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The Impact of Inflation on Stock Prices

By Douglas K. Pearce

The rapid and variable inflation experienced since the late 1960s has caused wealthholders to seek to protect themselves against increases in the general price level. At the beginning of this period of inflation, it is likely that common stock—which represents a claim on real capital—was recommended as such a hedge. However, those who followed such advice and placed funds in a broad portfolio of stocks in 1968 have seen the real value of their holdings fall by about 50 percent. This surprising result has spurred considerable research on the relationship between inflation and the stock market. While no consensus has yet emerged on the theoretical nexus between inflation and equity prices, several empirical studies have confirmed that inflation and stock returns have been negatively related in the postwar period.[1]

It is important to investigate the reasons for this anomalous finding given the significance of the stock market. Movements in share prices are viewed as a prime indicator of the private sector's evaluation of current and future business conditions. Moreover, the stock market is thought to have a substantial influence on the consumption behavior of households and the investment decisions of business firms.[2] A fall in the real value of stocks is likely to reduce consumption demand since households hold about one-sixth of their net worth in common stock.[3] Lower stock prices should also discourage investment spending because they signal firms that the market places

Douglas K. Pearce is an associate professor of economics at the University of Missouri-Columbia and a visiting scholar at the Federal Reserve Bank of Kansas City. Research assistance was provided by Dan Vrabac, a research assistant with the Bank.

[1] Studies reporting a negative relationship between returns and inflation include John Lintner, "Inflation and Common Stock Prices in a Cyclical Context," *NBER 53rd Annual Report,* September 1973; Zvi Bodie, "Common Stocks as a Hedge Against Inflation," *Journal of Finance,* May 1976, pp. 459-70; Jeffrey F. Jaffe and Gershon Mandelker, "The 'Fisher Effect' for Risky Assets: An Empirical Investigation," *Journal of Finance,* May 1976, pp. 447-58; Charles R. Nelson, "Inflation and Rates of Return on Common Stocks," *Journal of Finance,* May 1976, pp. 471-83; and Eugene F. Fama and G. William Schwert, "Asset Returns and Inflation," *Journal of Financial Economics,* November 1977, pp. 115-46.

[2] For a detailed discussion of the stock market and the economy, see Barry Bosworth, "The Stock Market and the Economy," *Brookings Papers on Economic Activity,* 1975:2, pp. 257-90.

[3] The role of wealth in the consumption function is stressed in the influential life-cycle hypothesis of saving. See Franco Modigliani and Richard Brumberg, "Utility Analysis and the Consumption Function," in *Post-Keynesian Economics,* ed. by Kenneth K. Kurihara, New Brunswick, N.J.: Rutgers University Press, 1954; and Albert Ando and Franco Modigliani, "The 'Life Cycle' Hypothesis of Savings: Aggregate Implications and Tests," *American Economic Review,* March 1963, pp. 55-84.

a lower value on their capital stock, and thus should encourage mergers rather than the purchase of new capital equipment and structures.[4] If there is a negative, causal relationship running from inflation to stock prices, inflation will reduce the growth of the corporate capital stock and thus have direct, adverse effects on productivity and output.

The purpose of this article is to analyze the possible connections between stock prices and inflation to see if such a causal link exists. The first section briefly reviews the traditional model of stock price determination. The second section presents the historical record of stock prices, stock returns, and inflation. The third section surveys the major alternative hypotheses which have been put forth to explain the negative relationship between equity prices and inflation. The fourth section investigates the plausibility of these explanations by examining how well they accord with the empirical evidence. The final section summarizes the findings of the article.

INFLATION AND THE PRESENT VALUE MODEL OF STOCK PRICES

The effect of inflation on stock prices and stock yields can be analyzed using the traditional model for asset prices, the present value model. This model asserts that the price of a share of stock is the discounted, or present, value of all future dividends. For simplicity, it is assumed that all corporate profits are paid out so that the terms profits, earnings, and dividends are interchangeable. If real dividends are expected to be constant and inflation is zero, the stock price of a debt-free (unlevered) corporation can be computed using a simple formula:[5]

$$S_t = \frac{D^e}{r} \tag{1}$$

where S_t = the price of the stock at the beginning of period t

D^e = the expected dividend to be received at the end of each period

r = the real rate of return required by stockholders.

For example, if the required real rate of return is 5 percent and the corporation is expected to earn $5 per share every year, the stock should sell for ($5/.05), or $100. Stock price movements, according to this model, reflect some combination of changes in the expected dividend stream or the required rate of return. This required rate is assumed to equal the real interest rate on a default-free security plus a risk premium, due to the uncertainty of dividend payments. The one-period yield on the stock is defined as

$$\text{Stock yield}_t = \frac{D^e + S_{t+1}}{S_t} - 1 \tag{2}$$

and thus the expected yield is r, the required rate of return.[6]

In this model, inflation will cause nominal

[4] James Tobin has emphasized the ratio of the market value of a firm to the replacement cost of its capital stock, the q ratio, as the primary determinant of investment spending. See James Tobin, "A General Equilibrium Approach to Monetary Theory," *Journal of Money, Credit, and Banking,* February 1969, pp. 15-29. A more recent paper which finds that a model emphasizing stock prices yielded forecasts superior to those from several alternative frameworks is Robert F. Engle and Duncan K. Foley, "An Asset Price Model of Aggregate Investment," *International Economic Review,* October 1975, pp. 625-47.

[5] The present value model for share prices is generally associated with John Burr Williams, *The Theory of Investment Value,* Cambridge: Harvard University Press, 1938. The general expression for the present value of dividends is:

$$S_t = \sum_{i=0}^{\infty} \frac{D^e_{t+1}}{(1+r)^{i+1}}$$

which can be expressed as equation (1) when all dividends are assumed to be equal.

[6] If D^e is constant,

$$\text{Stock yield}_t = \frac{D^e + \frac{D^e}{r}}{\frac{D^e}{r}} - 1 = r.$$

stock prices to rise at the same rate as the general price level, leaving real stock prices constant, unless inflation changes expected real dividends or the required rate of return. If inflation is neutral in the sense that all prices rise at the same rate, firms will see their revenues and costs increasing at this same rate so that nominal profits and dividends also rise at the rate of inflation. When inflation is at rate p (and is fully anticipated), the equation for the nominal price of stock becomes:[7]

$$S_t = \frac{D^e(1+p)^t}{r}. \tag{3}$$

Thus, for the example above, if inflation is 10 percent per year, nominal dividends would be expected to be \$5.50 at the end of the first year, \$6.05 at the end of the second year, and so on. The initial stock price, S_0, would still be \$100, but the price at the beginning of the next year, S_1, would be (\$5.50/.05), or \$110, and S_2 would be (\$6.05/.05), or \$121. The real price of the stock would remain unchanged since the nominal stock price increases just match the increases in the general price level. The nominal one-period yield on the stock would be approximately r + p, leaving the real yield unaltered.[8] Hence, inflation has no real effects on stock prices or yields unless it changes the real profitability of the corporation's capital, D^e, or the return demanded by shareholders, r.

This analysis assumes a firm which has no debt. If the firm raised some of its funds through issuing bonds or other debt, inflation might raise real equity prices. While inflation should not change the real market value of the firm—that is, the real value of all claims on the firm—if it is unexpected it will benefit shareholders (debtors) and hurt bondholders (creditors), thus raising share prices in real terms.[9] Again, this prediction is based on the assumption that inflation neither affects the profitability of capital nor raises the required rate of return.

It should be noted that the validity of the present value model is not unquestioned. Keynes, for example, considered this model of share prices only a convention.[10] Doubting that movements in stock prices were dominated by the long-run expectations embedded in equation (1), he considered short-run speculation to be the primary force. Speculators in the stock market, Keynes asserted, spend the majority of their time guessing the preference of other speculators instead of evaluating the future earnings of firms. While other critiques of the model have also appeared, the present value model remains the predominant tool for analyzing stock prices.[11]

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7 To see this result, note that

$$S_0 = \frac{D^e(1+p)}{(1+r)(1+p)} + \frac{D^e(1+p)^2}{(1+r)^2(1+p)^2} + \ldots$$

and $$S_1 = \frac{D^e(1+p)^2}{(1+r)(1+p)} + \frac{D^e(1+p)^3}{(1+r)^2(1+p)^2} + \ldots$$

thus $$S_1 = (1+p)S_0 = \frac{(1+p)D^e}{r}.$$

A similar development would show $S_2 = (1+p)^2 S_0$ and so on.

8 The actual nominal yield is r + p + rp, but the last term is generally negligible.

9 For a more detailed discussion of this argument, see Lintner. Support for the hypothesis that inflation raised the stock prices of net debtor firms was found by Reuben A. Kessel, "Inflation-Caused Wealth Redistribution: A Test of a Hypothesis," *American Economic Review,* March 1956, pp. 128-41.

