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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

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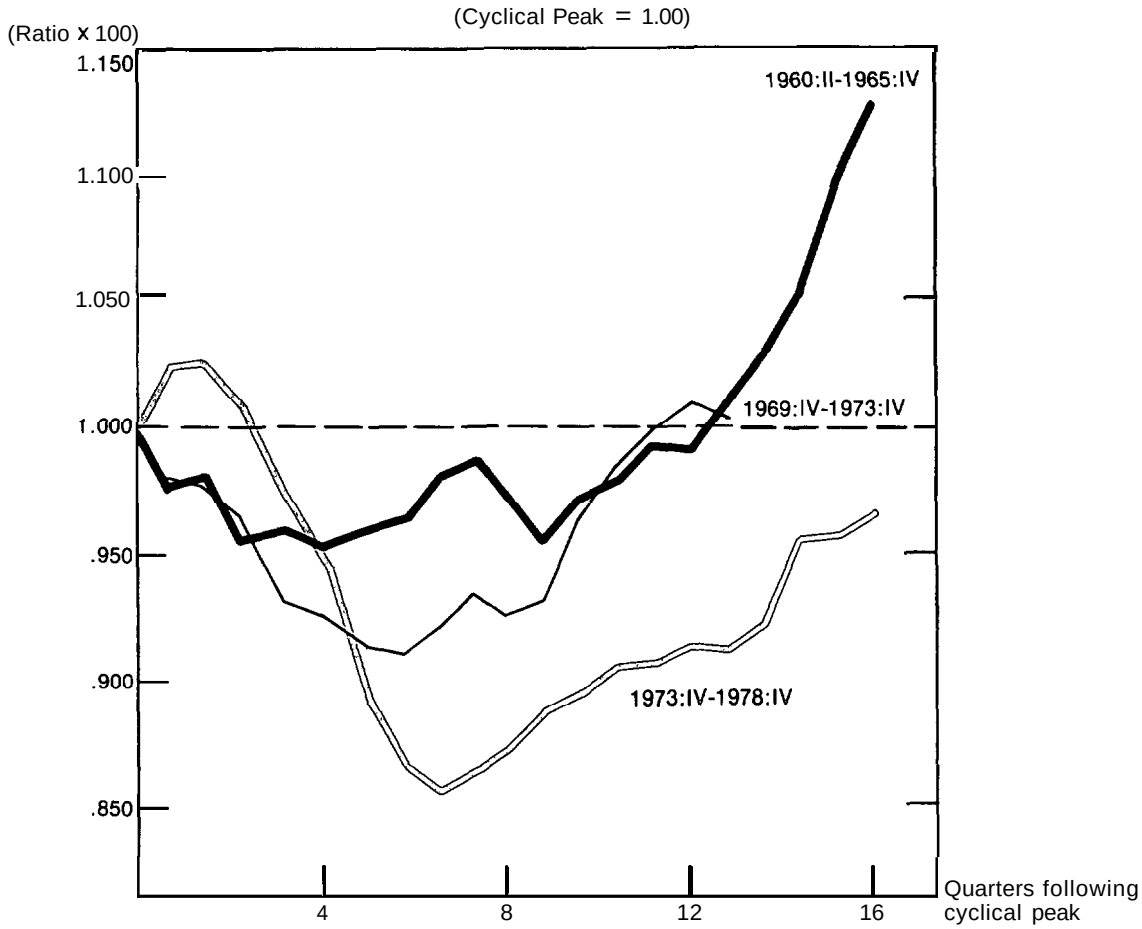
Chart 1
REAL BFI/REAL GNP: RATIO AS A PERCENTAGE OF CYCLICAL PEAK RATIO



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.

