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Is Growth Obsolete?

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A long decade ago economic growth was the reigning fashion of political economy. It was simultaneously the hottest subject of economic theory and research, a slogan eagerly claimed by politicians of all stripes, and a serious objective of the policies of governments. The climate of opinion has changed dramatically. Disillusioned critics indict both economic science and economic policy for blind obeisance to aggregate material "progress," and for neglect of its costly side effects. Growth, it is charged, distorts national priorities, worsens the distribution of income, and irreparably damages the environment. Paul Erlich speaks for a multitude when he says, "We must acquire a life style which has as its goal maximum freedom and happiness for the individual, not a maximum Gross National Product."

Growth was in an important sense a discovery of economics after the Second World War. Of course economic development has always been the grand theme of historically minded scholars of large mind and bold concept, notably Marx, Schumpeter, Kuznets. But the mainstream of economic analysis was not comfortable with phenomena of change and progress. The stationary state was the long-run equilibrium of classical and neoclassical theory, and comparison of alternative static equilibriums was the most powerful theoretical tool. Technological change and population increase were most readily accommodated as one-time exogenous shocks; comparative static analysis could be used to tell how they altered the equilibrium of the system. The obvious fact that these "shocks" were occurring continuously, never allowing the

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The paper is published in this volume upon recommendation of the Executive Committee and approval by the National Bureau of Economic Research because it stimulated considerable discussion at the conference, some of which is reproduced here. It was invited for presentation when an earlier paper by another author was not forthcoming, and most importantly because of its special relevance to the subject of this conference.

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system to reach its equilibrium, was a considerable embarrassment. Keynesian theory fell in the same tradition, attempting rather awkwardly, though nonetheless fruitfully, to apply static equilibrium theory to the essentially dynamic problem of saving and capital accumulation.

Sir Roy Harrod in 1940 began the process, brought to fruition by many theorists in the 1950s, of putting the stationary state into motion. The long-run equilibrium of the system became a path of steady growth, and the tools of comparative statics could then be applied to alternative growth paths rather than to alternative stationary states. Neo-Keynesian macroeconomics began to fall into place as a description of departures from equilibrium growth, although this task of reinterpretation and integration is still far from a satisfactory completion.

By now modern neoclassical growth theory is well enough formulated to have made its way into textbooks. It is a theory of the growth of potential output, or output at a uniform standard rate of utilization of capacity. The theory relates potential output to three determinants: the labor force, the state of technology, and the stock of human and tangible capital. The first two are usually assumed to grow smoothly at rates determined exogenously by noneconomic factors. The accumulation of capital is governed by the thrift of the population, and in equilibrium the growth of the capital stock matches the growth of labor-*cum*-technology and the growth of output. Simple as it is, the model fits the observed trends of economic growth reasonably well.

The steady equilibrium growth of modern neoclassical theory is, it must be acknowledged, a routine process of replication. It is a dull story compared to the convulsive structural, technological, and social changes described by the historically oriented scholars of development mentioned above. The theory conceals, either in aggregation or in the abstract generality of multisector models, all the drama of the events —the rise and fall of products, technologies, and industries, and the accompanying transformations of the spatial and occupational distribution of the population. Many economists agree with the broad outlines of Schumpeter's vision of capitalist development, which is a far cry from growth models made nowadays in either Cambridge, Massachusetts, or Cambridge, England. But visions of that kind have yet to be transformed into a theory that can be applied in everyday analytic and empirical work.

In any case, growth of some kind is now the recognized economic norm. A symptom of the change in outlook can be found in business cycle semantics. A National Bureau *recession* was essentially a period

in which aggregate productive activity was declining. Since 1960 it has become increasingly customary to describe the state of the economy by the gap between its actual output and its growing potential. Although the word recession is still a source of confusion and controversy, almost everyone recognizes that the economy is losing ground —which will have to be recaptured eventually—whenever its actual rate of expansion is below the rate of growth of potential output.

In the early 1960s growth became a proclaimed objective of government policy, in this country as elsewhere. Who could be against it? But like most value-laden words, growth has meant different things to different people and at different times. Often growth policy was simply identified with measures to expand aggregate demand in order to bring or keep actual output in line with potential output. In this sense it is simply stabilization policy, only more gap-conscious and growth-conscious than the cycle-smoothing policies of the past.

