# THE INTEREST RATE

## PRIVATE AND SOCIAL RATE DISCOUNT

From

Standards and critieria for formulating and evaluating Federal Water Resources Development - A report of Panel of Consultants to the Bureau of the Budget- 1961

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# THE INTEREST OR DISCOUNT RATE

## PRIVATE AND SOCIAL RATES OF DISCOUNT

Even if the objective of water resources development is taken simply to be the greatest possible contribution to national income, the goal is ambiguous without a means of rendering comparable the contributions to national income made by a project in different years. To express the overall contribution of a project in a single number, we must be able to add the contributions to national income over the project's economic life. This addition requires specification of a weight for each year's contribution which reflects the relative value of income in that year against income in another.

Implicit in the choice of weights is the interest or discount rate. This rate, according to traditional capital theory, balances the productivity of investment (which determines how fast the economy can grow for any given rate of investment) and the reluctance of society to sacrifice current consumption for future consumption. However, the interest rate which would arise from the free working of the private economy, even were the economy to satisfy the usual conditions of the economist's competitive model, would not necessarily represent an appropriate rate of discount for evaluating investment from the point of view of society as a whole. The private market does not provide as comprehensive a mechanism as is required to register the collective considerations attendant to investment. In selecting an interest rate, we are faced with the problem, all too familiar in the economics of water resources development, of discrepancies between valuation based upon individuals' market calculations and collective calculations weighing third party effects. [1]

In theory, the marginal productivity of investment could be brought into line with the social rate of discount throughout the economy by an appropriate combination of fiscal and monetary policy and direct controls.[2]

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1. For discussion of the differences between private and social evaluation of investment, see William J. Baumol, Welfare Economics and the Theory of the State (Harvard University Press, Cambridge, 1952), p. 92; Amartya K. Sen, "On Optimizing the Rate of Saving," Economic Journal, September 1961; Stephen A. Marglin in Arthur Maass et al., Design of Water-Resource Systems (Harvard University Press, Cambridge, in press), Chapter 4

2. See Jack Hirschleifer, James DeHaven, Jerome Milliman, Water Supply; Economics, Technology and Policy (University of Chicago Press, Chicago, 1960), Chapter 6, and Hirschleifer, "Comments on a 'Survey of the Theory of Public Expenditure Criteria' by Otto Eckstein" in Public Finances; Needs, Sources and Utilization (Princeton University Press, Princeton, 1961), pp. 495-501.

In practice, however, all market interest rates, even the government bond rate, reflect private rather than social rates of discount. This is caused by imperfections in capital markets and the fact that the U.S. Government does not exercise the degree of control over private investment through fiscal and monetary policy that would be necessary to insure private development of all socially desirable opportunities in the private sector. Thus, no market interest rates are directly applicable as discount rates in the formulations and evaluation of public water resources development plans.

Though we advocate the use of a discount rate based upon an estimated social rate of time preference, its divergence from the private market rate creates special difficulties. To some degree, the resources used by the water development projects will force the displacement of private investments. These investment opportunities have been evaluated at a different and possibly--if not usually--at a higher discount rate. But in order to decide if a shift of productive resources from the private to the public sector is economically efficient, the same rate used to evaluate the time stream of benefits (net of annual operation, maintenancce, and replacement costs) in the public sector must also be used to evaluate opportunities in the private sector. The shift of resources is socially desirable only if the present value of benefits per dollar of outlay in the public water resources sector exceeds the present value per dollar in the private sector--both present values being computed at the social rate of interest.[3]

An illustration of the consequences of a social time preference rate departing from private rates may serve to clarify this complication. Assume that a proposed project, which is estimated to have a capital cost of $100 million, produces a stream of benefits over time the present value of which, discounted at the social rate, say 2.5 percent, is $150 million. On this basis, the project has a benefit-cost ratio of 1.5:1. But suppose that each dollar of private investment on the margin yields $.05 of national income benefit per year in perpetuity. This marginal stream of benefits from an investment of $100 million in the private sector, discounted at the assumed social rate of interest of 2.5 percent, gives a present value of $200 million.[4] If investment of $100 million

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3. Following Otto Eckstein, Water-Resource Development, the Economics of Project Evaluation (Harvard University Press, Cambridge, 1958) and "A Survey of the Theory of Public Expenditure Criteria" in Public Finances: Needs, Sources and Utilization, op. cit.; Peter O. Steiner, "Choosing Among Alternative Public Investments, " American Economic Review, December 1959, and Stephen A. Marglin, op. cit.

