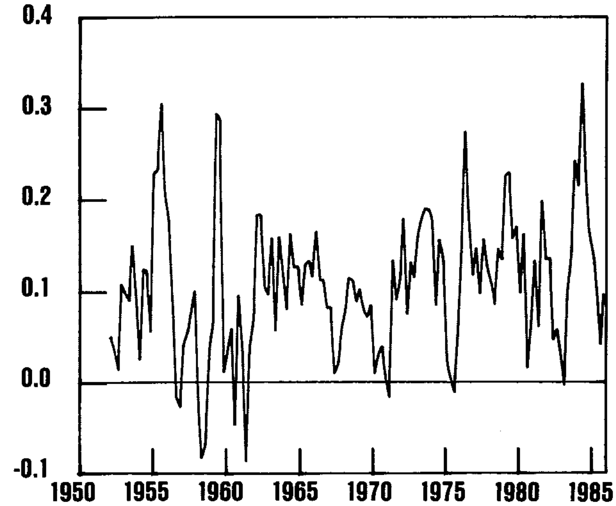


FIGURE 3

A third alternative is to fur the growth rate of earnings at its average value over the entire sample period, 6.4176 percent.[9] This procedure may be justified on the grounds that investors somehow possess perfect foresight of earnings growth and that they ignore short-run fluctuations. The infinite-horizon nature of the estimated model requires an unbiased estimate of perpetual earnings growth. It is possible, with the S&P data, to construct an estimate based on earnings growth as far back as 1926. The inclusion of a persistent recession and a major war, however, would likely result in a less satisfactory estimate of expected earnings.

COMPUTED p SERIES WITH FIXED EARNINGS GROWTH

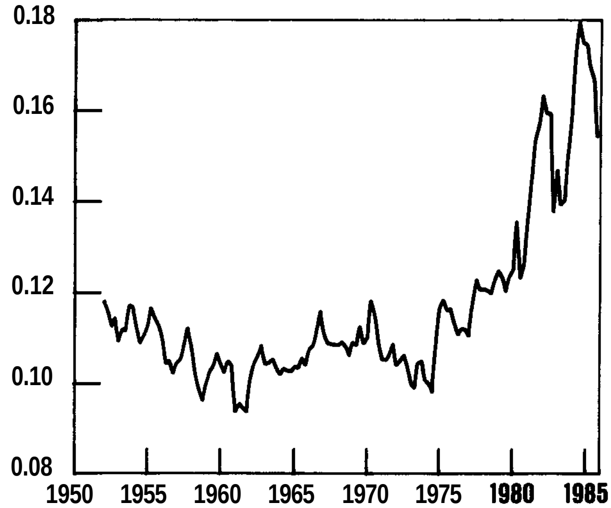


FIGURE 4

A time-series plot of p constructed with g fured at its average value is presented in figure 4. The required real rate of return ranged between 10 and 13 percent from 1952 through 1974, with moderate deviation. At the start of 1975, however, p began to rise slowly and then sharply in 1981. It peaked at the end of 1981 and again at the beginning of 1984. For comparison's sake, setting g equal to zero over the entire sample period produces values for p ranging between 4.5 and 7.5 percent from 1952 through 1976, topping out at 14.2 percent in mid-1984.

IV. Analysis of Computed p Series

In this section, we analyze the behavior of p, computed with expected earnings growth fixed at its actual mean value. Our goal is to shed light on this component of equity valuation. By their nature, however, it is not possible to completely separate the implications of the various hypotheses discussed above.