To economists schooled in postwar neoclassical growth theory, growth policy proper meant something more than this, and more debatable. It meant deliberate effort to speed up the growth of potential output itself, specifically to accelerate the productivity of labor. Growth policy in this meaning was not widely understood or accepted. The neoclassical model outlined above suggested two kinds of policies to foster growth, possibly interrelated: measures that advanced technological knowledge and measures that increased the share of potential output devoted to accumulation of physical or human capital.[1] Another implication of the standard model was that, unless someone could find a way to accelerate technological progress permanently, policy could not raise the rate of growth permanently. One-shot measures would speed up growth temporarily, for years or decades. But once the economy had absorbed these measures, its future growth rate would be limited once again by constraints of labor and technology. The level of its path, however, would be permanently higher than if the policies had not been undertaken.

Growth measures nearly always involve diversions of current resources from other uses, sacrifices of current consumption for the benefit of succeeding generations of consumers. Enthusiasts for faster

[1] The variety of possible measures, and the difficulty of raising the growth rate by more than one or two percentage points, have been explored by Edward Denison in his influential study, *The Sources of Economic Growth in the United States and the Alternatives Before Us*, New York, Committee for Economic Development, January 1962, Supplementary Paper No. 13.

growth are advocates of the future against the present. Their case rests on the view that in a market economy left to itself, the future would be shortchanged because too small a fraction of current output would be saved. We mention this point now because we shall return later to the ironical fact that the antigrowth men of the 1970s believe that it is they who represent the claims of a fragile future against a voracious present.

Like the enthusiasts to whom they are a reaction, current critics of growth are disenchanted with both theory and policy, with both the descriptive and the normative implications of the doctrines of the previous decade. The sources of disenchantment are worth considering today, because they indicate agenda for future theoretical and empirical research.

We have chosen to direct our attention to three important problems raised by those who question the desirability and possibility of future growth: (a) How good are measures of output currently used for evaluating the growth of economic welfare? (b) Does the growth process inevitably waste our natural resources? (c) How does the rate of population growth affect economic welfare? In particular, what would be the effect of zero population growth?

MEASURES OF ECONOMIC WELFARE

A major question raised by critics of economic growth is whether we have been growing at all in any meaningful sense. Gross national product statistics cannot give the answers, for GNP is not a measure of economic welfare. Erlich is right in claiming that maximization of GNP is not a proper objective of policy. Economists all know that, and yet their everyday use of GNP as the standard measure of economic performance apparently conveys the impression that they are evangelistic workshipers of GNP.

An obvious shortcoming of GNP is that it is an index of production, not consumption. The goal of economic activity, after all, is consumption. Although this is the central premise of economics, the profession has been slow to develop, either conceptually or statistically, a measure of economic performance oriented to consumption, broadly defined and carefully calculated. We have constructed a primitive and experimental "measure of economic welfare" (MEW), in which we attempt to allow for the more obvious discrepancies between GNP and economic welfare. A complete account is given in Appendix A. The main results will be discussed here and summarized in Tables 1 and 2.

In proposing a welfare measure, we in no way deny the importance of the conventional national income accounts or of the output measures based upon them. Our MEW is largely a rearrangement of items of the national accounts. Gross and net national product statistics are the economists' chief tools for short-run analysis, forecasting, and policy and are also indispensable for many other purposes.

Our adjustments to GNP fall into three general categories: reclassification of GNP expenditures as consumption, investment, and intermediate; imputation for the services of consumer capital, for leisure, and for the product of household work; correction for some of the disamenities of urbanization.

1. Reclassification of GNP Final Expenditures

Our purposes are first, to subtract some items that are better regarded as instrumental and intermediate than as final output, and second, to allocate all remaining items between consumption and net investment. Since the national accounts do not differentiate among government purchases of goods and services, one of our major tasks will be to split them among the three categories: intermediate, consumption, and net investment. We will also reclassify some private expenditures.

Intermediate products are goods and services whose contributions to present or future consumer welfare are completely counted in the values of other goods and services. To avoid double counting they should not be included in reckoning the net yield of economic activity. Thus all national income accounts reckon as final consumption the bread but not the flour and as capital formation the finished house but not the lumber. The more difficult and controversial issues in assigning items to intermediate or final categories are the following:

Capital Consumption. The depreciation of capital stocks is a cost of production, and output required to offset the depreciation is intermediate as surely as materials consumed in the productive process. For most purposes, including welfare indexes, NNP is preferable to GNP. Only the difficulties and lags in estimating capital consumption have made GNP the popular statistic.