4. The formula for the present value of a perpetuity of $r per year discounted at a rate of i percent is r/i. We make extensive use of this formula.

water resources sector forces the Nation to forego other investment which is socially valued at $200 million in the private sector, then the "real," or "opportunity" cost of the $100 million invested in the water Resources sector is $200 million--not the "money" or "nominal" cost of $100 million. Each dollar taken from private investment for public water resources development is really worth the $2 of present value of private investment benefits that are lost. Therefore, if public water resources development displaces private investment on a dollar-for-dollar basis, a cutoff benefit-cost ratio of 2:1 rather than 1:1 is required to correct the market's undervaluation of the social desirability of investment.[5]

In the special case in which the benefit streams of all Federal water resources projects are constant over a uniform economic life, we can, if we wish, retain the rule that increments should be included in project plans so long as their benefit-cost ratios exceed unity. For this special case we can create a synthetic discount rate that takes the yield foregone (the opportunity cost) of displaced investment into account as well as the social rate of discount. Use of this synthetic rate along with the benefit-cost ratio of unity is equivalent to use of an appropriately higher benefit-cost cutoff ratio and the social rate of discount.[6]

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5. See also Item 1 in Table in Appendix to this section.

6. Thus the criterion that the present value of benefits of an increment must exceed its capital cost can be expressed in two forms. First, if the opportunity cost is $2 per dollar of capital outlay and the (constant) annual benefit is $b per dollar of outlay on an increment, the criterion for inclusion of the increment in a project plan is

$$b \frac{1 - (1 + i)^{-n}}{i} \geq a$$

for an n year project and a social discount rate i. Alternatively, since the opportunity cost per dollar is

$$a = \frac{r}{i}$$

if the alternative private investment represents a perpetunity whose annual rate of yield is r, the criterion can be written

$$b \geq \frac{r}{1 - (1 + i)^{-n}}$$

or

$$b \frac{1 - (1 + j)^{-n}}{j} \geq 1,$$

where j is the rate of discount such that

$$\frac{1 - (1 + j)^{-n}}{j} = \frac{1 - (1 + i)^{-n}}{r}$$

It is sometimes proposed that a low social discount rate is required to avoid discrimination against desirable long-lived projects as against those investments with shorter life and quicker payoff. Does the higher opportunity cost in combination with social discount rate produce undesirable results? It does not follow that investments with time profiles skewed toward the present will be favored by the combination of a comparatively low social discount rate and an opportunity cost in the same manner as if the opportunity cost rate were used directly as a discount rate. The only time the combination of social discount rate and opportunity cost produces results similar to those produced by direct use of an opportunity cost rate is when the time profiles of alternative investments are constant and time horizons identical. But in such cases there is no possiblity of discrimination between projects on the basis of their time profiles.

In all other instances, a moderate social discount rate coupled with a higher opportunity cost tends to favor relatively longer payout investments in comparison with using the higher opportunity cost rate to discount time streams directly. It is true, however, that other things being equal, the higher the opportunity cost of capital (the higher the productivity of investment in the private sector) the fewer the projects (or marginal increments) in the public sector that will qualify for construction within the context of a national income objective. The justification of more long-lived public projects lies in demonstrating that the benefits they generate are sufficiently large to warrant the displacement of private investment when both are evaluated at the social rate of discount--not in neglecting the loss of benefits in the private sector.

## ESTIMATING THE RELEVANT RATES

As a practical matter, then, there will be two general problems in responding to the question, "what rate or rates should be used in evaluation projects?" The first is a value judgment regarding the correct social rate of time preference, or at least a judgment as to what answer might be obtained if a community consensus were developed in response to the question of time preference. The second is the

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6. Continued -
The discount rate j is the rate synthesizing opportunity cost and social time preference. In the example given above, taking n = 50.

$$\frac{1 - (1 + j)^{-n}}{j} = \frac{(.70905)}{.05} = 14.181,$$

and j is readily found in any compilation of interest tables to be approximately 6.75 percent.

empirical question of what time streams are foregone elsewhere in the economy as a result of investment in the public sector.