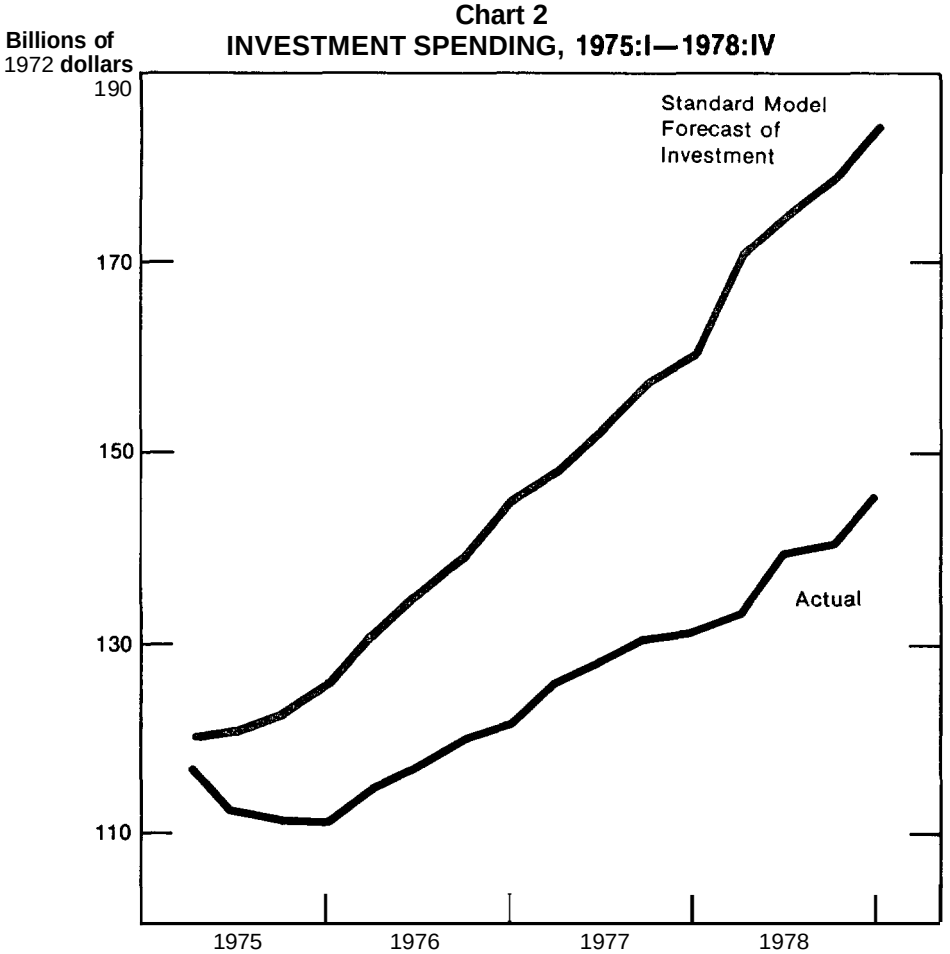
Forecasting with the Standard Model

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:

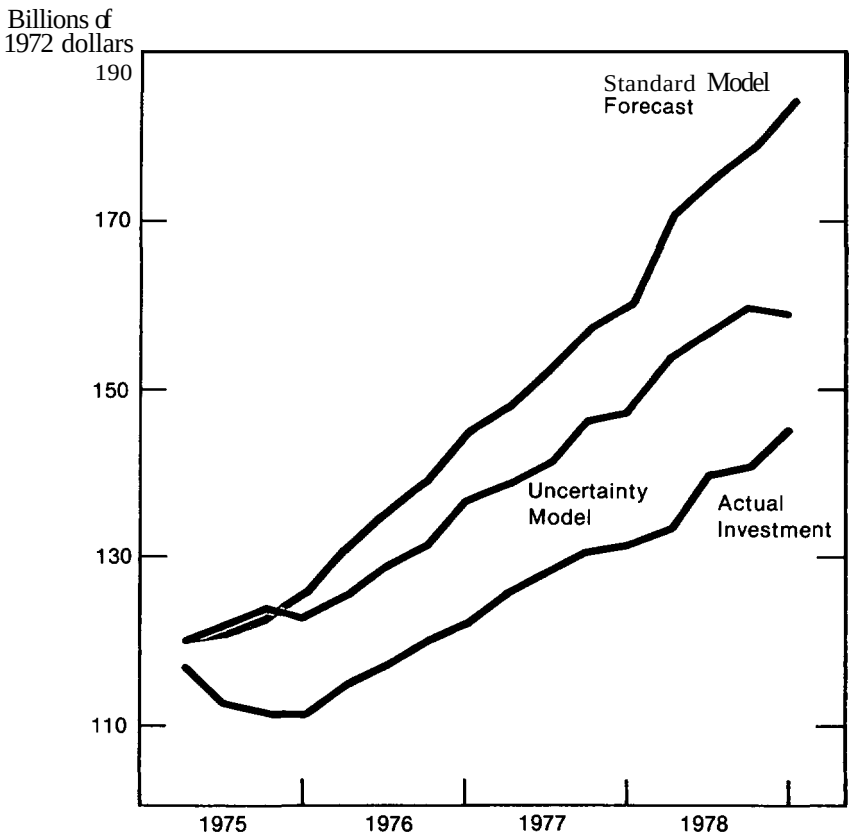
$$\tilde{\pi} = E(\pi) - mVar(\pi)$$

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:**

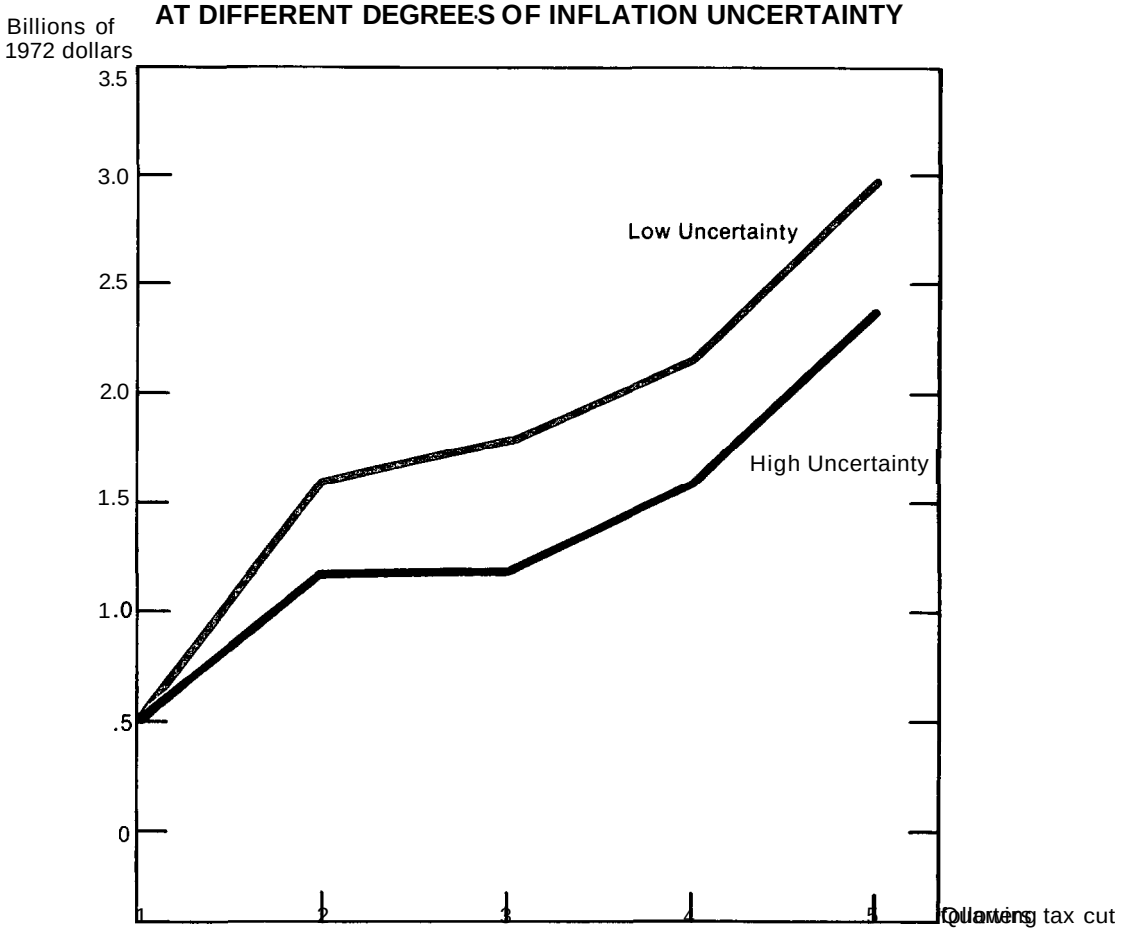
$$c = (1/1\text{-}u) \bullet q(r + \delta) \bullet (1\text{-}k\text{-}uz)$$

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) $\quad \gamma = -.0082$ (-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) $\quad \gamma = -.0026$ (-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.

