Inflation Uncertainty, Investment Spending, and Fiscal Policy

by Stephen L. Able

Business investment for new plant and equipment accounts for about 10 per cent of current economic activity, as measured by real GNP, and contributes importantly to the potential for future economic activity. By adding to the stock of capital, current business expenditures for plant and equipment help determine the future rate of productivity increase which, in turn, influences the long-run growth and inflationary potential of the economy.[1] Because of its importance for both the short- and long-run well-being of the economy, shortfalls in investment spending are viewed with concern.

A shortfall in investment spending may be described in terms of the ratio of real business fixed investment (BFI) to real GNP. One such shortfall has occurred in the most recent economic expansion (Chart 1). The BFI/GNP ratio was sustained for a few quarters above the business cycle peak reached in 1973:IV. It then dropped sharply, and 20 quarters after the onset of the recession, the previous cyclical peak level had not yet been regained. In the other two business cycles charted, the ratio of real BFI to real GNP fell moderately for several quarters and then began to move upward, reaching their previous cyclical peaks 16 quarters and 14 quarters, respectively, after the downturn's beginning.

The recent investment shortfall shown in Chart 1 has occurred during a period when inflation has been at historically high levels. As a result, several economists have suggested that high rates of inflation not only make forecasting future inflation rates more difficult, but that uncertainty regarding future inflation increases the risks associated with investment planning and thereby reduces the level of investment spending.

This article provides empirical evidence of the negative impact of inflation uncertainty on business fixed investment spending. In the first section, a standard model of investment spending — which excludes a variable for inflation uncertainty — is shown to substantially overpredict investment during the 1975-78 period. The next section describes a version of the standard investment model modified to incorporate uncertainty about future inflation. Forecasts of investment during 1975-78 were significantly improved by using the uncertainty model. The final section examines the impact

[1] For a detailed discussion of the problem of declining productivity growth, including its relation to investment, see Steven P. Zell, "Productivity in the U.S. Economy: Trends and Implications," *Economic* Review, Federal Reserve Bank of Kansas City. November 1979.

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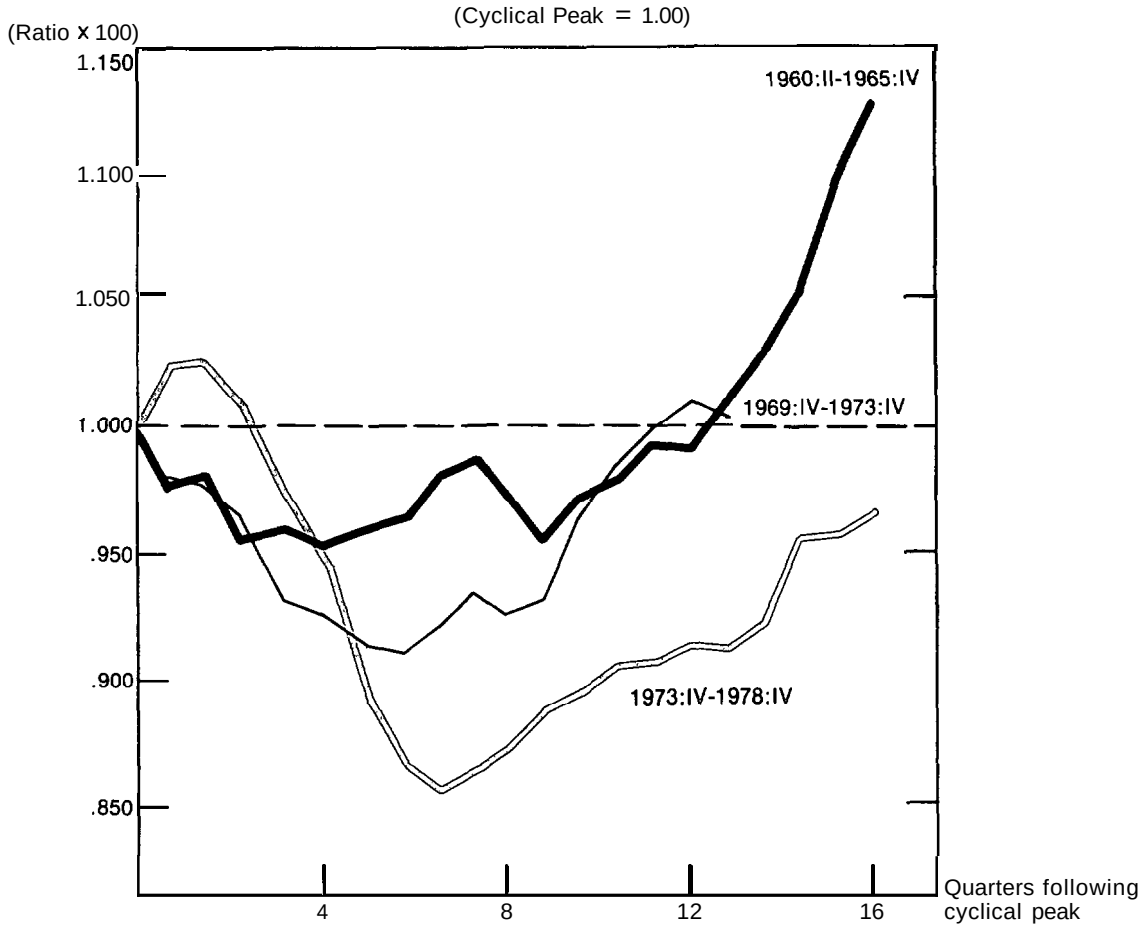
Chart 1
REAL BFI/REAL GNP: RATIO AS A PERCENTAGE OF CYCLICAL PEAK RATIO