However, NNP itself fails to treat many durable goods as capital, and counts as final their entire output whether for replacement or accumulation. These elementary points are worth repeating because some of our colleagues are telling the public that economists glorify wasteful "through-put" for its own sake. Focusing on NNP, and accounting for

all durables as capital goods, would avoid such foolish paradoxes as the implication that deliberate efforts to make goods more perishable raise national output. We estimate, however, that proper treatment of consumer durables has little quantitative effect (see Table 1, lines 3 and 5).

The other capital consumption adjustments we have made arise from allowing for government capital and for the educational and medical capital embodied in human beings. In effect, we have reclassified education and health expenditures, both public and private, as capital investments.

Growth Requirements. In principle net national product tells how much consumption the economy could indefinitely sustain. GNP does not tell that; consuming the whole GNP in any year would impair future consumption prospects. But *per capita* rather than aggregate consumption is the welfare objective; neither economists nor other observers would as a rule regard sheer increase in the numbers of people enjoying the same average standard of living as a gain in welfare. Even NNP exaggerates sustainable *per capita* consumption, except in a society with stationary population—another example of the pervasiveness of the "stationary" assumption in the past. Per capita consumption cannot be sustained with zero net investment; the capital stock must be growing at the same rate as population and the labor force. This capital-widening requirement is as truly a cost of staying in the same position as outright capital consumption.[2]

This principle is clear enough when growth is simply increase in population and the labor force. Its application to an economy with technological progress is by no means clear. Indeed, the very concept of national income becomes fuzzy. Should the capital-widening requirement then be interpreted to mean that capital should keep pace with output and technology, not just with the labor force? If so, the implied sustainable consumption per capita grows with the rate of technological progress. This is the point of view which we have taken in what follows. On the other hand, a given level of consumption per capita could be

[2] Consider the neoclassical model without technological change. When labor force is growing at rate g, the capital-labor ratio is k, gross product per worker is $f(k)$, net product per worker is $f(k) - \delta k$, then the net investment requirement is gk, and sustainable consumption per worker is $f(k) - \delta k - gk$. Denoting the capital-output ratio as $\mu = [k/f(k)]$, sustainable consumption per worker can also be written as $f(k)[1 - \mu(\delta + g)]$. Although NNP embodies in principle the depreciation deduction δk, it does not take account of the capital-widening requirement gk.

sustained with a steady decline in the capital-output ratio, thanks to technological progress.[3]

The growth requirement is shown on line 7 of Table 2. This is clearly a significant correction, measuring about 16 per cent of GNP in 1965.

Our calculations distinguish between actual and sustainable per capita consumption. *Actual MEW* may exceed or fall short of *sustainable MEW*, the amount that could be consumed while meeting both capital consumption and growth requirements. If these requirements are met, per capita consumption can grow at the trend rate of increase in labor productivity. When actual MEW is less than sustainable MEW, the economy is making even better provision for future consumers; when actual MEW exceeds sustainable MEW, current consumption in effect includes some of the fruits of future progress.

Instrumental Expenditures. Since GNP and NNP are measures of production rather than of welfare, they count many activities that are evidently not directly sources of utility themselves but are regrettably necessary inputs to activities that may yield utility. Some consumer outlays are only instrumental, for example, the costs of commuting to work. Some government "purchases" are also of this nature—for example, police services, sanitation services, road maintenance, national defense. Expenditures on these items are among the necessary overhead costs of a complex industrial nation-state, although there is plenty of room for disagreement as to the necessary amounts. We are making no judgments on such issues in classifying these outlays as intermediate rather than final uses of resources. Nevertheless, these decisions are difficult and controversial. The issues are clearly illustrated in the important case of national defense.