10 John Maynard Keynes, *The General Theory of Employment, Interest and Money,* New York: Harcourt Brace, 1936, p. 152.

11 For recent applications of this model, see Roger E. Brinner and Stephen H. Brooks, "Stock Prices," in *How Taxes Affect Economic Behavior,* ed. by Henry J. Aaron and Joseph A. Pechman, Washington, D.C.: Brookings Institution, 1981; and William C. Brainard, John B. Shoven, and Laurence Weiss, "The Financial Valuation of the Return to Capital," *Brookings Papers on Economic Activity,* 1980:2, pp. 453-502. For critiques of the model based on its apparent inability to account for the volatility of stock prices, see Stephen F. LeRoy and Richard D. Porter, "The Present Value Relation: Tests Based on Implied Variance Bounds," *Econometrica,* May 1981, pp. 555-74; and Robert J. Shiller, "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" *American Economic Review,* June 1981, pp. 421-36.

THE HISTORICAL PERFORMANCE OF COMMON STOCKS

The history of nominal stock prices is presented in Chart 1 along with the general price level for the 1901-80 period. The stock price index employed is Standard and Poor's Composite Index of 500 (S&P 500) of the largest stocks (measured by their market value) with the weights of each stock corresponding to the relative market value of the stock. The general price level is measured by the Consumer Price Index (CPI). While the two series are not closely related, they moved broadly together until the mid-1960s. From then on, however, the general price level has spurted sharply upward while nominal stock prices remained roughly constant. Chart 2 dramatizes this recent divergence by plotting the real value of stocks over the last 30 years.

As mentioned above, the constant purchasing power value of common stock peaked around 1968 and has since fallen to about 50 percent of that level. It is this dramatic plunge in real equity prices which has puzzled analysts.

The pattern of real stock prices is mirrored by the behavior of stock yields. Table 1 reports the nominal and real yields on the S&P 500 portfolio and the inflation rate for 1926-80 and subperiods. Over the entire period, investors enjoyed a 9.4 percent nominal yield and a 6.5 percent real yield on this portfolio. While similar yields occurred during the last 30 years, the last two columns of Table 1 indicate that

Chart 1
STOCK PRICES AND THE GENERAL PRICE LEVEL

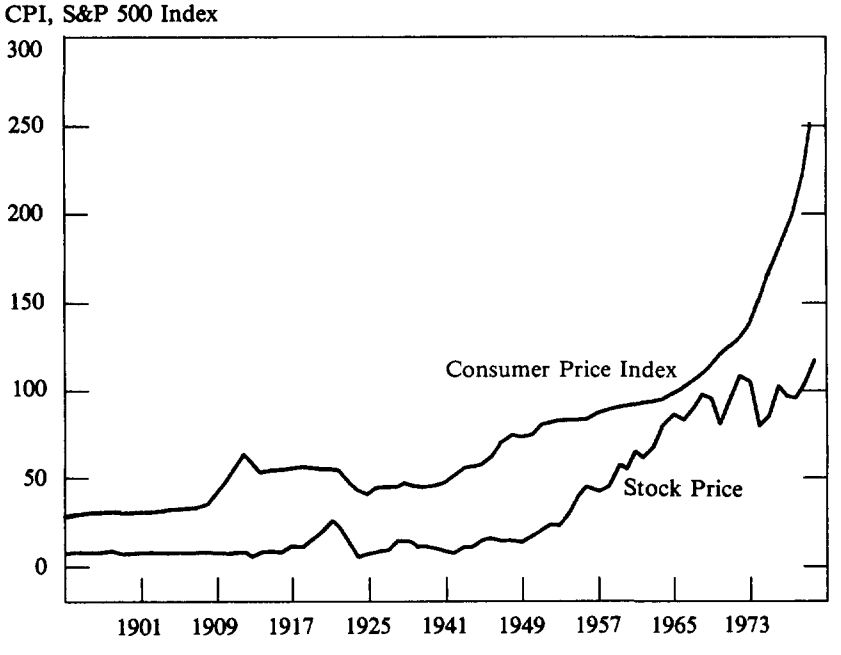
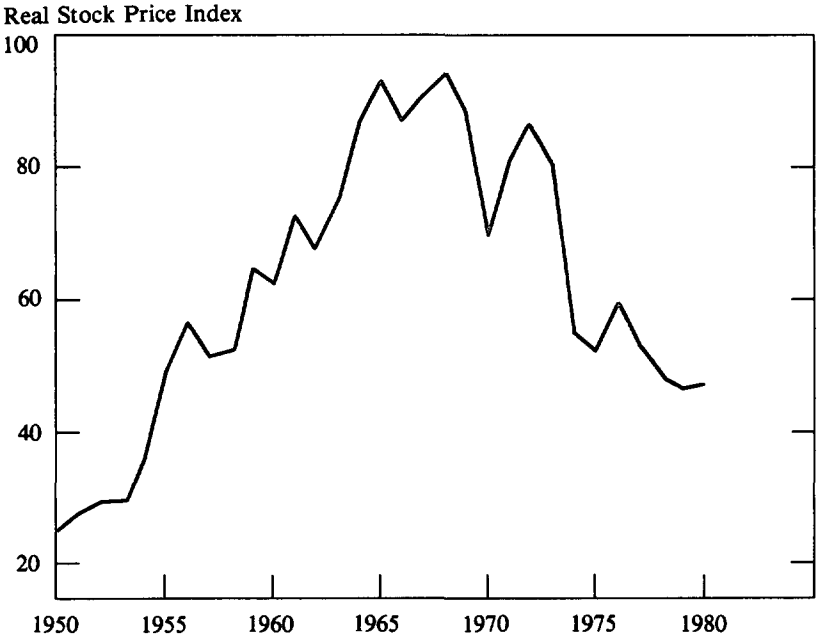


Chart 2
REAL STOCK PRICES



there were two distinct eras. From 1951 to 1965, stocks earned high nominal returns while inflation averaged less than 2 percent per year. However, from 1966 to 1980, the nominal yield was well below the historical mean while inflation was rapid, producing real returns that were negative. Thus, these data also suggest that recent inflation has had a substantial, adverse ef-

Table 1
NOMINAL AND REAL YIELDS ON COMMON STOCKS
(Amounts in percent)

	1926-80	1926-50	1951-80	1951-65	1966-80
Nominal Compound Yield on Standard and Poor's 500 Stock Portfolio	9.4	7.7	10.9	15.2	6.7
Inflation Rate (CPI)	2.9	1.3	4.2	1.6	6.9
Real Yield on Standard and Poor's 500 Stock Portfolio	6.5	6.4	6.7	13.6	−0.2

Note: The yields are computed assuming all dividends are reinvested and that the portfolio was held for each period.
Source: R. G. Ibbotson and R. A. Sinquefield, *Stocks, Bonds, Bills, and Inflation: Historical Returns (1926-1978)*, Financial Analysts Research Foundation, 1979. Updated to 1980 by the authors.

fect on the stock market.

WHY INFLATION HAS HURT THE STOCK MARKET: ALTERNATIVE VIEWS

The failure of stock prices to rise with the general price level and nominal yields to keep up with inflation during the last 15 years has stimulated several researchers to seek an explanation for this anomaly. The present value model indicates that the fall in real stock prices signals a reduction in expected real earnings and thus real dividends, or an increase in the required rate of return on stock.

This section reviews two arguments why inflation might reduce expected earnings—namely, that inflation raises the real tax burden on corporate capital and that inflation causes investors to underestimate the returns to shareholders. Following this discussion is an examination of why inflation might raise the rate of return required by stockholders by either increasing returns on alternative assets, increasing perceived risk, or confusing investors into misapplying the present value model.[12]

Inflation and Expected Corporate Earnings

Tax Effects. Much of the discussion concerning the poor performance of stocks during periods of inflation has centered on the role of taxes. Several researchers believe that inflation substantially increases the real tax rate on corporate profits and, therefore, that expected inflation causes investors to revise downward their forecasts of real after-tax corporate earnings.[13]

Inflation is thought to raise the effective tax rate faced by corporate capital because of the tax treatment of depreciation charges and inventory changes. When computing its taxable profits, a corporation deducts the amount of depreciation of its physical assets. This deduction helps the firm to maintain its capital stock. During inflation, however, the replacement cost of equipment and structures rises with the general price level. Because the depreciation deductions are based on the historical cost of the assets, they no longer reflect the amount required to keep the capital stock intact. Since inflation swells nominal revenues but does not increase the depreciation charges, nominal profits rise and overstate the true profits of an ongoing firm. With taxes based on nominal income, the real tax burden on the corporation is enlarged and real after-tax earnings are reduced.