of inflation uncertainty on the effectiveness of tax policies designed to stimulate investment spending.

A STANDARD MODEL OF INVESTMENT SPENDING

The standard neoclassical investment model used here to explain aggregate investment spending is based on an analysis of individual firm behavior.[2] Its basic premise is that firms try to maintain the stock of capital that allows them to maximize their anticipated profits, and that investment occurs as firms gradually adjust their stock of capital to the desired

[2] The standard neoclassical investment model was developed primarily by Dale Jorgenson and his associates. The most comprehensive presentations of the theoretical foundations of the model are found in Jorgenson, "Capital Theory and Investment Behavior," *American Economic Review*, 1963, pp. *247-59*, and "Theory of Investment Behavior," in R. Ferber, Ed., *Determinants of Investment Behavior*. Columbia University Press, New York, 1967, pp. 129-56.

level.[3] In its simplest form, the model states that investment undertaken to expand the stock of capital (net investment) depends upon past changes in the level of output and in the prices of output and of capital, and that investment undertaken to replace worn out capital (replacement investment) is proportional to the existing stock of capital.

The model may be expressed in the following equation:

$$(1) \quad I_t = \Sigma\omega_i \bullet \Delta \left(\frac{p \bullet Q}{c}\right)_{t-i} + \delta \bullet K_{t-1}$$

In equation (1), I_t denotes total, or gross current investment, p, the ptice of output, Q, the quantity of output, c, the cost of capital, K, the stock of capital, 6, the proportion of the capital stock which wears out during a single period, and the ω's are coefficients relating current investment to earlier changes in $p \bullet Q/c$.

Equation (1) states that total investment, I, in the current period depends on past changes in the value of output, $p \bullet Q$, and the cost of capital, c, and on the rate at which the existing stock of capital, K, wears out.[4] Even though investment plans are made on the basis of expected profits, which are related to the expected value of output and the expected cost of capital, past values of these variables are used in the equation because their past behavior 'is the maior determinant of expectations. In this model, then, an increase in either the expected price or the expected quantity of output will lead to subsequent increases in investment spending. And an increase in the expected price of capital will lead to subsequent decreases in investment. The price of capital used in the model is not the purchase price of a unit of capital, but rather an implicit price. The implicit price is used because of the nature of the capital input into the productive process. It is not the stock of capital that contributes directly to the production of output by a firm, but rather the services flowing from that stock. The implicit price of capital is the derived price of the services of the capital stock, and is determined by the rate of interest and the rate of depreciation, as well as the purchase price of capital.[5]

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3 To determine the desired or optimal stock of capital, the partial derivatives of profits and the production function with respect to capital are equated. Profits are defined as total revenues less total current costs, and production is assumed to follow a Cobb-Douglas function. The actual stock of capital is then assumed to be gradually adjusted to the desired stock in a manner described by Dale Jorgenson in "Anticipations and Investment Behavior," James S. Duesenberry, *et* al., Eds., *The Brookings* Quarterly *Econometric Model of the United States,* North Holland, Amsterdam, pp. 35-52.