We exclude defense expenditures for two reasons. First, we see no direct effect of defense expenditures on household economic welfare. No reasonable country (or household) buys "national defense" for its own sake. If there were no war or risk of war, there would be no need

[3] As is well known, the whole concept of equilibrium growth collapses unless progress is purely labor-augmenting, "Harrod-neutral." In that case the rate g above is $n+\gamma$, where n is the natural rate of increase and γ is the rate of technological progress, and "labor force" means effective or augmented labor force. In equilibrium, output and consumption per natural worker grow at the rate γ, and "sustainable" consumption per capita means consumption growing steadily at this rate. Clearly, level consumption per capita can be sustained with smaller net investment than $g\mu f(k)$; so μ and k steadily decline. See section A.2.3, below.

for defense expenditures and no one would be the worse without them. Conceptually, then, defense expenditures are gross but not net output.

The second reason is that defense expenditures are input rather than output data. Measurable output is especially elusive in the case of defense. Conceptually, the output of the defense effort is national security. Has the value of the nation's security risen from $0.5 billion to $50 billion over the period from 1929 to 1965? Obviously not. It is patently more reasonable to assume that the rise in expenditure was due to deterioration in international relations and to changes in military technology. The cost of providing a given level of security has risen enormously. If there has been no corresponding gain in security since 1929, the defense cost series is a very misleading indicator of improvements in welfare.

The economy's ability to meet increased defense costs speaks well for its productive performance. But the diversion of productive capacity to this purpose cannot be regarded simply as a shift of national preferences and the product mix. Just as we count technological progress, managerial innovation, and environmental change when they work in our favor (consider new business machines or mineral discoveries) so we must count a deterioration in the environment when it works against us (consider bad weather and war). From the point of view of economic welfare, an arms control or disarmament agreement which would free resources and raise consumption by 10 per cent would be just as significant as new industrial processes yielding the same gains.

In classifying defense costs—or police protection or public health expenditures—as regrettable and instrumental, we certainly do not deny the possibility that given the unfavorable circumstances that prompt these expenditures consumers will ultimately be better off with them than without them. This may or may not be the case. The only judgment we make is that these expenditures yield no direct satisfactions. Even if the "regrettable" outlays are rational responses to unfavorable shifts in the environment of economic activity, we believe that a welfare measure, perhaps unlike a production measure, should record such environmental change.

We must admit, however, that the line between final and instrumental outlays is very hard to draw. For example, the philosophical problems raised by the malleability of consumer wants are too deep to be resolved in economic accounting. Consumers are susceptible to influence by the examples and tastes of other consumers and by the sales efforts of producers. Maybe all our wants are just regrettable neces-

sities; maybe productive activity does no better than to satisfy the wants which it generates; maybe our net welfare product is tautologically zero. More seriously, we cannot measure welfare exclusively by the quantitative flows of goods and services. We need other gauges of the health of individuals and societies. These, too, will be relative to the value systems which determine whether given symptoms indicate health or disease. But the "social indicators" movement of recent years still lacks a coherent, integrative conceptual and statistical framework.

We estimate that overhead and regrettable expenses, so far as we have been able to define and measure them, rose from 8 per cent to 16 per cent of GNP over the period 1929–65 (Table 2, line 4).

2. Imputations for Capital Services, Leisure, and Nonmarket Work

In the national income accounts, rent is imputed on owner-occupied homes and counted as consumption and income. We must make similar imputations in other cases to which we have applied capital accounting. Like owner-occupied homes, other consumer durables and public investments yield consumption directly, without market transactions. In the case of educational and health capital, we have assumed the yields to be intermediate services rather than direct consumption; that is, we expect to see the fruits of investments in education and health realized in labor productivity and earnings, and we do not count them twice. Our measure understates economic welfare and its growth to the extent that education and medical care are direct rather than indirect sources of consumer satisfaction.

The omission of leisure and of nonmarket productive activity from measures of production conveys the impression that economists are blindly materialistic. Economic theory teaches that welfare could rise, even while NNP falls, as the result of voluntary choices to work for pay fewer hours per week, weeks per year, years per lifetime.