A similar argument is relevant to the treatment of inventories. During an inflationary period, firms selling goods from inventory realize nominal gains which are taxed as ordinary income. These gains arise because the firm can only deduct the original cost of buying goods rather than the current cost of replenishing the inventory. Again, an ongoing firm has made no real gains, but its real tax bill has increased. This problem is exacerbated by the still prevalent use of the first-in, first-out (FIFO) accounting method.[14] A rise in inflation

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12 A recent paper by Eugene F. Fama, "Stock Returns, Real Activity, Inflation and Money," *American Economic Review,* September 1981, pp. 545-54, gives a fourth explanation for the negative correlation between stock returns and inflation. Fama argues that this finding is really the result of omitting the effects of real activity from the analysis. He contends that stock returns are positively related to expected real activity, while inflation is negatively related to expected real activity. This produces the negative contemporaneous correlation between stock returns and inflation. A key assumption of his model, which many analysts may question, is that commodity prices are flexible enough to keep the money market in equilibrium even when the period of analysis is monthly.

13 Richard Kopcke, "Are Stocks a Bargain?" *New England Economic Review,* May-June 1979, pp. 5-24; and Martin Feldstein, "Inflation and the Stock Market," *American Economic Review,* December 1980, pp. 839-47.

14 Firms could reduce their tax liability (assuming inflation continues) by switching to the last-in, first-out (LIFO) method, yet only about one-quarter of inventories were under LIFO accounting in 1977. See Martha S. Scanlon, "Postwar Trends in Corporate Rates of Return," in *Public Policy and Capital Formation,* Board of Governors of the Federal Reserve System, 1981, pp. 75-87.

Table 2
EFFECT OF INFLATION ON ACCOUNTING PROFITS

Initial Conditions of Firm: Equity = $1,000 Debt = $1,000
Initial Economic Conditions: Nominal Interest Rate (i) = 0.05
Inflation (p) = 0

Period	Revenue	Labor Cost	Interest Cost	Accounting Profit	Dividends	Change in Debt	True Profits
0 (p = 0)	200	100	50	50	50	0	50
1 (p = 100)	400	200	1,100	−900	100	1,000	100
2 (p = 100)	800	400	2,200	−1,800	200	2,000	200
3 (p = 0)	800	400	200	200	200	0	200

Note: When expected inflation is 100 percent, the nominal interest rate rises from 5 percent to 110 percent in order for the real interest rate to be unaffected. The equation for this relationship is $i = r + p + r \cdot p$ where i is the nominal interest rate, r is the real interest rate, and p is inflation.

will thus raise taxable profits and therefore taxes, even when real profits have not increased, with the result that real after-tax earnings fall.

Gains From Debt. It has been argued that inflation reduces real corporate debt and that such gains offset much or all of the impact of taxes on corporate earnings. However, some economists believe that shareholders ignore the gain from debt in evaluating their equity and thus underestimate true profits and undervalue the supporting stocks. This argument assumes a kind of money illusion on the part of investors because they fail to adjust reported profits adequately for all the effects of inflation.[15]

Table 2 illustrates why gains from debt should be added. Assume a firm initially has a net worth of $1,000 and debt of $1,000. The debt is in the form of one-period bonds paying 5 percent. Inflation is known to be zero, there are no taxes, and equity also yields a real return of 5 percent. Line one gives the initial revenues, costs, and profits, with all profits distributed as dividends. Line two shows the effects of 100 percent inflation, completely anticipated. Revenues and labor costs double, but interest expense rises to $1,100 because the nominal interest rate fully reflects expected inflation. Accounting or book profits are now negative (−$900), but the firm can still pay the same real dividend and cover the increased interest expense by borrowing $1,000. All the firm is doing is maintaining the same real debt. Thus, accounting profits provide a misleading guide to the true picture of the firm since inflation is actually neutral. There are no effects on real dividends, real debt, or the debt-equity ratio. The correct measure of profits in the last column equals accounting profit plus the gain on real debt—that is, the inflation rate times nominal debt.

Inflation and the Required Rate of Return on Stocks

Even if it had no effect on expected profits, inflation would cause real stock prices to fall if it raised the required rate of return on stocks. This might occur if inflation increased the after-tax real returns on alternative assets or if

[15] The money illusion argument is made by Franco Modigliani and Richard A. Cohn, "Inflation, Rational Valuation and the Market," *Financial Analysts Journal*, March-April 1979, pp. 24-44.

investors believed that stocks had become riskier because of inflation and thus demanded a higher risk premium. Also, investors might mistakenly use the nominal interest rate, which moves with inflation, to discount real earnings.

Return on Alternative Assets. Some analysts have attributed much of the fall in real stock prices to the exceptionally high real returns that owner-occupied housing has provided during recent inflationary times.[16] This asset enjoys two tax advantages when the general price level rises. The main return is the rental services of the house for which the owner, in effect, pays himself. Since this imputed return rises with inflation but is not taxed, the real, after-tax earnings of the house rises relative to other assets. Second, unlike common stock, realized nominal capital gains largely can be avoided by reinvestment in houses until age 55. The adjustment of portfolios by wealthholders results in housing prices being bid up and in stock prices falling, so that comparable real after-tax returns might be reestablished.

Greater Risk. An alternative reason for a rise in the required rate of return is a rise in the perceived riskiness of corporate profits. If increases in the risk premium for stocks are associated with higher inflation rates, inflation would reduce share prices even if it left expected earnings unaffected. It has been argued that much of the decline in stock prices can be attributed to added uncertainty about corporate earnings and that inflation is a primary cause of this uncertainty.[17]

There are several reasons why inflation might make corporate profits less predictable. There is evidence that a rise in the level of inflation is accompanied by an increase in both the variability and the dispersion of relative price movements.[18] Either of these factors will tend to make the profits of any firm less certain. For example, an unpredictable inflation rate imposes real efficiency losses as economic agents scramble to protect themselves by using shorter contracts. In addition, a volatile inflation rate makes it more difficult to distinguish relative price movements from changes in the overall price level, possibly resulting in incorrect allocation decisions.

A higher level of inflation, even without more variability, may also cause corporate earnings to be less certain if agents anticipate corrective measures by the government. Investors may fear the imposition of wage-price controls with their inherently arbitrary effects on profits. Similarly, rapid inflation is likely to bring on some form of restrictive monetary or fiscal policy which may not only dampen profit expectations but, given the unknown nature of the exact policies that will be undertaken, make planning an even more hazardous task.

Finally, energy-related inflationary jumps may add to the unpredictability of profits. Over the 1970s, the two largest jumps reflected steep increases in energy prices. Uncertainty about future energy prices and supplies coupled with the existence of production techniques and capital equipment geared to low energy prices is likely to have reduced the perceived stability of corporate earnings. Thus, the inflation rate may serve as a proxy for the riskiness assigned to returns to corporate capital. Therefore, increases in inflation may lead investors to re-

16 Patric H. Hendershott and Sheng Cheng Hu, "Inflation and Extraordinary Returns on Owner-Occupied Housing: Some Implications for Capital Allocation and Productivity Growth," *Journal of Macroeconomics,* Spring 1981, pp. 177-203; and Lawrence H. Summers, "Inflation, the Stock Market and Owner-Occupied Housing," *American Economic Review,* May 1981, pp. 429-34.

17 See Burton G. Malkiel, "The Capital Formation Problem in the United States," *Journal of Finance,* May 1979, pp. 291-306. Increased risk has also been emphasized by William Fellner, "Corporate Asset-Liability Decisions in View of the Low Market Valuation of Equity," in *Contemporary Economic Problems 1980,* Washington, D.C.: American Enterprise Institute, 1980.

18 For a review of this literature, see John B. Taylor, "On the Relation Between the Variability of Inflation and the Average Inflation Rate," in *The Costs and Consequences of Inflation,* Carnegie-Rochester Conference Series on Public Policy, ed. by Karl Brunner and Allan H. Meltzer, Amsterdam, Netherlands: North-Holland, 1981.

quire higher returns on stock.

Incorrect Discount Rate. A third reason why inflation could raise the required rate of return on stocks is the use by investors of a nominal interest rate rather than a real interest rate to discount future real profits.[19] This is roughly equivalent to shareholders comparing the earnings-price ratios of stocks to the nominal interest rate on bonds when making portfolio decisions. As discussed earlier in the paper, inflation should raise earnings and the price of stocks at the same rate, leaving the earnings-price ratio unchanged. In other words, the earnings-price ratio is a real yield. Thus, the correct comparison is the earnings-price ratio to the real rate of interest, the nominal rate less expected inflation. If investors do commit the error of looking at nominal interest rates, then as inflation pushes up nominal interest rates, stock prices would have to fall to provide comparable yields.

EMPIRICAL EVIDENCE ON STOCK PRICES AND INFLATION

This section reviews empirical evidence on the possible connections between inflation and stock prices. The first part examines both whether inflation has reduced the expected profitability of corporate capital through raising effective tax rates and the impact of ignoring the gains from debt on the return on equity. The second part of the section investigates the proposition that inflation has raised the required return on stock which, if true, would force stock prices down.