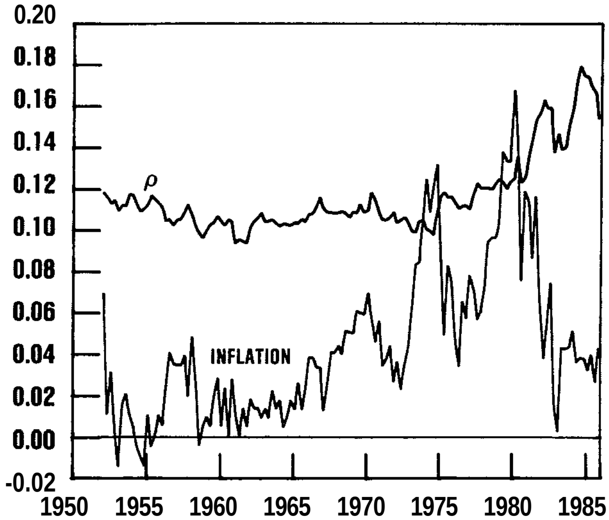
The computed value of p appears to support Malkiel's hypothesis that p begins to rise in the mid-1970s due to the risk factors cited earlier. In addition, the rapid rise in 1981 could be explained by Bodie, Kane, and McDonald (1986), who concluded that there was a dramatic increase in the risk premium required in long-term bonds in the early 1980s. They attribute this to the switch in operating procedures by the Federal Reserve in late 1979.

The disinflation hypothesis presented earlier suggests that p should vary inversely with the level of inflation. In figure 5, we present plots of p and the rate of inflation. Note that the major upturns in p appear to coincide with the inflationary peaks occurring in 1974 and again in 1981. Smaller, previous inflation spikes do not, however, seem to be accompanied by any significant movement in p.

The same figure can be used to examine Hendershott's claims. Conspicuously absent is the hypothesized decline in p as inflation rises. The lack of noticeable downward movement in p during rising inflation eliminates much of the support for his arguments. His main conclusion, however, that p is tied to the real rate of return on debt, can now be addressed.

9 The average annual growth rate of adjusted earnings over the sample period was 17.01 percent. The growth rate of this series since mid-1983 has been so great as to completely dominate this figure. It was felt that the effects of this adjustment could not have been reasonably foreseen over much of the sample period and, in fact, should "wash" over the long run. We therefore chose to use the average annual growth rate of unadjusted earnings in the computation of p.

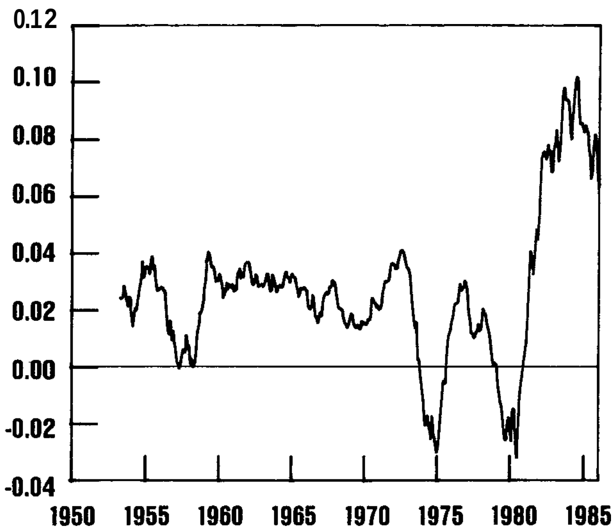
COMPUTED ρ WITH FIXED EARNINGS GROWTH AND INFLATION



SOURCE: Author's calculations: and U.S. Department of Commerce, Bureau of Labor Statistics.

FIGURE 5

REAL Aaa-CORPORATE BOND YIELD



SOURCE: Moody's Investors Service.

FIGURE 6

A plot of *ex-post* real long-term corporate bond rates is shown in figure 6. This figure was constructed by simply subtracting 1 from the ratio of the gross yield on Aaa-rated corporate bonds to the previous year's gross inflation rate at each date. Note that real required rates of return on fixed income securities reached unprecedented levels in 1981, the same year in which ρ significantly departs from its postwar behavior. Hendershott's hypothesis, therefore, appears to explain the sharp rise in ρ that occurred in 1981. However, it does not shed light on the moderate increase beginning in 1975, but it does help explain the slight decline in ρ that occurs between the end of 1971 and the end of 1974.