4 The first term on the right-hand side of equation (1) represents net investment. Net investment is directly related to past changes in the value of output, $p \bullet Q$, and inversely related to past changes in the cost of capital. Thus an increase in anticipated demand, estimated on the basis of past changes in output, Q, or in the anticipated price of output, estimated on the basis of past changes in price, p, will lead to an increase in the level of net, and hence in total, investment. Since the cost of capital depends in part on the rate of interest, a decrease in the rate of interest will lead to a decrease in the cost of capital and an increase in net and total investment. The second term on the right-hand side of equation (1) represents replacement investment. As the stock of capital grows, a greater amount of investment is undertaken merely to maintain the existing stock of capital.

5 The interest rate is included to account for the opportunity cost associated with the purchase of capital. Funds not allocated to the purchase of physical capital can be used to repay loans or to purchase interest-earning financial assets. The rate of depreciation is included because capital is used up in the productive process and must be replaced if a constant flow of productive services is to be provided by the capital. A simple version of the cost of capital (abstracting from Federal tax policy, which is discussed later) is thus:

$$c = q \bullet (r + \delta)$$

where c is the cost of capital, q is the purchase price of capital, and r and 6 the rates of interest and depreciation, respectively.

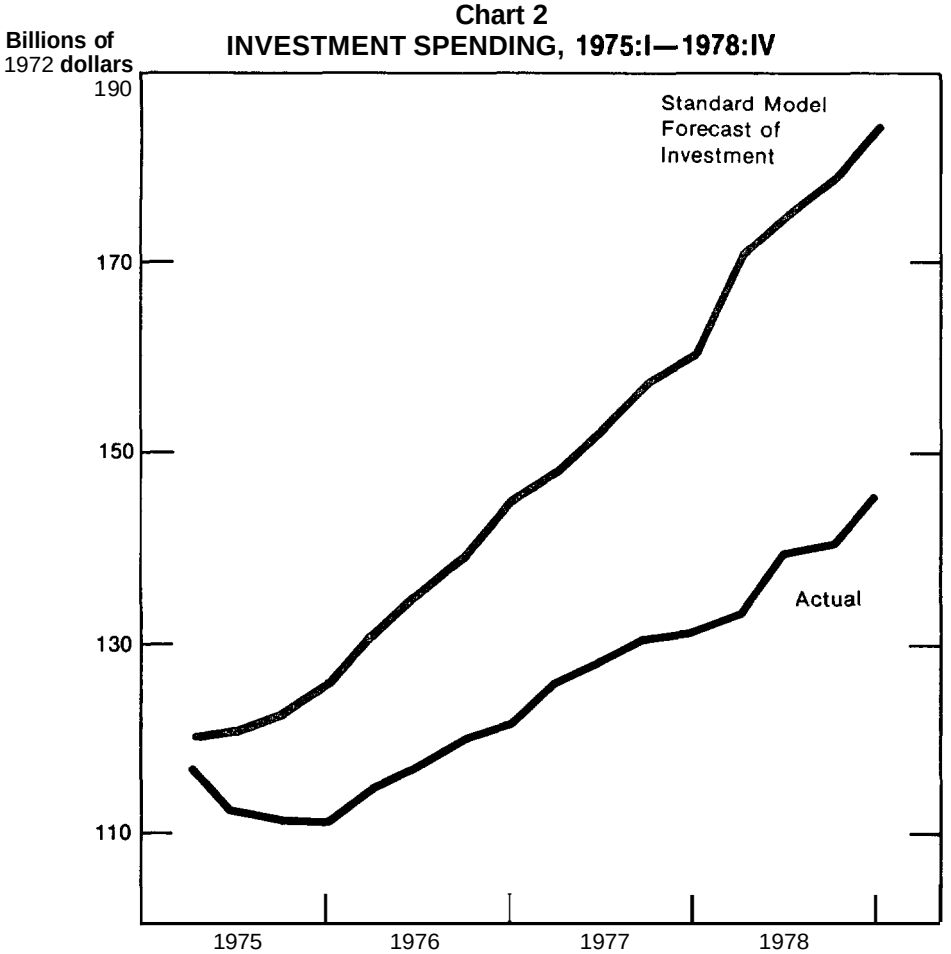
Forecasting with the Standard Model

A version of the standard neoclassical investment model given in equation (1) was estimated with quarterly data over the period from 1958 through 1974. (See Appendix for estimation details.) The model was then used to predict investment during the 1975-78 period. As shown in Chart 2, the model substantially overpredicted investment spending for the 1975-78 period. Thus, it can be concluded that the investment spending shortfall following the last recession cannot be explained by changes in the variables included in the standard model, i.e., by changes in output or in the prices of output or capital during the period. Other explanations of the shortfall must therefore be sought.

INFLATION UNCERTAINTY AND INVESTMENT SPENDING

Many economists view inflation as partly to blame for the recent investment shortfall. Theoretically, high rates of inflation should not have any direct effect on investment spending, except for effects on the tax structure. There is no intrinsic reason why, for example, a 10 per

Chart 2
INVESTMENT SPENDING, 1975:I—1978:IV



cent rate of inflation should produce a lower level of investment than a 5 per cent rate, if both rates of inflation are perfectly anticipated. However, it is widely believed that high rates of inflation can produce a high degree of uncertainty about future inflation, which might indirectly affect investment spending adversely. For example, Alan Greenspan, former chairman of the Council of Economic Advisors, has stated that the recent investment shortfall is the result of

> . . . a failure of confidence. More exactly, the uncertainty that plagues the investment commitment process is far more pervasive than a decade ago . . . . [The most important cause of this uncertainty is] inflation, the fear of an increasing rate in the years ahead . . . . An inflationary environment makes calculation of the rate of return on new investment more uncertain.[6]