Western Water Resources: Coming Problems and the Policy Alternatives

By Marvin Duncan and Ann Laing

The United States is now entering an era in which the supplies of many natural resources previously taken for granted are becoming increasingly scarce and expensive. Water in the western United States is one such resource. Agricultural and urban interests are making conflicting claims on a limited supply of water. Development of Indian owned resources and energy production add huge potential claims against the available water supply. Problems in allocating water in the West, where potential demands appear to exceed likely supplies, are compounded by environmental constraints and the high cost of adding to present water supplies. Furthermore, the legal and institutional framework for resolving these problems may be inadequate to meet the challenge presented.

These problems are becoming more apparent, and answers are urgently required by the western United States, and by the rest of the nation as well. Recognizing this, the Federal Reserve Bank of Kansas City recently hosted a symposium to examine the coming problems related to water resources and to identify policy alternatives for coping with these problems.

This article summarizes the major issues and the alternative solutions addressed in the presentations and discussions at that symposium. Thus, the viewpoints expressed in the article are those of the participants at the symposium. The dimensions of the water resource problems are first outlined, summarizing some of the more serious conflicts over water use. Alternative policies to cope with the water resource problems are considered, with special attention to those associated with financing water resource development. Next, the sometimes contradictory state and federal policy positions on water are outlined, along with areas of potential agreement and cooperation. Finally, the article examines a number of methods to improve the water allocation process.

Marvin Duncan is an assistant vice president and economist and Ann Laing is a research associate, both with the Federal Reserve Bank of Kansas City. This article represents ideas discussed at a symposium conducted September 27-28, 1979, in Denver.

DIMENSIONS OF THE WATER RESOURCE PROBLEMS

Keynoting the Symposium

Emery N. Castle, president of Resources for the Future, Inc., indicated that the usual

western response to water shortage of developing more supply will prove inadequate by itself to address future problems. The need to use water more efficiently will generally be acknowledged, but the means to implement that goal will not be easily reached. Water resources development and management will be further complicated by the interaction of efficiency and equity considerations, as questions of environmental protection and fairness assume increased importance for decisionmakers.

Castle asserted that America faces two fundamental problems in formulating a natural resource policy that will best serve the nation's needs. The first problem arises from society's desire to provide for a mix of both private and public resource development. The second concern is deciding how to harmonize individual and group decisionmaking. Successful water resource policy decisions will likely require that both of these problems be concurrently resolved. Four major policy guidelines for water policy seem useful in resolving these two issues, according to Castle.

1. Water policies of the future need to recognize the powerful role of ***individual incentives.***
2. It is critically important to make improvements in ***state water laws.***
3. Society must determine the ***appropriate role of government*** at various levels in water programs and policy.
4. Special effort should be made to ***reduce the uncertainty associated with group action*** affecting water policy.

Water policy decisions in the coming decade will force Americans to consider how they are going to achieve some of their most fundamental goals. The appropriate policies will permit Americans to choose a combination of market and nonmarket goods in a way that will not damage the country in the process. It is reasonable to expect that these policies will recognize the need for group action but will also promote individual decisionmaking that supports the common good.

Conflicts Over Water Use

Conflicts over water occur when one group is not adequately compensated for changes in water use, quality, or supply. "Socially efficient policies and projects remain situations of conflict in the absence of adequate compensatory channels," according to Charles Howe, professor at the University of Colorado. Present water supply conflicts stem from the competition among users for the available water. Industrial and municipal water users are putting increasing demands on water previously allocated to agriculture in many areas of the West. The actual diversion of water is, however, constrained by interstate compacts among water basins, by the physical characteristics of each water system, and by the legal difficulties in transferring water rights among users. Transfers of water from lower valued uses to higher valued uses are desirable, although the direct and indirect effects of such action ought to be evaluated prior to implementation of any shift in use. Howe cautioned that "because of the regional nature of water systems, we must anticipate localized problems within sub-basins even if aggregate data exhibit no difficulties."

Future water supply development is constrained by cost. Additional impoundments may not be economically viable due to rapidly increasing construction costs and lack of adequate sites. Measures such as interbasin transfers or desalinization of ocean water are presently infeasible because of the high energy costs associated with the movement or

conversion of large quantities of water. Heavier mining of groundwater has been suggested as an alternative to augment present supplies, but present use may preclude future use. Howe said, therefore, that it is essential to balance present and future needs in determining an appropriate pattern of use over time.