Inflation and Expected Corporate Earnings

Tax Effects. The tax effects hypothesis asserts that inflation reduces real after-tax corporate profits because it raises the effective tax rate. This view implies that the after-tax profitability of corporate capital should be inversely related to inflation and that the before-tax profitability should be unrelated to inflation. If inflation has little or no impact on real after-tax profitability, the tax effects theory would not account for the fall in real stock prices.

The before-tax rate of return on nonfinancial corporate capital (BTROR) is defined here as the ratio of profits plus net interest paid to the replacement cost of the nonfinancial corporate stock. The after-tax rate of return (ATROR) is similarly defined but with corporate income taxes subtracted from the numerator. The profits in both measures are adjusted for the effect of inflation on inventory and depreciation charges.[20]

Chart 3 plots the BTROR and the ATROR for the last 30 years. The series follow a similar pattern, peaking in 1965 and dropping sharply to lower levels thereafter. Since the difference between the two measures, which reflects corporate income taxes, narrowed over the whole period, it would seem that inflation has not raised the tax burden on capital. However, the impression from Chart 3 may be misleading since other factors such as fluctuations in the economy also affect tax liabilities.

To isolate the effect of inflation on the rates of return, a model was estimated in which the

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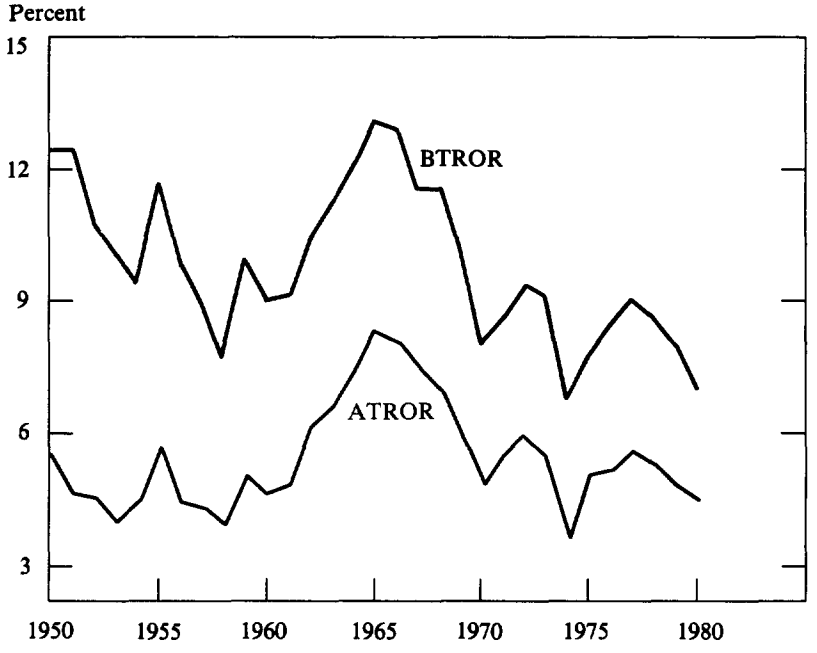
19 This is the second part of the money illusion theory of Modigliani and Cohn.

20 The correction for the understatement of inventory costs is the Inventory Valuation Adjustment (IVA) which essentially removes the distortion arising from firms using FIFO accounting. The impact of inflation on depreciation allowances is measured by the Capital Consumption Adjustment (CCA) which converts reported depreciation into true depreciation by taking into account both the accelerated depreciation allowed by tax laws, which overstates depreciation, and the difference between replacement cost and historic cost. For a detailed discussion of these adjustments, see John B. Shoven and Jeremy I. Bulow, "Inflation Accounting and Nonfinancial Corporate Profits: Physical Assets," *Brookings Papers on Economic Activity,* 1975:3, pp. 557-98; and Phillip Cagan and Robert E. Lipsey, *The Financial Effects of Inflation,* National Bureau of Economic Research, Cambridge, Mass.: Ballinger, 1978.

Chart 3
BEFORE AND AFTER-TAX RETURNS ON CORPORATE CAPITAL

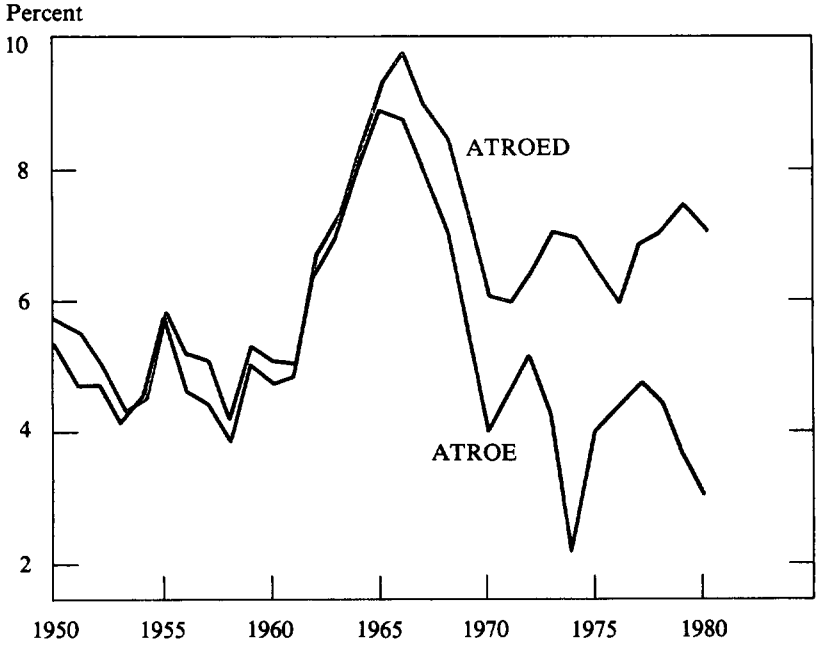


rate of return depends on inflation and the level of economic activity as measured by the percentage gap of actual real GNP from full employment real GNP.[21] As expected, both the BTROR and the ATROR were found to be sensitive to movements in the real economy with the before-tax rate falling about 0.3 percent and the after-tax return about 0.17 percent for every 1 percent rise in the GNP gap. The estimated impacts of inflation on the rates of return give weak support for the tax effects theory. No statistically significant relationship was found between the BTROR and inflation, but inflation was found to have a negative effect on the ATROR, although the level of statistical significance is somewhat low. While the results are consistent with the tax effects view, the estimated reduction in the ATROR is only 0.1 percent for a 1 percent rise in inflation. Since the ATROR has fallen about three percentage points since 1965 while inflation has risen about eight percentage points, inflation accounts for only 0.8 percentage points of the drop in the ATROR.[22]

[21] The estimated models are reported in Table A of the Appendix. The models allow for the intercept and time trend to differ for 1951-65 and 1966-80, following the study by Richard W. Kopcke, "The Decline in Corporate Profitability," *New England Economic Review,* May-June 1978, pp. 36-60.

[22] Nicholas J. Gonedes also found little support for the tax effects hypothesis. See his "Evidence on the 'Tax Effects' of Inflation Under Historical Cost Accounting Methods," *Journal of Business,* April 1981, pp. 227-70.

Chart 4
RATES OF RETURN ON STOCKHOLDERS' EQUITY



Gains From Debt. To evaluate the proposition that inflation causes investors to underestimate the returns on equity by ignoring the gains from debt, it is necessary to look at the rate of return on stockholders' equity, with and without these gains. The rate on stockholders' equity is defined as adjusted profits divided by the net worth of the corporation (the replacement cost of the capital stock less the value of net debt). Chart 4 gives two measures of the return on equity. One is the after-tax return (ATROE), which includes an adjustment of profits for the effects of inflation on inventory and depreciation charges but ignores gains from debt due to inflation. The other measure is the after-tax rate of return (ATROED), which includes gains from debt. The latter measure assumes investors make all relevant adjustments for inflation while the former assumes that investors do not recognize the full effects of inflation on corporate earnings.

As Chart 4 illustrates, the ATROE has fallen dramatically to less than half its 1965 peak. The ATROED has also decreased substantially, but the drop is about 25-30 percent from the peak return. To assess the contribution of inflation to these decreases, the same model employed above for the return on capital was estimated.[23] While both measures of the return on equity fall significantly when the economy weakens, the impact of inflation on these returns differs.

23 The estimated models are given in Table A of the Appendix.

As predicted by the tax effects theory, inflation has a negative effect on the ATROE, similar to that found above for the ATROR. The ATROED, however, is positively related to inflation which suggests that the benefits inflation produces by reducing real debt outweigh the costs coming from higher taxes. If investors ignore these benefits, inflation does appear to decrease the return on equity, although the size of this effect can account for only a small portion of the observed total decline.