Burton Malkiel has echoed this claim, stating that investment has been sluggish because

> A number of economic developments of the early 1970s have undoubtedly raised substantially the risk premium attached to the investment decision . . . . Inflation has remained at a high rate despite considerable slack in the economy, and the inflation rate has been accelerating as we approach fuller capacity utilization. High levels of inflation make long-run planning especially hazardous.[7]

It is thus hypothesized that the high degree of uncertainty that has accompanied the high rates of inflation in recent years has inhibited fixed business investment. To test this hypothesis, it is necessary to incorporate inflation uncertainty into a model of investment behavior.

According to the standard neoclassical investment model, investment decisions are based on firms' forecasts of future profits. However, a particular forecast should be viewed as only a best guess (or an average value) among a possible range of future values. For example, a forecast of a 10 per cent increase in profits might represent the forecaster's view that profits will increase between 8 and 12 per cent, or it might represent his view that profits will increase between 5 and 15 per cent. The larger the perceived range of values associated with a given forecast, the greater the uncertainty regarding the accuracy of the forecast.

The greater the degree of uncertainty about a forecast, the greater is the chance of an erroneous decision based on that forecast. In the case of investment decisions, the greater the uncertainty regarding forecast profits, the greater is the possibility of investing more or less than needed to maximize actual profits when they occur. Because a postponed investment can generally be started later at a smaller loss than the loss involved in scrapping an investment already begun, the risk associated with investing too much outweighs the risk of investing too little. Thus, it is likely that firms respond to increases in uncertainty by investing less than would be suggested by the forecast of profits.

The response to increased uncertainty can be incorporated in the standard investment model

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6 Alan Greenspan, "Investment Risk: The New Dimension of Policy," *The Economist,* August 6, 1977, pp. 31-32.

7 Burton Malkiel, "The Capital Formulation Problem in the United States," *The* Journal of *Finance,* May 1979, p. 297.

by treating uncertainty as an implicit cost of production.' This requires that the uncertainty associated with future profits be quantified and deducted from the forecast profits, producing an uncertainty-adjusted profit expression.[9] Because it is likely that uncertainty regarding all prices of inputs and outputs are closely related, the uncertainty associated with the overall inflation rate may be used as the appropriate measure of uncertainty in making the investment decision.[10]

An uncertainty-adjusted version of the standard investment model is thus derived which differs from the original in that it includes a variable that measures the degree of inflation uncertainty. Like the standard version, the modified version of the neoclassical model indicates investment is positively related to past changes in the value of output, and negatively related to past values of the cost of capital. It also indicates that investment is negatively related to the degree of uncertainty about inflation, as measured by the variation in actual output prices about their forecast value.