An area of great potential conflict may be Indian water claims—most of which remain to be settled by legal action, according to Richard Simms, general counsel to the Interstate Stream Commission. Indian tribes are presently claiming the right to water passing through their reservations based upon a 1908 legal decision known as the Winters Doctrine. In this case, the U.S. Supreme Court determined that when the federal government set aside public land, it also reserved sufficient water to satisfy the purpose of the land. Unfortunately, the Winters decision did not state whether the reserved right applied to present or future use. The Indians now assert that they are entitled to enough water for future development of any type. The water claimed by the Indians could be leased back to the present users of the water until needed for reservation development. However, in the extreme case, the city of Los Angeles and other users of the Colorado River would pay the Indians for the use of Colorado River water--or could lose access to future use of the water. Until definitive judicial decisions on the whole question of Indian water rights are handed down, the validity of these claims and the disposition of the contested water will continue to be cloaked in uncertainty.

Water Quality Problems

Availability of a particular quality of water to meet a certain demand is what society is really concerned about, rather than a general shortage of water, according to John Timmons, professor at Iowa State University. The quantity theory of water has, in the past, ignored variations in water quality and treated all water alike. Increasingly, projections of water demands by quality type are recognized as basic and necessary elements in planning and carrying out water policy. Changes in quality may preclude or increase the cost of subsequent use of the same water. To resolve that dilemma, Timmons advocated permitting a use as long as the water quality was returned to a level required by the next user.

A whole new generation of water quality problems requiring the attention of policymakers is emerging. Point source pollution has thus far been the main focus of water quality control measures, but focusing on nonpoint sources may lead to far greater progress in managing water quality.

A recent area of concern is the problem of toxic pollutants introduced into the watershed via the atmosphere, mainly from coal combustion. Acid rain, one result of these toxic pollutants, has had deleterious effects on many areas. Another serious problem is excessive sediment, resulting from irrigation and clogging streams and reservoirs. Large scale changes in agricultural practices may be necessary to deal with this problem.

"To deal directly with these new-generation problems, we must better understand the natural systems that are involved, including the chemistry and hydrology of river basins," said Allen Kneese of Resources for the Future. Interaction among the various components of our nation's water supply ought to be fully understood before further actions are taken that may adversely affect it.

POLICIES TO COPE WITH THE PROBLEMS

There are real shortages of water in many regions now, and many experts feel that policy changes are necessary to alleviate even greater future shortages. Theodore Schad, deputy

director of the Commission on Natural Resources, suggested some means of augmenting water supplies to meet growing water demand.

Regional water shortages might be relieved by interbasin transfers across both states and countries. The vast majority of North America's unused fresh water resources are in Canada. Therefore, it has been suggested that the U.S. might look to Canada for a solution to our water supply problems. Transfers are unlikely, though, as uses and needs for water in the future may differ greatly from those at present. Moreover, huge interbasin transfers are not practical considering current technical, economic, energy, and political constraints. In North America, Canadian and U.S. water deficient regions are contiguous, thus making transfers across that international border seem very unlikely. The Columbia River, which presently. remains largely undeveloped due to environmental concerns about wild and scenic rivers, is a possible source of additional water for the western United States. However, Canada considers its rivers an undeveloped resource which may be needed for future economic development. Hence, Canada is likely to be reluctant to sell its water birthright to the U.S.

Additional impoundments — transferring water supply from one time period to another — are another method for equalizing the stream flow. But impoundments are subject to high evaporative losses and to strong opposition by environmental interest groups. Controlled mining of groundwater is another possibility since presently accessible groundwater supplies are estimated at 35 times the volume of annual surface runoff.

However, better knowledge of aquifer recharge systems is necessary to achieve adequate groundwater management. Advance forecasting of hydrologic events, allowing management of long- and short-term precipitation, may be a relatively low cost, yet productive method of augmenting water supplies. Other possible, although exotic, methods are snowfield management, iceberg towing, and undersea aqueducts. However, such exotic proposals are costly and may have adverse environmental impacts.

On balance, symposium participants concluded that many of the possible means to augment the present water supply are not economically or politically feasible as methods of resolving either current or future supply problems.

In fact, the most practical and economically viable solution to the nation's emerging water shortages is to reduce demand by the full-cost pricing of water, and to increase supply by reuse and recycling water for industrial purposes. More efficient use of irrigation water alone would result in substantial savings of water.

Financing Water Resource Development

Financing of water projects is an area where the present institutional system functions inadequately and inequitably, according to Leo Eisel, director of the U.S. Water Resources Council. Historically, the federal government has been the major factor in financing water resource development on a cost-sharing basis. But the difficulty associated with identifying the beneficiaries has led to inequities in cost distribution.