Social Rate of Discount

There is no opportunity here to appeal to the market for objective evidence as to the rate of social time preference since the market does not reflect collective preferences with respect to time discounts. One method of ascertaining its value lies in discovering the marginal rate implicit in the Administration's goal of a certain rate of economic growth. This value judgment with respect to growth rate contains an implicit balancing at the margin of the Administration's time discount rate and social productivity of investment. For example, to increase the rate of growth to x percent would require extra investment of y billion dollars this year at full employment.[7]

The marginal rate of discount in this case is the rate which just makes this amount of extra investment, no more and no less, the optimal amount. This is the rate which makes the present value of the consumption stream generated by the last dollar of the extra investment just equal to $1.00; it can also be called the "social rate of return" or "social marginal productivity" of the marginal dollar of investment, and is a datum that can be directly estimated.[8] For purposes of this report, the social rate of discount is assumed to lie between 2.5 and 4 percent, and remainder of this section.

7. The extra investment required to achieve a given rate of growth depends on the mix of investments chosen, because of the divergence in marginal productivities throughout the economy (alluded to in the remainder of this section). On June 28, at his press conference, President Kennedy suggested that output should grow at a rate of 4.5 percent a year (Washington Post, June 29, 1961, pp. A-1 and A-16). The Council of Economic Advisers is the logical group to fill in the second blank, that is, advise the President on rate and mix of investment to achieve this rate of growth.

8. One cannot really expect the Administration to hit upon a rate of growth regarded as optimal without much more knowledge of the economy's investment opportunities than we possess today. Thus the board-brush targets of growth and investment rates which determine the marginal rate of time discount should themselves be revised in light of the marginal rate of discount implicit in them. In short, optimal rates of investment, growth, and marginal rate of discount are properly determined iteratively.

## Opportunity Costs

The question of opportunity costs, although more manageable, also requires a substantial amount of additional empirical study before it can be answered satisfactorily. Which investments are foregone when the public sector undertakes resource development expenditures will depend, in part, on how the public sector activities are financed, the degree of imperfections in the capital market which prevent returns from being equalized at the margin in the several subsectors of the market, and what can be assumed with respect to the effectiveness of the national stabilization policy.

# ASSUMING EFFECTIVE STABILIZATION POLICY

## Tax Financing

Under the assumption that the resource development projects are financed by taxation within the context of an effective overall stabilization policy, it is the specific nature of the tax that determines the opportunity cost of funds raised from the private sector. Otto Eckstein has made suggestive estimates of these magnitudes on the assumption of two particular types of tax changes.[9]

Eckstein's estimates have indicated an opportunity cost of funds diverted from the private sector in the neighborhood of 5 to 6 percent for the two specific types of tax changes postulated. The weighted average of yields from investment foregone in the various subsectors in the private sector, as computed by Eckstein can be taken as a perpetuity of 5 to 6 percent per annum. However, the appropriate opportunity cost depends as well on the proportion of the total investment in the water resources project which was financed by foregoing private consumption as well as foregone investment, and the social time preference attaching thereto. For example, assume the following: (1) Private investment is assumed to yield national income benefits of $.055 per year in perpetuity per dollar of present outlay. (2) Private consumption is assumed to be reduced by an amount equal to a half of the project's capital requirement. (3) The social time preference is taken to be 2.5 percent. Under these assumptions, the opportunity cost per dollar of investment in water

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9. John V. Krutilla and Otto Eckstein, Multiple Purpose River Development; Studies in Applied Economic Analysis (Johns Hopkins Press, Baltimore, 1958), Chapter IV.

resources development is $1.60.[10] If, on the other hand, we assumed a social time preference of 4 percent, the opportunity cost would be $1.18.[11]