To sum up, the rate of return on both corporate capital and stockholders' equity was substantially lower in the 1970s compared with the mid-1960s. The poor performance of capital does not, however, appear to be due primarily to inflation since empirical evidence indicates that the tax effects hypothesis cannot account for most of the fall in the after-tax return on capital. The fall in the return on stockholders' equity, the return relevant to the determination of stock prices, can account for a little over one-half of the decrease in real stock prices, but this lower rate of return cannot be attributed to inflation if investors correctly compute this return.[24]

The Required Rate of Return on Stocks and Inflation

The analysis above suggests that inflation has not caused real stock prices to fall by lowering the return on equity if shareholders include the gains from debt in this return. Nevertheless, inflation may have depressed real share prices by increasing the required rate of return on stocks. This argument is supported by the pattern of the earnings-price ratio given in Chart 5. As discussed in the beginning of the paper, if inflation does not raise the required rate of return on stocks, earnings and the price of stocks should both rise at the inflation rate, leaving the earnings-price ratio unaffected. However, as Chart 5 illustrates, the earnings-price ratio for the S&P 500 rose substantially as inflation worsened.[25] Assuming that the gains from debt are taken into account by investors, the required rate of return on stocks has increased. This section considers evidence on the three alternative factors mentioned earlier by which inflation may have caused a rise in the required rate: higher returns on alternative assets, higher perceived risk on stock returns, and the incorrect use of the nominal interest rate to discount real earnings.

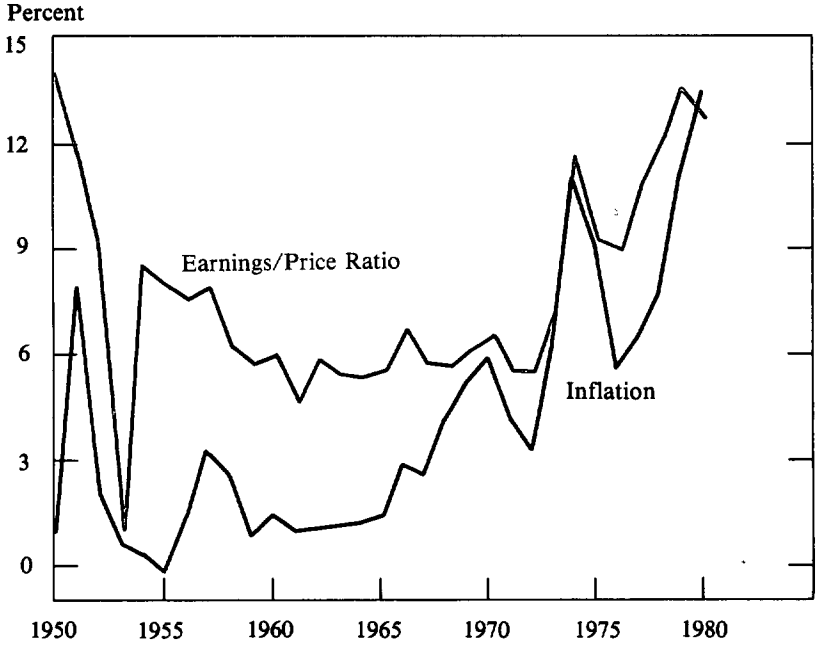
Return on Alternative Assets. Because fixed income financial assets exhibited negative real returns over the last 15 years, they seem unlikely candidates for attracting investors away from stocks.[26] A more plausible possibility is owner-occupied housing. Imputed nominal rents rise with inflation but are untaxed, and the tax liability on nominal capital gains can generally be avoided. Hence, inflation should increase the relative return to houses, and investors should react to higher inflation by bidding up housing prices. It has been estimated that the escalating inflation rate of the 1970s reduced the real rental cost of owner-occupied housing to close to zero for higher income

24 A major negative effect of inflation is found by Richard Kopcke, "Are Stocks a Bargain?" while a smaller impact is reported by Marcelle Arak, "Inflation and Stock Values: Is Our Tax Structure the Villain?" *Quarterly Review,* Federal Reserve Bank of New York, Winter 1980-81, pp. 3-13.

25 Since the earnings figure in this ratio is reported after-tax profits unadjusted for any effects of inflation, the higher ratios may have resulted from investors correcting these earnings for inflation distortions. This conjecture is not supported by a comparison of reported earnings to earnings which incorporate the IVA, CCA, and gains from debt since the two series move together quite closely, generally differing by less than $5 billion in the post-1965 period. In those years when the difference was greater, adjusted profits were greater than book profits, so earnings-price ratios should have fallen rather than increased.

26 From 1966 to 1980, the real yield on U.S. government long-term bonds was −4.3 percent while U.S. Treasury bills had a real yield of −0.5 percent. R. G. Ibbotson and R. A. Sinquefield, *Stocks, Bonds, Bills, and Inflation: Historical Returns (1926-1978),* Financial Analysts Foundation, 1979.

Chart 5
EARNINGS-PRICE RATIO AND INFLATION



families and that much of the fall in real stock prices can be attributed to investors reacting to this low real cost of housing by diverting funds from the stock market to the housing market.[27] Additional support for this view comes from the finding that the return to housing, unlike that for corporate equity, rises with expected inflation.[28] This hypothesis is also consistent with the rise in the median price of existing homes by 9.8 percent per year for the 1969-80 period—over 2 percent more than inflation—which occurred while stock prices fell relative to the general price level.

Greater Risk. The second factor which may have raised the required rate of return on stocks is higher perceived risk. If corporate profits are less predictable in an inflationary environment, risk-averse wealthholders will place a lower value on them. Past work has found a statistically significant negative effect of risk on the market value of firms, although the size of the effect was generally small.[29]

Was the decade of the 1970s a period of increasing risk to investment in corporate capital? One traditional measure of risk is the actual

[27] See Hendershott and Hu.
[28] See Summers.
[29] Brainard, Shoven, and Weiss.

Table 3
VARIABILITY OF PROFITS AND MACROECONOMIC ACTIVITY

Variable	Standard Deviations* Time Period					
	1951-55	1956-60	1961-65	1966-70	1971-75	1976-80
Percentage Change in Real Book Profits	20.5	16.3	8.5	9.9	12.5	11.2
Percentage Change in Adjusted Real Profits (IVA + CCA)	20.1	19.9	9.8	11.8	39.9	15.1
Percentage Change in Adjusted Real Profits Including Gains From Debt	21.3	17.9	11.7	9.8	11.4	11.1
Percentage Growth in Real GNP	3.6	2.3	1.4	2.3	3.3	2.4
Inflation (CPI)	3.3	1.0	0.2	1.4	3.3	3.3

*Standard Deviation for a variable x is defined as

$$S.D. = \left[\frac{1}{n-1}\sum_{i=1}^{n}(x-\bar{x})^2\right]^{1/2}$$

where n = number of observations
$\bar{x}$ = arithmetic mean of x.

variability experienced. Table 3 reports one gauge of variation: the standard deviation for the annual growth rates of three real profit measures, real GNP, and the CPI for five-year intervals, 1951-80. These data indicate that variation in these variables generally declined over the first 15 years and then rose again over the last 15. However, the only dramatic rise in variability of profits was for adjusted profits excluding gains from debt for the 1971-75 interval. Moreover, the last half of the 1970s exhibited less variability than the first half, and yet real stock prices continued to fall. Thus, these data suggest that rising variability in the economy may have contributed to lowering real share values, but it cannot be the whole story.

On the other hand, actual variability may be a poor measure of perceived risk. Another suggested measure of the change in risk is the differential between medium grade bonds and U.S. government bonds.[30] More uncertainty about corporate earnings is expected to raise this differential, which has grown substantially from an average of just under 1 percent for 1951-65 to about 1.65 percent for 1966-80. If higher expected inflation is an important contributor to higher risk, the interest differential should be positively related to expected inflation. This proposition is supported by the data, using lagged inflation to proxy expected inflation, with a one percentage point increase in expected inflation being associated with an increased differential of about 0.16 percentage points.[31] While this evidence is supportive of the risk hypothesis, the differential, while higher in the 1970s, does not trend upward and

30 Malkiel. The use by Malkiel of a bond series which included low yielding "flower" bonds was criticized by Patric H. Hendershott, "The Decline in Aggregate Share Values: Taxation, Valuation Errors, Risk, and Profitability," *American Economic Review*, December 1981, pp. 909-22.

31 The estimated relationship was:

$$\text{Interest Differential}_t = \underset{(4.633)}{.077} + \underset{(5.978)}{.156}\, I_{t-1}$$

$R^2 = .59$ SEE = .00028 DW = 1.82 $\hat{\rho} = .554$
Time Period 1954-80 annual observations
where I_{t-1} = inflation rate lagged one period
$\hat{\rho}$ = estimated autocorrelation coefficient
t-statistics in parentheses.
Additional lagged inflation rates do not alter the results.

thus cannot explain the downward trend in real share prices.

Incorrect Discount Rate. A third possible reason for a higher required rate is the comparison by investors of the earnings-price ratio with the current nominal interest rate on bonds. Since the correct comparison is with the real interest rate, use of the nominal interest rate, which rises roughly with inflation, means stock prices have to fall steeply, relative to earnings, in order for the earnings-price ratio to rise.