In equation form, the modified model may be written

$$(2)\quad I_t = \Sigma\omega_i \bullet \Delta\left(\frac{pQ}{c}\right)_{t-i} - \Sigma\gamma_i \bullet \Delta U_{t-i} + \delta \bullet K_{t-1}$$

In equation (2) U is the uncertainty variable.[11]

Equation (2) is identical to equation (1) except for the inclusion of U, a variable which depends primarily upon the degree of inflation uncertainty. The negative sign associated with past changes in the uncertainty variable indicates that investment is inhibited by increases in the degree of uncertainty.

Forecasting with the Uncertainty Model

Explicit introduction of inflation uncertainty into the investment model permits a test of whether the recent shortfall in business investment was at least partly attributable to the greater uncertainty about future inflation associated with the existence of high rates of inflation. The modified investment equation (2) was estimated with quarterly data over the period from 1958 to 1974 (see Appendix for estimation details) and was used to forecast investment spending from 1975 to 1978. As seen in Chart 3, the uncertainty model, like the standard model, overpredicts investment since the last recession. However, the amount of overprediction is substantially reduced by the introduction of a measure of inflation uncertainty. The $40-billion overprediction of fourth quarter 1978 investment by the standard

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8 A complete description of this model may be found in the author's unpublished Ph.D. dissertation, Uncertainty, Risk Aversion, and the Neoclassical Investment Model: An Empirical Study, Indiana University, 1979.

9 Profits are traditionally defined as gross revenue less total operating costs. In the modified version of the neoclassical model used in this study, expected profits (based on forecasts of future revenues and costs) are adjusted by deducting, in addition to traditional costs, an implicit cost associated with uncertainty:

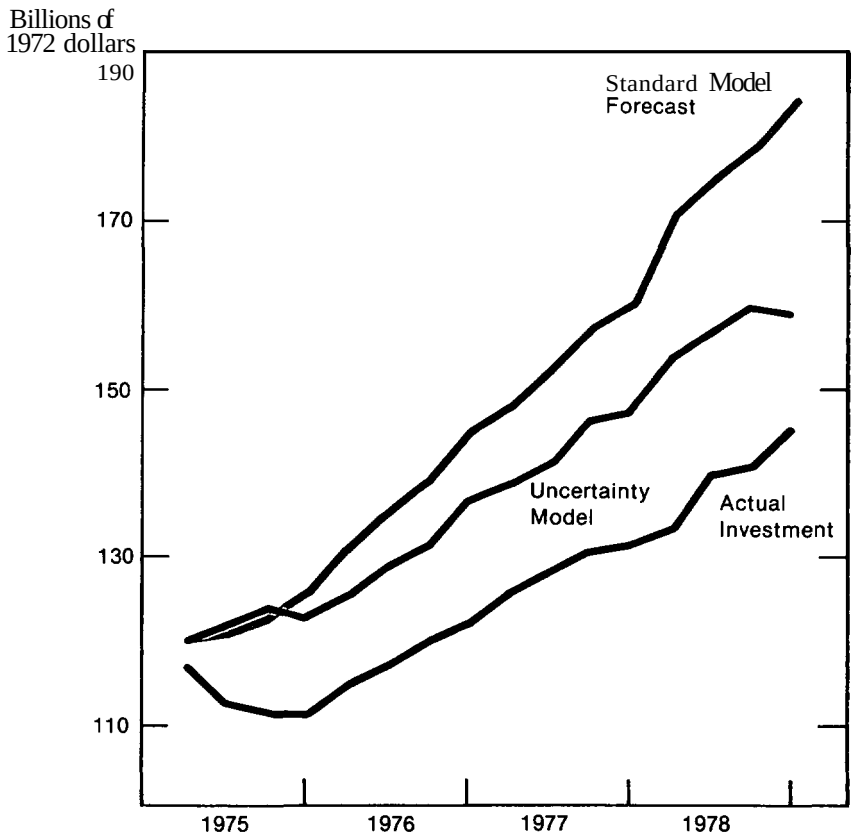
$$\tilde{\pi} = E(\pi) - mVar(\pi)$$

where $\tilde{\pi}$ represents uncertainty adjusted profits, $E(\pi)$ represents expected profits, and $Var(\pi)$ represents the variance of profits, which is assumed an appropriate measure of uncertainty. The coefficient, m, may be interpreted as the implicit price of risk, so that the more averse a given firm is to the potential loss arising from erroneous forecasts, the larger the deduction from profits for a given level of uncertainty. In deriving the model, it is this amended version of profits which is maximized to derive the optimal stock of capital.

10 Assuming that all variances and covariances associated with the prices of inputs and output are proportional to output prices allows the variance of profits to be expressed as proportional to $Var(p) \bullet Q^2$.

11 The value of U is equal to $\frac{Var(p) \bullet Q^2}{}$, where Var(p) is treated as a measure of inflation uncertainty.

Chart 3
INVESTMENT SPENDING, 1975:I—1978:IV
(Actual, Standard Model Forecast, and Uncertainty Model Forecast)



model is reduced by $25 billion by introducing the uncertainty variable in the investment equation. Though other factors were also at work, the investment shortfall during the recent expansion apparently was, in large part, caused by the high degree of inflation uncertainty throughout this period of rapidly rising prices.

INFLATION UNCERTAINTY, INVESTMENT SPENDING, AND FISCAL POLICY

Because of investment's important contribution to the long-run well-being of the economy, evidence of an investment shortfall may lead to consideration of policy actions aimed at stimulating additional capital spending. In recent years, fiscal policy instruments have been used to stimulate investment spending. For example, corporate tax rates have been lowered, an investment tax credit has been given, and adjustments have been made in the rate at which assets are depreciated for tax purposes. Such changes in tax policy have their effect on investment spending by altering the cost of capital to the firm. Because firms' investment spending decisions are made in the light of after-tax costs and returns, a model of

investment performance should include the cost of capital in after-tax form.[12]

The uncertainty model of investment spending—shown above to be a better predictor of investment spending than the standard model—may be used to estimate the potential impact of tax policy on investment spending when inflation uncertainty is taken into account. To do so, the effect of a change in taxes on the implicit price of capital is calculated, which leads to a policy-induced change in investment spending in the modified, or uncertainty, investment equation.

Using the uncertainty model might aid in the formulation of fiscal policy. Economic policy-makers not taking account of the investment-depressing influence of inflation uncertainty might expect a greater impact from a given stimulative change in tax policy than would. actually occur. Indeed, it may be hypothesized that the greater the degree of inflation uncertainty present among firms, the smaller will be the increase in investment spending following a given piece of fiscal policy stimulus.

To determine the effect of inflation uncertainty on a stimulative tax policy change, the impact on investment spending of a reduction in the corporate tax rate from 48 to 42 per cent was calculated. Two alternate assumptions were made about the degree of inflation uncertainty existing at the time of the policy change.[13] In one case, a high level of inflation uncertainty was assumed, representing the high level of uncertainty that existed during the rapid inflation period of the late 1970s. In the other case, a low degree of inflation uncertainty was assumed, similar to that of the slower inflation of the early 1970s.

The results of these simulations support the view that the impact of stimulative tax policy measures on investment spending is impaired when inflation uncertainty is high, as it was in the late 1970s. The estimated increases in investment spending attributable to the reduced corporate tax rate are shown in Chart 4, for each assumption about the degree of inflation uncertainty. Three quarters after the assumed tax cut, the investment spending generated by this particular stimulative policy change is about 50 per cent greater in a low inflation uncertainty environment than the investment spending generated when inflation uncertainty is high. And the difference in additional investment between the high and low uncertainty cases is maintained in subsequent periods.