These imputations unfortunately raise serious conceptual questions, discussed at some length in section A.3, below. Suppose that in calculating aggregate dollar consumption the hours devoted to leisure and nonmarket productive activity are valued at their presumed opportunity cost, the money wage rate. In converting current dollar consumption to constant dollars, what assumption should be made about the unobservable price indexes for the goods and services consumed during those hours? The wage rate? The price index for marketed con-

TABLE 1
Measures of Economic Welfare, Actual and Sustainable, Various Years, 1929–65
(billions of dollars, 1958 prices, except lines 14–19, as noted)

	1929	1935	1945	1947	1954	1958	1965
1 Personal consumption, national income and product accounts	139.6	125.5	183.0	206.3	255.7	290.1	397.7
2 Private instrumental expenditures	−10.3	−9.2	−9.2	−10.9	−16.4	−19.9	−30.9
3 Durable goods purchases	−16.7	−11.5	−12.3	−26.2	−35.5	−37.9	−60.9
4 Other household investment	−6.5	−6.3	−9.1	−10.4	−15.3	−19.6	−30.1
5 Services of consumer capital imputation	24.9	17.8	22.1	26.7	37.2	40.8	62.3
6 Imputation for leisure							
B	339.5	401.3	450.7	466.9	523.2	554.9	626.9
A	339.5	401.3	450.7	466.9	523.2	554.9	626.9
C	162.9	231.3	331.8	345.6	477.2	554.9	712.8
7 Imputation for nonmarket activities							
B	85.7	109.2	152.4	159.6	211.5	239.7	295.4
A	178.6	189.5	207.1	215.5	231.9	239.7	259.8
C	85.7	109.2	152.4	159.6	211.5	239.7	295.4
8 Disamenity correction	−12.5	−14.1	−18.1	−19.1	−24.3	−27.6	−34.6
9 Government consumption	0.3	0.3	0.4	0.5	0.5	0.8	1.2
10 Services of government capital imputation	4.8	6.4	8.9	10.0	11.7	14.0	16.6
11 Total consumption = actual MEW							
B	548.8	619.4	768.8	803.4	948.3	1,035.3	1,243.6
A	641.7	699.7	823.5	859.3	968.7	1,035.3	1,208.0
C	372.2	449.4	649.9	682.1	902.3	1,035.3	1,329.5
12 MEW net investment	−5.3	−46.0	−52.5	55.3	13.0	12.5	−2.5
13 Sustainable MEW							
B	543.5	573.4	716.3	858.7	961.3	1,047.8	1,241.1
A	636.4	653.7	771.0	914.6	981.7	1,047.8	1,205.5
C	366.9	403.4	597.4	737.4	915.3	1,047.8	1,327.0
14 Population (no. of mill.)	121.8	127.3	140.5	144.7	163.0	174.9	194.6

(continued)

Table 1 (concluded)

		1929	1935	1945	1947	1954	1958	1965
	Actual MEW per capita							
15	Dollars							
	B	4,506	4,866	5,472	5,552	5,818	5,919	6,391
	A	5,268	5,496	5,861	5,938	5,943	5,919	6,208
	C	3,056	3,530	4,626	4,714	5,536	5,919	6,832
16	Index (1929 = 100)							
	B	100.0	108.0	121.4	123.2	129.1	131.4	141.8
	A	100.0	104.3	111.3	112.7	112.8	112.4	117.8
	C	100.0	115.5	151.4	154.3	181.2	193.7	223.6
	Sustainable MEW per capita							
17	Dollars							
	B	4,462	4,504	5,098	5,934	5,898	5,991	6,378
	A	5,225	5,135	5,488	6,321	6,023	5,991	6,195
	C	3,012	3,169	4,252	5,096	5,615	5,991	6,819
18	Index (1929 = 100)							
	B	100.0	100.9	114.3	133.0	132.2	134.3	142.9
	A	100.0	98.3	105.0	121.0	115.3	114.7	118.6
	C	100.0	105.2	141.2	169.2	186.4	198.9	226.4
19	Per capita NNP							
	Dollars	1,545	1,205	2,401	2,038	2,305	2,335	2,897
	1929 = 100	100.0	78.0	155.4	131.9	149.2	151.1	187.5

Note: Variants A, B, C in the table correspond to different assumptions about the bearing of technological progress on leisure and nonmarket activities. See section A.3.2, below, for explanation.

Source: Appendix Table A.16.

sumption goods? Over a period of forty years the two diverge substantially; the choice between them makes a big difference in estimates of the growth of MEW. As explained in Appendix A, the market consumption "deflator" should be used if technological progress has augmented nonmarketed uses of time to the same degree as marketed labor. The wage rate should be the deflator if no such progress has occurred in the effectiveness of unpaid time.

In Tables 1 and 2 we provide calculations for three conceptual alternatives. Our own choice is variant B of MEW, in which the value of leisure is deflated by the wage rate; and the value of nonmarket activity, by the consumption deflator.