This hypothesis is difficult to test directly. One study of it employed a model in which stock prices depended mainly on expected earnings and the real interest rate.[32] The latter variable was measured by the nominal interest rate and expected inflation proxied by lagged inflation. Accordingly, if investors did not suffer from money illusion and thus used the real interest rate to discount real earnings, the coefficients on the nominal interest rate and expected inflation should have summed to zero. However, it was found that the coefficient on expected inflation was negative in sign and statistically insignificant from zero, which was interpreted as evidence of money illusion. Other investigators reported results which also can be construed as consistent with this view. It has been calculated that the discount rate required to equate the present value of future earnings to the market value of firms roughly doubled from 1968 to 1977.[33] This latter result is also consistent with rising risk. The unanswered question is why investors would confuse nominal and real rates of return. Since evidence suggests that bondholders demand compensation for inflation and households see the inflation-induced benefits of homeownership, it is puzzling why investors would be confused by inflation only in the stockmarket.[34]

SUMMARY AND CONCLUSIONS

Over the last 15 years the real value of common stock has fallen about 50 percent, coincident with a generally rising inflation rate. If inflation is to blame for the dismal performance of stocks, then it must reduce expected real corporate profits or raise the required rate of return on stocks, according to the traditional model of stock prices. This paper has examined several arguments as to why inflation may have had these consequences.

One prominent theory asserts that inflation reduces expected profits by raising the real tax burden on corporate earnings through nonindexation of inventory and depreciation charges. An alternative proposal is that inflation confuses investors, causing them to undervalue corporate profits by failing to take account of the inflation-induced fall in the real debt of corporations. On the other hand, it has been argued that inflation may have increased the required rate of return on stock by raising the return on owner-occupied housing, by creating more uncertainty about corporate profits, or by misleading investors into using too high a discount rate.

The analysis of this article indicates that the crucial issue is whether investors take into account the gains from debt which accrue to corporations when inflation occurs. The rate of return on stockholder equity when these gains are ignored has dropped by about half since the mid-1960s, consistent with the belief that lower stock prices reflect lower earnings. However,

32 Modigliani and Cohn. For an alternative explanation of these results, namely, that the lagged inflation rates are an inadequate proxy for expected inflation and are really picking up the negative tax effects of inflation, see Arak.

33 Brainard, Shoven, and Weiss.

34 Hendershott, "The Decline in Aggregate Share Values," argues that the inflation illusion argument of Modigliani and Cohn implies lower nominal interest rates when inflation occurs rather than lower share values, an implication which does not accord with experience.

this decline in returns seems to have been due primarily to the low return on corporate capital, before as well as after taxes, reflecting perhaps the rise in energy costs and regulatory activity which characterized the period. Rising real tax burdens on corporate capital could not account for this fall in the rate of return.

Assuming investors correctly include the gains from debt when estimating corporate profits, the fall in real stock prices was caused in part by a higher rate of return required by stockholders. This conclusion is supported by the observed rise in the earnings-price ratio. Evidence indicates that inflation has been an important determinant of the increase in the required rate by producing large returns on homeownership, by increasing the perceived risk attached to stock, and by deceiving stockholders into using the nominal rather than the real interest rate to discount earnings. Thus, while inflation cannot account for all of the decrease in real stock prices which has occurred in the last 15 years, it has been a significant factor in the decline.

Appendix
Table A
ESTIMATED RATE OF RETURN EQUATIONS: 1951-80
(Rate of Return Measure)

	BTROR	ATROR	ATROE	ATROED
Constant	.102	.040	.046	.034
	(10.623)	(6.130)	(4.442)	(4.380)
PCGAP	−.338	−.149	−.153	−.228
	(−4.149)	(−2.683)	(−2.228)	(−4.856)
Inflation	−.043	−.100	−.173	.123
	(−.460)	(−1.556)	(−2.177)	(2.255)
Time	.0007	.002	.002	.003
	(.793)	(3.171)	(1.900)	(3.959)
Time • D66	−.002	−.003	−.003	−.004
	(−1.15)	(−2.217)	(−1.767)	(−3.037)
D66	.019	.034	.045	.055
	(.709)	(1.836)	(1.599)	(2.665)
R^2	.582	.534	.509	.623
SEE	.0087	.0059	.0074	.0051
DW	1.80	1.87	1.83	1.63
$\hat{\rho}$	.541	.548	.685	.725

Notes: PCGAP = (Full employment real GNP-actual real GNP)/Actual real GNP
Inflation = Rate of change in the CPI
Time = time trend with 1951 = 1
D66 = 0 for 1951-65
= 1 for 1966-80
SEE = standard error of estimate
DW = Durbin-Watson statistic
$\hat{\rho}$ = estimated autocorrelation coefficient

Modeling Agriculture for Policy Analysis in the 1980s

By Marvin Duncan and Ann Laing Adair

Agricultural policy issues, in both the public and the private sectors, have become increasingly complex and intertwined with other economic and political issues. In the years ahead, these issues will be of considerable importance to farmers and to nonfarmers alike. Yet the methodology used by economists to support decisionmaking in these areas has not kept pace with the emerging issues.

In an effort to identify the shortfalls in policy analysis methodology and to contribute to proposed solutions, the Federal Reserve Bank of Kansas City brought together a distinguished group of participants at a symposium held on September 24 and 25, 1981, to examine the issue of "Modeling Agriculture for Policy Analysis in the 1980s."[1] This article summarizes the papers and the discussant remarks presented at that symposium.

THE VALUE OF MODELS IN POLICY ANALYSIS

The conference's keynote address examined the role of models in policy analysis. In that address, Lawrence Klein identified models as approximations of reality, noting there is no single model for all purposes. Rather, the design of the model chosen for a purpose is in large part determined by the objectives for that model's use. While some models are very general in design and can be used in a variety of applications, special-purpose models are probably best for use in dealing with specialized problems.

Marvin Duncan is an assistant vice president and economist and Ann Laing Adair is an assistant economist, both with the Federal Reserve Bank of Kansas City. The views expressed here are not necessarily those of the authors or of the Federal Reserve System.

[1] Participants at the symposium were Lawrence R. Klein, chairman of the professional board, Wharton EFA, Inc., and 1980 Nobel laureate in economics; Richard L. Feltner, consultant and former president, Federal Intermediate Credit Bank of Louisville; Don Paarlberg, professor emeritus, Purdue University; Lynn M. Daft, senior associate, Schnittker Associates; Dale E. Hathaway, principal member of Consultant International Group; John B. Penson, Jr., professor, Texas A&M University; Dean McKee, director of market economics, Deere & Co.; G. Edward Schuh, head of the Department of Agricultural and Applied Economics at the University of Minnesota; D. Gale Johnson, chairman of the Department of Economics and Eliakim Hastings Moore distinguished service professor, University of Chicago; Stanley R. Johnson, professor, University of Missouri-Columbia; Earl O. Heady, director of the Center for Agricultural and Rural Development and Charles F. Curtiss distinguished professor, Iowa State University; Gordon C. Rausser and Richard E. Just, department head and professor of agricultural and natural resource economics, respectively, University of California-Berkeley; Kenneth R. Farrell, senior fellow and director of the Food and Agricultural Policy Program, Resources for the Future; Bruce L. Gardner, professor, University of Maryland; William E. Kibler, deputy administrator for statistics in the Economic and Statistics Services, U.S.D.A.; and Luther G. Tweeten, Regents Professor of Agricultural Economics, Oklahoma State University.

Klein reported that the increasing capacity of computers to handle large amounts of data and to solve complex mathematical problems has led to the emergence of a number of large econometric models, such as those of Wharton Econometric Forecasting Associates, Data Resources, Inc., and others. These models typically are used for a variety of purposes, the most common being for forecasting the macroeconomy or significant parts of it. While the forecasting application is important and occupies a great deal of a modelbuilder's time, the largest use of econometric models in the policy process is for the study of economic alternatives.

In examining alternatives, a baseline solution that reproduces the actual economic outcome for a given time period is computed. Then policy targets are chosen, and policy controlled variables within the model are used to move the solution toward the policy objective. By examining various scenarios, the policymaker can examine the impact of a particular policy alternative on all sectors of the economy without actually having to implement the policy. In this manner, the best method for achieving a particular policy objective can be chosen. However, determining optimal policy outcomes still involves the use of the search and experimentation process.

Models of the agricultural sector have some distinctive features that are important to their applicability for policy analysis. They represent one sector of a total economy model and hence are an incomplete system. In the United States, agriculture does not dominate the country's economy as might be the case in some less developed countries. Yet, agriculture plays a major role in determining a politically sensitive component of the price level in the U.S. and is a major net contributor to the country's trade balance. In addition, agricultural models are distinctive in their incorporation of uncertainty, mainly due to weather variation, as a major factor. By drawing on the expertise of meteorologists and combining this with economic relationships, one can use models in ways that take account of uncertainty, in a quantitative sense, even though one is unable to make precise point estimates of the variables affected by uncertainty.