Debt Financing

On the other hand, if the project's costs were financed by borrowing rather than by taxation, again with the context of an effective stabilization policy, we would expect to find the relevant opportunity cost to vary depending on what restrictive monetary policy were employed to offset the investment expansion in the water resources sector.[12] Typical of recent experience,[13] however, the effects of restrictive monetary policy have been confined to a limited number of areas, and they have been affected unevenly. The factors most influenced appear to be residential housing, State and local government investments, and, to some extent, small business. No discernible effect has been observed on plant and equipment outlays of large business, a fact which can be explained by a variety of factors.[14] The influence of restrictive monetary policy

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10. The present value of 2.5 percent of the alternative employment of $1 of present resources, $[.5(.055) + .5(.025)] / .025 = 1.6$. See also item 2 in Appendix table. A social interest rate of 2.5 percent coupled with an opportunity cost of $1.60 per dollar is equivalent in project evaluation, for a constant benefit stream of 50 years, to an interest rate of 5-3/8 percent and substitution of the nominal cost of $1 for the opportunity cost of capital of $1.60, as long as all projects have constant benefit streams of 50 years.

11. That is, $[.5(.055) + .5(.04)] / .04 + 1.18$. See also item 3 in Appendix table. The 4 percent interest rate and corresponding opportunity cost of $1.18 is for a 50-year life of constant benefits equivalent to an interest rate of 5 percent and evaluation of capital at its nominal cost.

12. See G. L. Reuber and R. J. Wonnacott, The Cost of Capital in Canada with special reference to public development of the Columbia River (Resources for the Future, Washington, 1961), for an elaboration of this model.

13. Staff Report on Employment, Growth and Price Levels, prepared for consideration by the Joint Economic Committee, Congress of the United States, 86th Congress, 1st Session, December 1959, Chapter 9, especially Section III, pp. 362-394. A similar experience for Canada is indicated in William C. Hood, Financing of Economic Activity in Canada, prepared for the Royal Commission on Canada's Economic Prospects (Ottawa, 1958).

14. Staff Report, op. cit., p. 371 ff.

on public utility investment is inconclusive and negligible at most.[15] Perhaps a small effect on consumption expenditures is felt, although not much evidence exists that increases in the interest rate of general credit controls are effective in curtailing consumer credit.[16] Thus, on the basis of the Staff Report on Employment, Growth and Price Levels, one might infer that the distribution of the curtailment of private activity might be roughly 70 percent for residential housing, 20 percent for State and local governments, 7 percent for small business, and 2 percent for consumption. These are crude estimates admittedly, but may serve as a convenient basis for discussion until systematic studies are made to refine these estimates. Now, we attach perpetuities of 4.0 percent[17] for residential housing; 3.2 percent[18] for State and local government; 18 percent[19] for small business; and 2.5 percent[20] for consumption per year,[21] and discount this precluded composite investment at a social time preference rate of 2.5 percent. From this, we obtain an opportunity cost of about $1.90 per $1 of resource development investment.[22] Accordingly, assuming a social time preference rate of 2.5 percent, and the impact of monetary policy over the past decade, benefit-cost ratios of about 1.9:1 would be required to justify undertakings of project increments assumed to be financed by borrowing.[23]

If, on the other hand, we assume a social time preference on the order of 4 percent, the opportunity cost of a dollar's worth of resources

15. Ibid., p. 375

16. Ibid., pp. 389-90

17. Krutilla and Eckstein, op. cit., pp. 95-96

18. Following the Treasury-Federal Reserve Accord, the annual average State and local general obligation bond rates. Federal Reserve Bulletin.

19. Krutilla and Eckstein, op. cit., pp. 115-16 and footnote 38.

20. Arbitrarily assuming a social time preference rate of 2.5 percent.

21. These estimates of the benefit stream of investment in various private sectors in some cases reflect private pecuniary benefits rather than social national income benefits. Thus, they are illustrative only.

22. That is, $[.70(.04) + .20(.032) + .07(.18) + .03(.025)] / .025 = 1.90$. See also item 4 in Appendix table.

23. The 2.5 percent rate of interest and $1.90 opportunity cost are interchangeable with an interest rate of 6.4 percent and use of nominal cost for a 50-year economic life of constant benefits.

diverted from the private sector for resource development investments--under assumptions similar to those described in the Staff Report on Employment, Growth and Price Levels--would be approximately $1.19.[24] The resultant cutoff benefit-cost ratio (recalling that the benefit stream from the project would be discounted now also by 4 percent) would have to be 1.19:1.