TABLE 2
Gross National Product and MEW, Various Years, 1929–65
(*billions of dollars, 1958 prices*)

	1929	1935	1945	1947	1954	1958	1965
1. Gross national product	203.6	169.5	355.2	309.9	407.0	447.3	617.8
2. Capital consumption, NIPA	−20.0	−20.0	−21.9	−18.3	−32.5	−38.9	−54.7
3. Net national product, NIPA	183.6	149.5	333.3	291.6	374.5	408.4	563.1
4. NIPA final output reclassified as regrettables and intermediates							
a. Government	−6.7	−7.4	−146.3	−20.8	−57.8	−56.4	−63.2
b. Private	−10.3	−9.2	−9.2	−10.9	−16.4	−19.9	−30.9
5. Imputations for items not included in NIPA							
a. Leisure	339.5	401.3	450.7	466.9	523.2	554.9	626.9
b. Nonmarket activity	85.7	109.2	152.4	159.6	211.5	239.7	295.4
c. Disamenities	−12.5	−14.1	−18.1	−19.1	−24.3	−27.6	−34.6
d. Services of public and private capital	29.7	24.2	31.0	36.7	48.9	54.8	78.9
6. Additional capital consumption	−19.3	−33.4	−11.7	−50.8	−35.2	−27.3	−92.7
7. Growth requirement	−46.1	−46.7	−65.8	+5.4	−63.1	−78.9	−101.8
8. Sustainable MEW	543.6	573.4	716.3	858.6	961.3	1,047.7	1,241.1

NIPA = national income and product accounts.

Note: Variants A, B, C in the table correspond to different assumptions about the bearing of technological progress on leisure and nonmarket activities. Variant A assumes that neither has benefited from technological progress at the rate of increase of real wages; variant C assumes that both have so benefited; variant B assumes that leisure has not been augmented by technological progress but other nonmarket activities have benefited. See section A.3.2, below, for explanation.

Source: Appendix Table A.17.

3. Disamenities of Urbanization

The national income accounts largely ignore the many sources of utility or disutility that are not associated with market transactions or measured by the market value of goods and services. If one of my neighbors cultivates a garden of ever-increasing beauty, and another makes more and more noise, neither my increasing appreciation of the one nor my growing annoyance with the other comes to the attention of the Department of Commerce.

Likewise there are some socially productive assets (for example, the environment) that do not appear in any balance sheets. Their services to producers and consumers are not valued in calculating national income. By the same token no allowance is made for depletion of their capacity to yield services in the future.

Many of the negative "externalities" of economic growth are connected with urbanization and congestion. The secular advances recorded in NNP figures have accompanied a vast migration from rural agriculture to urban industry. Without this occupational and residential revolution we could not have enjoyed the fruits of technological progress. But some portion of the higher earnings of urban residents may simply be compensation for the disamenities of urban life and work. If so we should not count as a gain of welfare the full increments of NNP that result from moving a man from farm or small town to city. The persistent association of higher wages with higher population densities offers one method of estimating the costs of urban life as they are valued by people making residential and occupational decisions.

As explained in section A.4, below, we have tried to estimate by cross-sectional regressions the income differentials necessary to hold people in localities with greater population densities. The resulting estimates of the disamenity costs of urbanization are shown in Table 1, line 8. As can be seen, the estimated disamenity premium is quite substantial, running about 5 per cent of GNP. Nevertheless, the urbanization of the population has not been so rapid that charging it with this cost significantly reduces the estimated rate of growth of the economy.

The adjustments leading from national accounts "personal consumption" to MEW consumption are shown in Table 1, and the relations of GNP, NNP, and MEW are summarized in Table 2. For reasons previously indicated, we believe that a welfare measure should have the dimension *per capita*. We would stress the per capita MEW figures shown in Tables 1 and 2.

Although the numbers presented here are very tentative, they do suggest the following observations. First, MEW is quite different from conventional output measures. Some consumption items omitted from GNP are of substantial quantitative importance. Second, our preferred variant of per capita MEW has been growing more slowly than per capita NNP (1.1 per cent for MEW as against 1.7 per cent for NNP, at annual rates over the period 1929–65). Yet MEW has been growing. The progress indicated by conventional national accounts is not just a myth that evaporates when a welfare-oriented measure is substituted.