Modelers and policymakers alike argue that credibility in model performance must be built on the basis of their ex ante forecast record. Klein asserted that as forecasting devices, mainstream econometric models have stood the test of time. The challenge is to improve that track record in the even more dynamic and interconnected environment of the future.

Richard L. Feltner, commenting on Klein's paper, suggested two ways to improve the use of models for policy formulation and decisionmaking. First, further developments in both methodology and variable definition are needed. In particular, more input by decisionmakers is needed in model development, especially in the definition of variables. Secondly, there is need for much greater understanding and acceptance of models by decisionmakers. The need for decisionmakers to inject intuition and personal judgment cannot be overemphasized. In that context, an understanding of the emerging issues likely to affect agriculture is important to both modeling and decisionmaking.

EMERGING ISSUES AFFECTING AGRICULTURE

Don Paarlberg addressed the emerging farm and food policy issues of the 1980s which are likely to confront decisionmakers and policymakers. Based on his assumptions for the decade of the 1980s, he outlined six major issues:

1. Commodity programs for farmers will be of diminishing importance. Moreover, those that remain

will likely limit price increases as well as provide a floor under farm product prices.

2. Resource issues will grow in importance. Agriculture's assumed first claim on land and water will come under question.

3. Energy pricing and rationing by market or by regulatory fiat will be debated. Biomass assistance programs will come under increasingly unfavorable scrutiny.

4. Consumer interest and influence in agriculture, while it may not increase, is not likely to diminish.

5. The structure of agriculture and the fate of the family farm will continue to be an important policy issue.

6. Finally, agriculture's white male tradition will be strongly challenged by labor, ethnic groups, and others on the fringe of the industry.

Paarlberg asserted that these issues will be addressed in a policy setting in which farmers no longer have the initiative. Instead, food and fiber issues will be decided in a broader economic and social context in which the role of policy analysis in support of decisionmaking will be even more important than at present. No longer will freestanding agricultural models suffice. Rather, policy models capable of capturing the interrelationships between agriculture and the rest of the U.S. economy as well as the economies of other major U.S. trading partners must be developed more fully.

Lynn Daft, in reviewing the Paarlberg paper, questioned the certainty of the assumptions underlying Paarlberg's agenda of issues. He noted that the element of surprise in history, the mistakes in identifying a central tendency underlying policy issues, and the complicated and often conflicting attitudes toward government held by Americans contribute uncertainty and complication to the policy process. Agreeing with Paarlberg's description of the prospective policymaking environment, Daft added that although government policy relies on economic analysis to a greater degree than is commonly realized, the increasingly broad array of interests involved in agricultural policymaking will result in a process that is both more difficult to manage and more prone to error.

THE INTERFACE BETWEEN POLICYMAKERS AND MODELERS

For models to be useful, they must serve as effective aids in decisionmaking; therefore, the interface between modelers and policymakers is an important facet of the policy process. To the extent that there is a productive interaction, the difficulties and errors inherent in both modeling and policymaking can be reduced.

Dale Hathaway noted that policymaking, agricultural or otherwise, does not take place in a vacuum. Rather, it occurs within a number of constraints. For policymakers, the decision time frame is typically far shorter than is desirable for good decisionmaking, making the role of policy modeling and analysis both critical and difficult. Since political reality is the backdrop against which decisions are made, the path to an objective can become as important a consideration as the objective itself. This

point is particularly relevant since most policy decisions involve both benefit to some and cost to others.

Policymakers relying on models for guidance in decisionmaking are always concerned about the problem of misplaced preciseness. That is to say, it is far more tenable to have indicated the right direction of movement in a policy variable such as export sales, even though the exact magnitude proves incorrect, than to have been wrong on the direction of movement. Even when correct about direction, policymakers understand that they control a limited number of policy variables in the U.S. economic system. However, they often fail to recognize the risk of having those variables swamped by uncontrollable factors such as weather or interest rates.

As policymakers and modelers interact, Hathaway indicated, there are two sets of questions to which they must find answers. First, what are the possible means of achieving desired results and what will be the impact on various groups of using these different means? Second, what problems may occur, what are the consequences, and what is the probability of their occurence?

Policymakers often fail to ask these questions and sometimes disregard the answers which they are given. They tend to ask modelbuilders for answers within a preconstrained philosophical framework, and modelbuilders tend to provide answers that are further constrained by the limits of their data and models. When events outside the framework of their questions intervene, policymakers are disappointed with the model results and look elsewhere for advice. Modelbuilders are likewise frustrated to find policymakers taking actions based upon inaccurate or incomplete judgments on issues they could have addressed. However, once policymakers and modelbuilders learn the answers to these basic questions, they will be more able to work toward an acceptable solution for both parties. Achieving such a solution, however, will require improved policy models.

IMPROVING THE MODELS

A major portion of the symposium agenda was allocated to examining ways to improve the models used for policy analysis. The following set of papers explored this issue from a number of perspectives.

Linkages to the Domestic Economy

John B. Penson, Jr. explained the need for models to capture the linkages between agriculture and the general economy if models are to be of maximum use to policymakers. He argued, as did Paarlberg and Daft, that agriculture is increasingly linked to the general economy through its needs for capital and manufactured inputs, for off-farm employment opportunities, and for a viable market for its products. He added that the linkage can be made in the other direction as well. The U.S. economy with a growing population depends on agriculture for food and fiber; and as U.S. farm export markets expand, processors, handlers, and marketers of farm products depend on a reliable source of supply. Agriculture makes a positive contribution to the nation's balance of trade, partially offsetting the continuing U.S. trade deficit.

Among the transmission mechanisms between agriculture and the general economy that need to be better specified in policy models are the indirect effects on agriculture of nonagricultural events. These include supply related factors affecting agricultural input markets and demand related factors affecting agricultural product markets. The direct effects of government actions such as monetary and

fiscal policy, farm policy, or other actions affecting the cost of capital to the farm sector or the mix of asset holdings for agriculture should also be specified in policy models, according to Penson.

Three generations of policy models are currently in use by policymakers. First generation models represent agriculture as a separate entity influenced by few macroeconomic variables, omitting the transmission mechanisms through which events in other sectors of the economy are relayed to agriculture. Second generation models forecast events in agriculture in a recursive fashion, taking current period outputs from macroeconomic model solutions as input into the agricultural sector model solutions. Such models represent the most commonly used policy models. Penson asserted that a third generation of models, which incorporate the desired linkages between agriculture and the rest of the economy simultaneously solving for desired values, offers the greatest promise as a policy analysis tool. That is because they have been demonstrated to lower forecast error and to have the capacity to answer a broader range of policy questions.

Dean McKee, while agreeing with Penson on the potential usefulness of such third generation models, noted that for many applications, second generation models have thus far proved adequate when measured against cost and data limitations.

Foreign Trade Linkages

As important as the U.S. domestic market is to agriculture, export markets exhibit greater growth and for a number of important commodities are already larger than domestic markets. Consequently, to be of increased usefulness to policymakers, future policy models must incorporate foreign trade linkages.

The ability of currently used trade models to perform effectively in light of changing international financial markets and government policy interventions was examined by G. Edward Schuh. He emphasized that monetary policy has had an increasingly important effect on world trade. Shifts to flexible exchange rates have permitted underlying comparative advantages to reveal themselves to a greater extent than under a fixed rate regime. Moreover, in the presence of well integrated international capital markets, flexible exchange rates force trade sectors to bear the adjustment of changes in monetary policy. Thus, Schuh argued, the impact of exchange rate change must now be incorporated into foreign trade models. Indeed, the increasingly well integrated international capital market itself has implications for agricultural markets and hence must be reflected in trade models.

Commodity markets need to be linked directly to domestic and international financial markets if models are to be of optimal use to policymakers in the future policy environment. To do so, agricultural sector models must be components of general equilibrium models of the economy—an argument frequently made at this symposium. Finally the policymodeler examining trade questions must model world agriculture, and must account for the interaction between agriculture and government policy.

D. Gale Johnson, responding to Schuh's analysis, cautioned policymodelers that the long-run effects of monetary policy on trade may be quite different from the short-run effects. Hence, the linkage of monetary policy to the trade sector promises to be far more complex than at first realized. Moreover, Johnson raised questions about the capacity to predict trade flows and about the importance of doing so, except as it reflects the trade policies of either exporter or importer. Indeed, price differentials within a commodity which reflect dif-

ferences in quality may be more important to policymakers. Johnson concluded that understanding the role of government decisions in policy analysis is complex and at the same time very desirable. For example, the impact on world commodity markets of the Russian decision to expand meat production has been very substantial.

Evaluating Alternative Model Designs

Stanley R. Johnson examined alternative statistical designs for policy models of the agricultural sector. Emphasizing the role of econometric models in support of decision-making, he argued that models ought to be both theoretically sound and have predictive accuracy. All too often, however, models, particularly large scale ones, have specifications that possess only a weak or perhaps nonexistent basis in economic theory. Thus, model performance has sometimes broken down when predictions have depended on environmental variables that were not, or could not be, adequately projected. The suggested solution for such a problem is twofold: include these variables in the model and have them predicted with the rest of the system; and provide better theoretical support for model specification.