CONCLUSION

Two major conclusions emerge from this study. First, empirical support has been provided for the judgment that increased uncertainty about future inflation—which generally exists when the rate of inflation is high—adversely affects investment spending. When a variable measuring the degree of inflation uncertainty is included in an investment model, forecasts of the 1975-78 period overpredict actual investment expenditures by substantially less than when such an uncertainty variable is excluded. Second, simulations of the uncertainty model show .that higher degrees of inflation uncertainty have

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12 Inclusion of tax policy variables cause the cost of capital expression given in footnote 5 to be amended as follows:

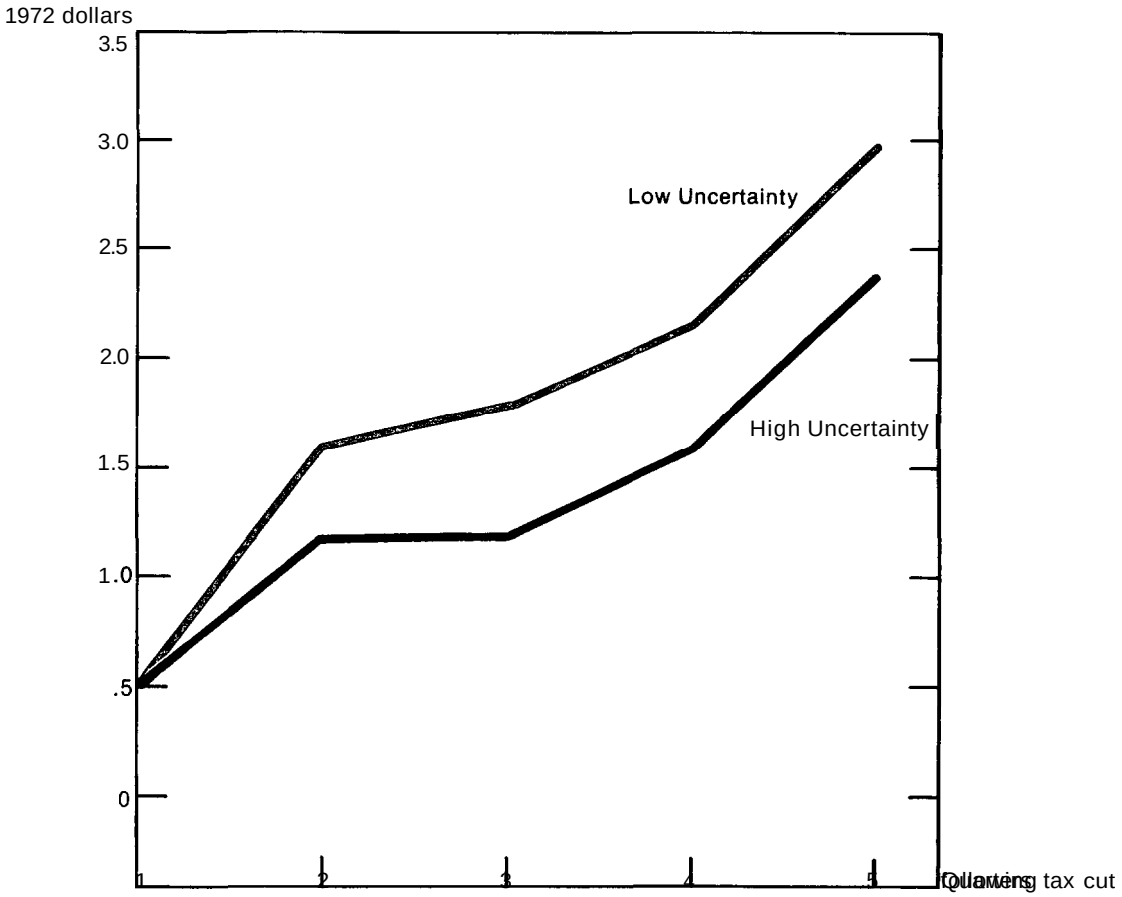
$$c = (1/1\text{-}u) \bullet q(r + \delta) \bullet (1\text{-}k\text{-}uz)$$

where u is the corporate tax rate, k is the investment tax credit and z is the present value of the depreciation allowance.

13 The values of all the explanatory variables (other than the uncertainty variable) in equation (2) were assumed to be approximately equal to their values at the end of 1978.