The current situation for U.S. water resource development reflects a lack of uniform policies with respect to participants, methods, and timing. The existance of 12 separate major development purposes further complicates the cost-sharing picture. Federal financing is currently regulated by a complex web of 185 separate rules developed by Congress. Thus far recommendations for reform of

these rules have gone unheeded.

"Federal financing exists because many of the proposed projects are not economically feasible or the outputs of the projects are collective goods; therefore entrepreneurs have little incentive to invest," B. Delworth Gardner, director of the University of California-Giannini Foundation, told the symposium audience. Because of their collective nature, outputs such as flood control, recreation, and navigation will not be allocated in socially optimal quantities in a completely private market.

Federal financing of water may also exist because rights to water by certain classes of users have never been created. External effects created by the interdependence of water demand cannot easily be included in market transactions because use by one affects the availability and value to others. For this reason, political allocations have been thought to be better than market allocations. However, Gardner said, "political allocations have been shown to be economically inefficient and are certainly no better than a water market."

Policymakers increasingly prefer that those who benefit from water resource development pay the associated costs. However, water charges to users have almost always been set at well below the actual supply costs in order to encourage development in the West. Since development no longer needs encouragement, a water market institution to cope with changing supply and demand conditions could work far more efficiently than the present method, some experts assert. Under such a system, water users would pay full costs if all outputs from water projects were treated like private goods for pricing purposes. For the outputs that are collective, one method of achieving efficient resource use could be the sale of water contracts which require full payment in advance.

STATE AND FEDERAL POLICY: MOVING TOWARD A CONVERGENCE OF PURPOSE AGAIN?

"The western character has been shaped by the relentless struggle to put water to land," said Governor Scott M. Matheson of Utah, in outlining the water policy position of the western states. As migration moved into the semi-arid regions of the American West, water's availability and allocation quickly became a focal issue.

The West resolved part of that issue to its satisfaction with the emergence of a new concept in water rights—the doctrine of prior appropriation. That doctrine held that the first user to put water to a beneficial use established a superior claim to a specified quantity of water as long as it continued to be used for that purpose. A whole set of water laws developed around this new doctrine, one well suited to the region and to the times.

The federal government appeared to acquiesce in the states' solutions to water policy issues. States were left free to allocate water and to form interstate compacts. The federal government both permitted these actions by default—by permitting state water institutions to assume primary control of water resources management— and by providing generous amounts of public funds to reduce flood damage, harness water power, provide recreational opportunities, and supply irrigation and municipal water.

The implicit cooperation between western states and the federal government might have continued were it not for the emergence of policy questions that have grown more important in recent years and now demand solutions. Indians have instituted legal action to establish their claim to sufficient water to support economic development on Indian lands. Urban growth in the West placed new

pressures on available water—and set in motion tensions between urban and agricultural water users. Eastern taxpayers openly asked whether public funding of western water development was responsible for migration of jobs and tax base from the industrial East to the Southwest and West. An increasingly urban population began to insist upon the preservation of unspoiled mountains, forests, and rivers. And finally, the need to develop western energy resources placed a potential overload on an already overallocated water supply.

In short, a classic confrontation between western states and private water rights holders, on one hand, and perceived national interests on the other hand has developed. Residents of the West contend that proposed national legislation disregards experience and disdains custom, both of which are hallmarks of western water law. The issue of reserved federal water rights continues unresolved, as the federal government attempts to claim water rights on many public lands without regard to state water laws. Less difficult to resolve will be a shift in Federal water development funding requiring initial financial participation by states.

A resolution of the most difficult differences between national and state perspectives on water policy seems likely to require compromise and accommodation by all concerned. Given the urgency of issues' faced, the process of resolution can hopefully proceed with deliberate speed. Assistant Secretary of the Interior Guy Martin suggested that solutions will likely be built upon at least two fundamental—and perhaps not always consistent—premises:

1. Solutions must recognize that states have the primary authority and responsibility for water resources.
2. The general welfare of the nation must somehow be accommodated.

Solutions to the most pressing of these issues appear to be in the making. With luck, they will be solutions that all participants can live with. Indicative of a mood of conciliation and cooperation at the national level is Martin's remark to the symposium audience: "For my part, I will be most happy if we can improve all federal programs so that they are water- and cost-efficient, honest and modern in their economics and selection of solutions, and publically credible in the priorities chosen for use of the budget."