Though separate from the risk-related hypotheses, Benjamin Friedman (1986) claimed that an increase in the government deficit, such as that beginning in early 1981, would drive down the realized rate of return on equity relative to either short- or long-term debt, thereby increasing the required rate of return on a pure equity stream. This theory then suggests that the rise in ρ is a function of deficits, thus explaining the sharp rise in 1981.

Had we found no rational explanation for the behavior of ρ, we would have searched for evidence of measurement errors related to corporate earnings. For instance, Feldstein (1980) claimed that biases in the tax system, rather than inflation-induced valuation errors, could explain the poor performance of the stock market. In particular, Feldstein emphasized that corporate capital depreciation deductions are based on historical, rather than current, costs. In inflationary periods, with a rising price of investment goods, this implies that the real value of depreciation deductions declines. This, in turn, implies that taxable profits (net of depreciation deductions) rise, causing real after-tax profits to fall. Feldstein also pointed out that nominal rather than real capital gains are subject to capital gains taxes. This implies that even if the nominal value of equities increased at the inflation rate, the real after-tax yield on equities would decline. In contrast to Modigliani and Cohn, Feldstein viewed the stock market decline as a rational response to inflation.

Modigliani and Cohn, in response to the criticism of Feldstein, discussed the possibility of tax biases due to inflation. They noted that other analyses of the interaction of inflation and taxes have ignored the fact that firms are not taxed on the portion of returns used to depreciate debt. They argue that this offsets the decline in real after-tax profits that results fi-om the decline in real depreciation deductions. They support this by noting that the share of corporate income paid as taxes has remained relatively constant in inflationary periods. In their empirical work, as well as in our construction of ρ, an adjustment factor constructed fi-om the National Income and Product Accounts was used that attempts to correct reported earnings for depreciation and inventory distortions caused by inflation. The NIPA adjustment, however, may misstate the lagged response of tax shelters to inflation. In addition, the analysis is complicated further by the fact that much corporate debt is fixed-rate and thus debt yields do not adjust instantly to inflation expectations.

In figure 7 we present both unadjusted and adjusted reported four-quarter earnings per share using the NIPA data. For the early part of the sample period the two series are virtually identical. They begin to diverge at the end of

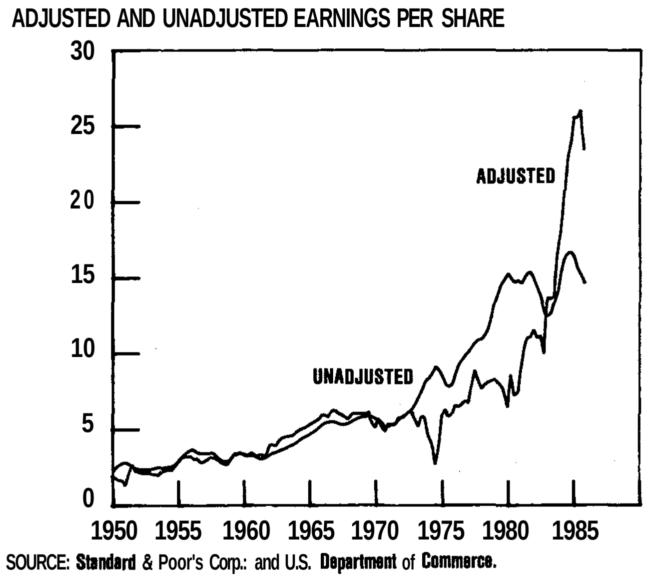


FIGURE 7

1972, with adjusted earnings falling somewhat below unadjusted earnings. The situation reverses dramatically, however, in 1983. At this point, adjusted earnings climb far above unadjusted earnings. Further study may shed light on the sensitivity of our results to the adjustment of earnings, especially for the period following 1981.