## ASSUMING INEFFECTIVE STABILIZATION POLICY

### Slack Economy

Without the convenient assumption that there would be an effective stabilization policy guaranteeing full employment, the problem becomes more difficult. We must estimate the percentage of public investments which takes up slack in the economy--which uses otherwise unemployed resources--instead of displacing private investment or consumption. Unemployed resources can be thought of as an "investment" yielding zero percent per annum, so that $.50 of each dollar spent on water resources development puts otherwise unemployed resources to work. On this basis, and employing the three assumptions given on pages 16 and 17 with regard to the remaining $.50, and also using a social rate of discount of 2.5 percent, the opportunity cost becomes approximately $.95.[25] Thus, the lower cutoff benefit-cost ratio of .95:1 would replace the ratio of 1:1.[26]

### Full Employment Economy

Finally, mention should be made of a means of financing inconsistent with our assumption that resource development projects are financed within the context of an effective stabilization policy. The existence of inflationary techniques for financing public activities, where deliberate or unintended, makes possible the curtailment of activities in the private

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24. That is, $[.70(.04) + .20(.035) + .07(.18) + .03(.04)] / .04 = 1.19$. See also item 5 in Appendix table. For an economic life of 50 years of constant benefits this is equivalent to a discount rate of 5 percent and evaluation of capital outlay at the nominal cost of $1 per dollar.

25. That is, $[.5(0) + .35(.04) + .10(.032) + .035)(.18) + .015\ (.025)] / .025 = .95$. See also item 6 in Appendix table. This procedure for reflecting the divergence between the social and money costs of unemployed resources is described more fully from the point of view of secondary benefits in the following section.

26. The combination of a 2.5 percent interest rate and an opportunity cost of $.95 is equivalent to a 2.25 percent interest rate and a nominal cost of $1 under the assumption that benefits occur in a constant stream over 50 years.

sector in response to the inflationary process. Unfortunately, there is little more than qualitative information on how this method of financing public activities affects the private sector.

Part of the resources utilized in the public sector, financed by inflationary means, would come at the expense of curtailed consumption.[27] In terms of the national income objective, the social rate of time discount should be applied to this component of curtailed resource use in the private sector. However, beneficiaries of programs designed explicitly to implement objectives other than increasing national income, such as old-age and survivors insurance, unemployment compensation, and the like, are required to curtail their consumption.[28] The beneficiaries of such programs are the very individuals for whom a dollar's worth of additional income or consumption may be weighted in excess of a dollar within the context of an income redistributive objective.[29]

Other real effects accompanying process inflation have quantitative effects of relevance to this problem; however, little work has been done as a systematic attempt to evaluate these. For example, inflationary discounts get incorporated into the interest rates and yields on bonds.[30] Accordingly, in evaluation of opportunity costs the entire structure of yields must be examined with substantial care and sophistication to ascertain real rates abstracting from inflationary and other short-term influences.[31] However, up to now the resereach has not yet been undertaken which will permit obtaining meaningful estimates for the relevant set of rates when financing is undertaken by means which contribute to the inflationary process. This area of investigation should have high priority.

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27. Seymour E. Harris, The Incidence of Inflation: Or Who Gets Hurt, Study Paper No. 7, in the series in the study of Employment, Growth and Price Levels, op. cit.

28. Ibid., pp. 4-7.

29. The choice of interest rate when the distribution as well as the level of national income is an objective of development is discussed in Section VIII.

30. Op. cit., p. 3

31. Reuber and Wonnacott, op. cit., provide an example of a skillful attempt to come to grips with these issues.

## OPPORTUNITY COST UNDER BUDGET CONSTRAINTS

### General Constraint on the Public Sector Budget

Water resources development may displace investment not only in the private sector but also in other subsectors of the public sector. Total budgetary funds may not be sufficient to undertake all socially desirable public investment projects (that is, projects whose benefit-cost ratios are in excess of the opportunity costs of displacement of private investment and consumption). In that case, water resources projects may come at the expense of other programs in the public sector.