IMPROVING THE WATER-ALLOCATION PROCESS

A difficult and important policy question is what changes should be made in the laws and institutions that presently control water resources development. Agreement on required changes is far from unanimous, although some widely supported principles do emerge.

The development of western water law and practice is a substantial change over that which existed in the humid and semi-humid eastern United States. Riparian rights, common in the East, simply allocated the right to use water to those property owners whose property adjoined the water. Hence, it was quite possible that water would be used in a way that had no economic value—or perhaps even a negative value. But with ample surface water, groundwater, and rainfall, the resource could be treated in that way without seriously impeding the use of water by others.

Not so in the semi-arid and arid West. There water was scarce, and some means had to be developed to assure society that water was put to beneficial use. Hence, the evolution of the doctrine of prior appropriation, under which the first person to put water to a beneficial use—one of benefit to mankind, or wealth-producing-secured those rights into perpetuity, contingent upon continued beneficial

use. To facilitate such use, the water right came to be recognized as a property right and could thus be transferred from one owner to another via the marketplace.

Prior appropriation, while putting water to a beneficial use, did not assure that water would be put to its highest and best use. Before the end of the 19th century, states began to implement administrative law—usually beginning from the premise that state ownership of water was the basic rule. Legislation was developed in an attempt to insure that water was put to its highest and best use, not just to a beneficial use. While the principle of maximizing the return to society from use of water is well defined in law, only in recent years have private property owners begun to appreciate the full implications of that action. Water rights—although widely regarded as private property rights—are in most western states circumscribed by legal limitations. Increasingly the public has seen fit to define and exercise those limitations.

Water laws, in recent years, have been used for other purposes than just to allocate water. Increasingly, laws are written, ostensibly to govern water use, but in fact as thinly disguised attempts to control land use and shape economic development. Frank Trelease, dean emeritus of the University of Wyoming School of Law, is critical of such practices.

To include narrowly defined, specific rules in statutes may well be counterproductive to rational water resources development. Conversely, Trelease said that such decisions might better be made through adininistrative decisions within broad principles defined in statutes. Trelease noted that under legislative decisionmaking, all appropriate alternatives are seldom considered and decisions tend to be inflexible and subject to political pressure. Moreover, states that are politicizing water laws may engage in activity ultimately found to be beyond their authority. The result of such activity—as in the case of coal slurry pipelines—may be the implementation of a Federal solution to water development that completely disregards state water policy, state mineral development policy, and state land use plans.

As society attempts to maximize the return from public and private water resources investment, the need for a quantitative decision standard becomes more important. Legislative and administrative decisionmaking alike have relied on benefit-cost analysis in selecting optimal water resource development strategies and projects. Such an exercise is intuitively appealing and apparently cleancut: if benefits exceed costs, a project should be developed. Among prospective projects, the one with the highest benefit-cost ratio should be undertaken first.

But considerably more confidence has been placed in the benefit-cost analysis than either theory or experience warrant. Daniel W. Bromley, editor of Land Economics, contended "the benefit-cost analyst—and the benefit-cost approach—have always been malleable to the wishes of those currently holding positions of power . . . Benefit-cost analysis is often the lubricant of politically sanctioned greed." To further cloud the answers obtained by the method, there has never been any clear understanding of just what benefits and what costs to include in the analysis. Future resource development, more closely associated with a concept of common property resources, may well occur in a framework of redefined and expanded definitions of both benefits and costs.

Evaluation of future projects will continue to use this analytical tool, but Bromley urged policymakers to recognize the problems with the measure. Such analysis implicitly assumes that the losers (those who bear costs) are able to adjust, and that the surplus of benefits over costs accrue to society rather than to a few

fortunate gainers. Another significant problem, apparently, is that the efficiency measure of benefit-cost analysis is employed to select public sector activities which will change the distribution of economic and political advantage.

Computation of costs in these analyses are far from straightforward. Costs can be assumed to include not only those associated with the project itself, but also benefits foregone by not building other projects with the same public funds. Additionally, discount rates used in the analysis are also subject to interpretation. In fact, it is probably not unreasonable to propose the use of one discount rate for the benefits and another for the costs associated with a particular project.