Policy models must be amenable to constant updating of the data base, as well as to model revisions and reestimation. Additionally, it is critically important that a model have a design that supports the policy decisions to be made. Such a model, according to Johnson, would include both those variables under the control of the policymaker and variables whose values will be determined within the model and by which the system can be evaluated. Since it is very difficult to incorporate theoretical richness in the specifications of such aggregate models, it is likely that theoretically sound models may be relatively simple in design.

To achieve the accuracy of forecasting and predictive content required by policymakers, localization of the model to the relevant problem setting is important. A number of approaches for localizing models to improve forecast accuracy and for linking of policy instruments to performance variables may be used. Such approaches include combining information derived from the pattern of the error term within the model solution or directly reestimating the model while more heavily weighting past data collected during circumstances similar to the proposed policy exercise.

Responding to the Johnson paper, Earl O. Heady added support to the importance of continuity, respecification, and updating of policy models. In this way, econometric models can be made to provide meaningful results to policymakers over time. Addressing the questions of model design, Heady noted that models must first be sufficiently complex to make useful and dependable predictions and that, as a separate step, the policy analyst must then translate the model's results into a form useful to the appropriate policymaker.

While Johnson directed his discussion toward econometric models, Heady argued that since many policy issues will involve circumstances not previously experienced, they cannot be reflected in time series or sample data. Under such circumstances, programming or simulation models will be appropriate. In fact, the linking of econometric models with programming or simulation models into a hybrid model to be solved recursively may provide the answers to some issues faced by policymakers. Because the problems of agriculture are so heterogeneous and the quantities to be analyzed so various, no single model form can meet all of these needs. Thus, Heady concluded, modelers should maintain diversity in the types of models available for policy analysis.

USING MODELS IN POLICY ANALYSIS

In examining the use of models in policy analysis, Gordon C. Rausser and Richard E. Just noted that while the costs of policy modeling have been incurred in recent years, the anticipated benefits have not yet emerged. However, adherence to a well-defined set of principles regarding model use and specifications, information use, and policy selection should enhance the anticipated payoff to modelers and to policymakers.

Modelers and policymakers alike should clearly understand the purposes and goals of a policy model. Indeed, the purposes and goals must be defined with a view to the policy decisions to be evaluated. When this is done, models can be used to conduct experiments which test the outcomes of various policy prescriptions without risking unexpected or adverse impacts on the real economy.

When constructing models, it is conceptually useful to have available as much data and information processing capacity as is possible. In a realistic policy modeling situation, data are always in short supply and sometimes of uncertain quality. Cost constraints limit the information processing capacity as well. Thus, care and judgment must be exercised in selecting a set of data that are most useful and an analytic framework—model specification—that is tractable. Moreover, the analytic framework should permit the policymaker to track and to accommodate the impact of changes in the economic systems being modeled.

Rausser and Just pointed out that designing a model which is both operationally elegant and adaptable is a demanding goal. Such a model requires a fair amount of theoretical structure, although the degree of such structure will vary from model to model depending on the amount of historical information available. In determining the structure of the policy model, emphasis is best placed on relationships that enable the modeler to understand an entire economic system, rather than simply one market or one side of a market within a system. The way in which information is used in a model can substantially alter the results of the analysis conducted. Policymodelers ought to use both intuition and common sense in determining when to include and when to exclude data from model estimation. More recent data, for example, may merit greater weight than older data in the estimation process.

Policymodelers have historically debated the relative merits of specialized or general purpose models. Rausser and Just suggest that attention could better be directed toward acquiring general purpose data sets which would facilitate speedy development of smaller more specialized policy models.

Finally, Rausser and Just indicate that policy models ought to be constructed in a way that permits policymakers to extract an increased amount of information by observing the model results. In this way, the "tidal wave" effect resulting from unexpected events overwhelming the effects of planned policy intervention or the examination of the path the economy takes as it moves toward a policy goal can be explored with the use of models. As a result, the probability of unexpected and undesirable consequences of policy actions occurring can be minimized.

These principals constitute a suggested code of conduct which should permit the potential value of quantitative policy models to be realized. They emphasize trade-offs to be examined as the transition from conventional models to more operational policy models is made. In the final analysis, of course, as Rausser and Just suggest, major benefits from modeling public policy problems depend critically upon the sound judgment and experience of public decisionmakers and the analyst involved.

In discussing the Rausser and Just paper, Kenneth R. Farrell offered some perspectives on the use of models in the policy process. He noted the distrust many policymakers have for formal economic models and added that there are a number of valid reasons for this attitude including lack of reliability in model estimates and poor communication between policymakers and analysts. Moreover, economists may not be as sensitive as is appropriate to the fact that no one type of model suffices for all policy purposes. Additionally, since policy formulation is not a dispassionate, intellectually pure process, models must produce reliable, plausible forecasts of critical variables with rapid turnaround of the analysis—quite a challenge for most economists. Finally, echoing Rausser and Just, Farrell noted that model results should not stand alone in a presentation to policymakers. Intuition, judgment, experience, and a knowledge of institutions and markets must be coupled with model results in the policymaking process.

REMOVING OPERATIONAL CONSTRAINTS

Despite the desirability of developing agricultural policy models that are consistent with the principles laid out by Rausser, Just, and Farrell, some operational problems remain. In a paper addressing these problems, Bruce Gardner argued that answers to policy questions usually need to be quantitative—that is, to have numbers attached. In some instances, quantitative answers are required to qualitative questions. Thus, to resolve the problems modelers face, two major constraints must be resolved. The first constraint is lack of data. Often there is an absence of data needed to model past economic events empirically or the data is of low quality. Sometimes there is an absence of past economic events that allow for assessment of proposed policy interventions. Without past experiences to provide data for modeling efforts, the modelbuilder's task becomes increasingly difficult. Additional funding for the collection and maintenance of data may be required to overcome this constraint.

The second constraint appears to be limitation of analysis. That is, economic theory is unable to properly forecast answers to questions, to guide empirical work that will do so, or to mobilize proper economic analysis in the political setting. Better theorizing by analysts could help alleviate this problem. And finally, when the chips are down in the real policy process, problems may on occasion not be resolvable because economic analysis may not be welcome.

In discussing the ways to relax constraints on modeling for policy analysis, Gardner questioned the usefulness of simulation—quantitative modeling without data—noting it is almost never a preferred analytical tool. When policy is involved, the issues in question are the unknown responses of human decisionmakers to policy options. A far more useful means to relax constraints on modeling may thus be experimentation, or using the data from the constantly occurring initiatives in agricultural policy to draw broader policy conclusions from such activities. According to Gardner, analytical shortcuts may be helpful in drawing inferences by indirect means. For example, the long-term consequences of a price-support regime in the United States are not observable, but a cross-country comparison of nations with different policy regimes might prove illuminating.

William Kibler, in response to Gardner's paper, noted the difficulty of funding data collection solely for policy analysis and suggested that data generated for production and marketing decisions might fill the gap if tapped.

Of course, more interaction between modelers and statisticians to determine what type of data should be collected for policy analysis purposes would help to assure useful data series. Kibler added that this interaction is important because due to financial constraints the ongoing problems of assuring data quality and adequate data series to support policy modeling will become more difficult to resolve in the future. Budget constraints make it necessary to carefully set priorities and standards for data collection that insure effective use of the resources available.

SUMMARY

In a closing luncheon address Luther Tweeten summarized the symposium, noting that economics has progressed from a science of classification and explanation to one that includes prediction. And while the predictive record of most models may leave something to be desired, they do provide a rich and systematic source of forecasts on a wide range of economic outcomes including alternative policy scenarios. As issues grow more complex, this source will become increasingly important in helping policymakers answer "what if" questions. Also, in part because large mainstream econometric models have educated the public and policymakers to the usefulness of quantitative analysis, the demand for model support for policymaking appears likely to grow.

Tweeten believes that the 1980s will bring to agriculture a rich and varied array of policy issues to which economists can apply their modeling skills. Among them are the supply-demand balance for farm commodities and attendant issues of inflation and terms of trade for agriculture; the structure of the U.S. economy, especially that of the agricultural industry and of agribusiness firms; and resource issues, including land losses to various causes including erosion.

The challenge before the economics profession, and modelers in particular, will be to address these issues in terms meaningful to policymakers. This will require some fundamental research relating to model structure and data use. But in an era of greater austerity in the universities and in government, it will also require better management and development of research tools—along with identification and careful maintenance of essential data series. Finally, Tweeten alleged, it will require better communication between modelers and policymakers as to both the identification of the relevant decision variables in policy formation and the transmission to policymakers of useful output from policy models.

Proceedings from the symposium are now available.

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Research Department
Federal Reserve Bank
of Kansas City
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