The implications for project formulation and planning are conceptually symmetric with the analysis developed above for displacement of private investment. The yields of public investment alternative to water resources development are evaluated at the social rate of discount and weighted into the opportunity cost formula--the weight being the fraction in which such investment is displaced by each dollar of investment in water resources development. To date, however, little has been done to explore the public sector margins in a quantitative way--that is, to measure benefits which are lost as a result of budgetary restraints on public programs such as housing, education, etc. This is an area to which a great deal of attention should be devoted if much guidance is to be expected from approaches seeking to maximize benefits subject to effective budgetary constraints on overall public investment.

It has been emphasized earlier that although the total income of a community is one index of its welfare, it is not the only one. The distribution of the total among the members of a community is another important dimension of welfare. The social discount rate appropriate for the determination of the present value of redistribution benefits need not be the same as the social rate of discount under the objective of increasing national income. While the latter reflects the marginal preferences over time in the consumption of the community for itself as a whole, the former represents the community's (i.e., policy makers') marginal time preferences for the special group to which it is redistributing income.

### Constraint on Water Resources Budget

References, so far, to budget constraints have been based on the assumption that the constraints apply to all public investment, rather than to water resources development alone. This is one interpretation of the position adopted by Steiner, [32] but is at odds with the assumption

32. Op. cit.

made by some economists exploring the problems occasioned by budgetary constraints.[33] Instead of, or in addition to, an overall public investment budget constraint, a budgetary constraint may apply to water resources development alone. Under this assumption, there is not only the external opportunity cost discussed above, but also an internal opportunity cost to be considered in the planning of each project. This internal opportunity cost is the present value of the benefits displaced on other water resources projects, for each dollar spent on the given project. The effective opportunity cost--whether external or internal--is the higher of the two. If the external opportunity cost exceeds the opportunity cost within the water resources sector, opportunities are socially more desirable outside the water resources sector than within, and the water resources budget should not be used in full. Conversely, if the internal exceeds the external opportunity cost, the opportunities within the water resources sector are socially more attractive than those outside, and the external opportunity cost is irrelevant. Optimally, of course, the water resources budget would in this case be expanded until the internal opportunity cost fell to the level of the external cost--that is, until the separate water resources budget was no longer binding.

## PRACTICAL COURSES OF ACTION

The foregoing discussion suggests that a fairly wide range of opportunity costs may prevail in connection with water resources development depending on the effectiveness of the economic stabilization program, methods employed to finance the projects, etc. In view of changes in investment opportunities throughout the economy and methods of financing water resources projects, the opportunity cost rate at the time of project design or plan formulation may no longer prevail when the project or program is actually undertaken. Yet it is necessary at the formulation stage to employ rates which are stable with respect to time, for plans involve a great deal of time and effort, and project designs are not amenable to a thoroughgoing redesign in response to continuously fluctuating circumstances. Accordingly, some compromise is required to permit both the requisite stability for design and the desired flexibility in response to changing conditions and circumstances with respect to the level of employment, the prospective means of financing, etc.

Under the circumstances, it is necessary to distinguish between the formulation of the plans on the one hand, and the decisions as to whether or not--or perhaps when--to undertake the construction of the elements of the plan. That is, for purposes of providing the necessary stability to permit the design of interdependent facilities without subjecting the design to continuously changing conditions, the social time discount and

33. Eckstein, Water Resources Development, op. cit., Chapters III-IV; Marglin, op. cit., Chapter 4.

opportunity cost, which approximate what may be considered as most likely to prevail "on the average," should be used for planning purposes. The design stage can thus be immunized from the degree of instability which would frustrate its completion. The opportunity cost rate relevant to the determination whether or not to undertake a project at any given time, on the other hand, is the one dictated by the specific circumstances governing the period of construction.

Judging from the crude estimates made in the preparation of this report, and the estimates of the equivalent composite rate of interest provided in the Appendix table in this section, it appears to the Panel that an interim rate of 4 to 5 percent, synthesizing a social rate of discount and opportunity costs, should be used, pending the full-scale investigation of the value of social rate of discount and the magnitude of opportunity costs by the President's Council of Economic Advisers.