V. Conclusion

We conclude that equity prices respond rationally to such factors as real interest rates and risk. When we use the model of Modigliani and Cohn to compute the discount factor applied to a pure equity stream of a levered firm, we find no evidence of inflation-induced valuation errors. The evidence presented, however, is consistent with the hypothesis that disinflation influences the risk premium applied to pure equity streams.

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APPENDIX

Reestimation of Modigliani and Cohn's Model

In this section, we describe our attempts to replicate the results of Modigliani and Cohn and then to reestimate their model, extending the sample period through 1984.

Modigliani and Cohn estimated the following regression, which is implied by expression (13), after taking the log of both sides:

$$s(t) = a0 = w1(L)\Pi(t) + w2(L)DIV(t) + a3\ w3(L)[LF/E](t) + a4DVF(t) - \beta w4(L)R(t) + \gamma w5(L)P(t) + u(t)$$

The variable L is the lag operator and the parameters w1 through $w5$ represent coefficients on the lagged terms of the five forecasted variables. The distributed lag, $w1(L)\Pi(t)$, embodies the assumption that expected, or *ex-ante*, profits equal a one-sided distributed lag of past profits. Profits were measured as described in the text and in Modigliani and Cohn. Although it is not unusual to view expected dividends as influencing stock prices, Modigliani and Cohn include a distributed lag of dividends, $w2(L)DIV(t)$, on the grounds that dividends provide information about future profits. They then restrict the coefficients of the distributed lag on dividends, so that a change in dividends has no permanent effect on firm value, given the history of profits. Dividends were measured as dividends per share for the issues in the S&P 500, adjusted as described by Modigliani and Cohn. $w3(L)LF/E$, a distributed lag of the ratio of the labor force to employment, is included to provide a cyclical adjustment to the ability of past profits to predict future profits. The term *DVF(t)* is included as a measure of the risk premium entering the formulation of **p.** Modigliani and Cohn measured *DVF* as the 15-year moving-average deviation of the unemployment rate from 4 percent. We chose instead to use a 12-quarter moving-average. The distributed lag on the nominal interest rate, $w4(L)R(t)$, and the distributed lag on inflation, $w5(L)P(t)$, are included to measure the real rate, $r(t)$, also a component of **p.** $R(t)$ is measured as the new issue yield on AA corporate bonds. $P(t)$ is measured as the annual percent change in the CPIU.

We used the current value and seven lagged values in each distributed lag. This choice of lag length differed from that of Modigliani and Cohn, but seemed only equally arbitrary. We maintained the following restrictions regarding the form of the distributed lags: a) the coefficients on profits sum to one, b) the coefficients on dividends sum to zero, c) the distributed lag on *LF/E* is quadratic, d) the distributed lag on dividends is linear, e) the distributed lag on the nominal rate is quadratic, and f) the distributed lag on inflation is quadratic with the endpoints constrained to equal zero.

The parameters to be estimated are $a0$, $a3$, $a4$, β, y, and the parameters in the distributed lags. The theoretical model of Modigliani and Cohn implies that the coefficient on the distributed lag of inflation, y, should equal *d/K*, where d is the debt-equity ratio and K is the capitalization rate. Their estimate of y, -0.08, differs from a computed value of *d/K*, 0.05. Thus, an increase in expected inflation reduced market values, although this should not have been the case if investors had been rational. In fact, Modigliani and Cohn calculated that a one percent increase in inflation would reduce the market value of equities by 13 percent. Thus, the market had been drastically undervalued due to inflation-induced valuation errors.

When we attempted to replicate the results of Modigliani and Cohn, over the same sample period, we estimated y to be .015. When the sample period was extended through 1984, however, the estimate of y was -0.025. If the misvaluation of equities was being eliminated, the estimate of y over the longer period would have been closer to the theoretically predicted value (*d/K*) than for the shorter period. Since our results not only differed from those of Modigliani and Cohn, but indicated worsening misvaluation, we chose to consider a different approach.