Chart 4

ADDITIONAL INVESTMENT ATTRIBUTABLE TO CORPORATE TAX RATE REDUCTION AT DIFFERENT DEGREES OF INFLATION UNCERTAINTY



greater negative impacts on the effectiveness of tax policy intended to stimulate business fixed investment.

The implications of these results are clear for the importance of achieving success in the fight against inflation. One effect of a reduction in the rate of inflation is likely to be a reduction in the degree of inflation uncertainty which, in turn, may be expected to have a direct positive effect on business investment. Furthermore, should fiscal policy actions to stimulate investment be deemed desirable, the impact of a given policy change would be greater in an environment of reduced uncertainty about future inflation accompanying lower rates of current inflation.

Appendix

ESTIMATION RESULTS

Table A.1

Estimation Results for Investment in Equipment (I_N = Net Investment)

Equation 1
(Standard Version)

$$\Delta I_N E = \sum_{i=0}^{3} \omega_i \bullet \Delta \left(\frac{p \bullet Q}{c}\right)_{-i}$$

$\omega_0 = .0038$ (1.86)

$\omega_1 = .0026$ (1.19)

$\omega_2 = .0011$ (0.50)

$\omega_3 = .0036$ (1.68)

Residual Variance 2.579

Equation 2
(Uncertainty Version)

$$\Delta I_N E = \sum_{i=0}^{3} \omega_i \bullet \Delta \left(\frac{p \bullet Q}{c}\right)_{-i} + \gamma \bullet \Delta U_{-1}$$

$\omega_0 = .0033$ (1.72) $\gamma = -.0082$ (-2.83)

$\omega_1 = .0034$ (1.66)

$\omega_2 = .0002$ (.14)

$\omega_3 = .0037$ (1.83)

Residual Variance 2.313

Table A.2

Estimation Results for Investment in Structures (I_N = Net Investment)

Equation 1
(Standard Version)

$$\Delta I_N S = \sum_{i=1}^{4} \omega_i \bullet \Delta \left(\frac{p \bullet Q}{c}\right)_{-i}$$

$\omega_1 = .0020$ (2.27)

$\omega_2 = .0007$ (.72)

$\omega_3 = .0007$ (.78)

$\omega_4 = .0025$ (2.75)

Residual Variance .93

Equation 2
(Uncertainty Version)

$$\Delta I_S N = \sum_{i=1}^{4} \omega_i \bullet \Delta \left(\frac{p \bullet Q}{c}\right)_{-i} + \gamma \bullet \Delta U_{-2}$$

$\omega_1 = .0018$ (2.12) $\gamma = -.0026$ (-1.98)

$\omega_2 = .0008$ (4.80)

$\omega_3 = .0005$ (.57)

$\omega_4 = .0022$ (2.39)

Residual Variance .89

Differences in the tax laws associated with different kinds of investments dictated that equations (1) and (2) be estimated separately for investment in equipment and in structures. An investment tax credit is allowed on investment in equipment, but not on investment in structures. Depreciation allowances depend upon the durability of a given asset, so that in general these allowances are quite different for structures, which are relatively long-lived, and for equipment, which is relatively short-lived. Investment, capital stock, and output data for the private domestic economy were used in estimating the equations, and the prices were the deflators from these series. The Aaa corporate bond rate and the statutory corporate income tax and investment tax credit rates were used in calculating the implicit price of capital. The value of U in equation (2) was based on the residual variances associated with a price forecasting model estimated for each period in the sample. The forecasting model was reestimated for each sample period on the basis of the prior 40 observations on output price.

In estimating the investment equations described above, technical considerations suggested the use of changes in net investment rather than levels of net investment as the dependent variable. Using such a specification reduced substantially the lag lengths associated with the explanatory variables in the equations, so that there was no need to employ sophisticated distributed lag techniques in estimating the equations. The best fitting versions of the standard and amended investment equations, derived on the basis of the ordinary least squared estimation (OLS) technique, are presented in Tables **A.1** and **A.2.**

These estimates support the hypothesis that increases in the degree of uncertainty adversely affect fixed business investment. The negative coefficients associated with the uncertainty variable in the amended equation imply that increases in the degree of uncertainty in the economy lead to decreases in the level of investment spending. As indicated by the size of the t-statistics associated with the estimated uncertainty coefficients, this is a statistically significant result.