Further complicating benefit-cost analysis will likely be the difficulty of demarcating the project region over which benefits and costs will be measured. Spillover effects—positive and negative—seem increasingly to be the rule rather than the exception. Moreover, symposium participants reminded the audience that equity considerations ought to be factored into the analysis—both with respect to the relative strengths of negotiating parties and to the structural dislocations associated with the project. In short, deterministic conclusions about water resources development projects based on benefit-cost calculations are probably no longer reasonable. Rather, the use of efficiency and equity considerations within the context of comprehensive resource use planning appears to hold greater promise.

Improving the legal tools for water management could provide powerful incentives for better water allocation. Western states constructed water laws around the linch pin of prior appropriation. And, as might be expected, a great deal of diversity in specifics has accumulated in individual states' laws.

While state laws have been reasonably effective in the past, changing needs and conditions outdate past practices. More dynamic legal and administrative processes will be required in the future if society's welfare is to be improved and individual property rights not violated. George Radosevich, attorney and Colorado State University professor, recommended a number of changes in the legal tools:

> Water laws should remain the foundation of water management, but they need to become more dynamic. Improved criteria for efficiency in water allocation and use are needed. Water quality considerations must be incorporated into water rights. A system of term permits with a periodic evaluation for all new and transferred water rights should be instituted along with a better defined market for water rights; and a greater recognition of the public trust of water agencies and the public duty of the users of water ought to be promoted.
>
> Water administration improvements are also necessary. A water registry system requiring annual reports of use by water rights owners along with the authority by a state agency to issue orders of compliance should be implemented. Additionally, basin or sub-basin water management districts ought to be created and empowered to resolve complex water rights problems and water deliveries. Finally, a water brokerage system ought to operate at the water management district level to facilitate transfer of water rights to higher value uses.

CONCLUSIONS

With water—as with a number of other resources—the United States is entering an era in which it will be increasingly less expensive to free water for new uses through conservation than it will be to develop new supplies. As Professor Kenneth Boulding of the University of Colorado told the symposium audience, "We will reach this position in regard to water irregularly, at different times, in different places, and in different circumstances—but that we will reach it . . . seems highly likely." Furthermore the interrelationships among resource use policies, resource use itself, and the economic and social variables of society will become more, rather than less, complex. The conflicts arising over water use can be expected to become sharper and require more expeditious resolution. Thus, the decision processes in water development and water allocation are badly in need of improvement to meet the challenges of the future.

Water management clearly belongs in both the public and the private domains. Changes in law and administrative practices are required at both state and federal levels. But greater use of the marketplace to allocate development dollars and to ration supplies is also desirable if the nation's water resources are to be allocated to their "highest and best use." Concurrently, it seems reasonable that increased attention to fairness and equity will accompany policy evolution.

The proceedings of this symposium on Western Water Resources: Coming Problems and the Policy Alternatives, sponsored by the Federal Reserve Bank of Kansas City, will be published in the near future. If you would like to receive a copy of these proceedings as soon as they become available, please send your name and address to:

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Two New Booklets Discuss Energy and Agriculture, Monetary Policy

Over the coming decades, conserving energy will be of major importance to farmers as they face rising prices and probable shortages, according to Marvin Duncan and Kerry Webb in a new booklet, ***Energy and American Agriculture.*** Better management and more efficient operations will become increasingly vital in the years just ahead.

Alternative energy sources, such as solar and wind, hold promise for the distant future, the authors note, but problems limit their use in the near future. Farmers could also cope with the energy crisis by substituting one resource for another, but such opportunities vary from region to region.

Finally, the authors suggest caution for those who advocate a widespread shift to human labor. Comparisons show the U.S. system—with its intensive use of commercial energy—produces far more food per unit of total energy used than systems in developing countries where human and animal labor are used extensively. And since farm energy use accounts for only **3** per cent of total U.S. energy consumed, this would do little to ease this nation's energy problems.

Ten articles with continuing relevance to monetary policy issues have been published by the Federal Reserve Bank of Kansas City in a booklet, ***Issues in Monetary Policy.*** The articles, which appeared previously in the ***Economic Review*** and its predecessor, the ***Monthly Review,*** have been reprinted in booklet form to provide a readily available source for persons interested in policy analysis.

The initial section of the booklet contains articles that examine some basic concepts relevant to monetary policy analysis.

In the second section, articles analyze the extent to which monetary and reserve aggregates are preferable to interest rates as policy guides. Various aspects of monetary control are discussed in the third section. And in the final section, the articles discuss the relationship between monetary growth and economic performance.

Both of these booklets are being published this month. Copies will be available free of charge by writing:

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