GROWTH AND NATURAL RESOURCES

Calculations like the foregoing are unlikely to satisfy critics who believe that economic growth per se piles up immense social costs ignored in even the most careful national income calculations. Faced with the finiteness of our earth and the exponential growth of economy and population, the environmentalist sees inevitable starvation. The specter of Malthus is haunting even the affluent society.

There is a familiar ring to these criticisms. Ever since the industrial revolution pessimistic scientists and economists have warned that the possibilities of economic expansion are ultimately limited by the availability of natural resources and that society only makes the eventual future reckoning more painful by ignoring resource limitations now.

In important part, this is a warning about population growth, which we consider below. Taking population developments as given, will natural resources become an increasingly severe drag on economic growth? We have not found evidence to support this fear. Indeed, the opposite appears to be more likely: Growth of output per capita will accelerate ever so slightly even as stocks of natural resources decline.

The prevailing standard model of growth assumes that there are no limits on the feasibility of expanding the supplies of nonhuman agents of production. It is basically a two-factor model in which production depends only on labor and reproducible capital. Land and resources, the third member of the classical triad, have generally been dropped. The simplifications of theory carry over into empirical work. The thousands of aggregate production functions estimated by econometricians in the last decade are labor-capital functions. Presumably the tacit justification has been that reproducible capital is a near-perfect substitute for land and other exhaustible resources, at least in the perspective of heroic aggregation customary in macroeconomics. If substitution for natural resources is not possible in any given technology, or if a particular resource is exhausted, we tacitly assume that "land-augmenting" innovations will overcome the scarcity.

These optimistic assumptions about technology stand in contrast to the tacit assumption of environmentalists that no substitutes are available for natural resources. Under this condition, it is easily seen that output will indeed stop growing or will decline. It thus appears that the substitutability (or technically, the elasticity of substitution) between the neoclassical factors, capital and labor, and natural resources

is of crucial importance to future growth. This is an area needing extensive further research, but we have made two forays to see what the evidence is. Details are given in Appendix B, below.

First we ran several simulations of the process of economic growth in order to see which assumptions about substitution and technology fit the "stylized" facts. The important facts are: growing income per capita and growing capital per capita; relatively declining inputs and income shares of natural resources; and a slowly declining capital-output ratio. Among the various forms of production function considered, the following assumptions come closest to reproducing these stylized facts: (a) Either the elasticity of substitution between natural resources and other factors is high – significantly greater than unity – or resource-augmenting technological change has proceeded faster than overall productivity; (b) the elasticity of substitution between labor and capital is close to unity.

After these simulations were run, it appeared possible to estimate directly the parameters of the preferred form of production function. Econometric estimates confirm proposition (a) and seem to support the alternative of high elasticity of substitution between resources and the neoclassical factors.

Of course it is always possible that the future will be discontinuously different from the past. But if our estimates are accepted, then continuation of substitution during the next fifty years, during which many environmentalists foresee the end to growth, will result in a small increase – perhaps about 0.1 per cent per annum – in the growth of per capita income.

Is our economy, with its mixture of market processes and governmental controls, biased in favor of wasteful and shortsighted exploitation of natural resources? In considering this charge, two archetypical cases must be distinguished, although many actual cases fall between them. First, there are appropriable resources for which buyers pay market values and users market rentals. Second, there are inappropriable resources, "public goods," whose use appears free to individual producers and consumers but is costly in aggregate to society.

If the past is any guide for the future, there seems to be little reason to worry about the exhaustion of resources which the market already treats as economic goods. We have already commented on the irony that both growth men and antigrowth men invoke the interests of future generations. The issue between them is not whether and how much provision must be made for future generations, but in what form

it should be made. The growth man emphasizes reproducible capital and education. The conservationist emphasizes exhaustible resources—minerals in the ground, open space, virgin land. The economist's initial presumption is that the market will decide in what forms to transmit wealth by the requirement that all kinds of wealth bear a comparable rate of return. Now stocks of natural resources—for example, mineral deposits—are essentially sterile. Their return to their owners is the increase in their prices relative to prices of other goods. In a properly functioning market economy, resources will be exploited at such a pace that their rate of relative price appreciation is competitive with rates of return on other kinds of capital. Many conservationists have noted such price appreciation with horror, but if the prices of these resources accurately reflect the scarcities of the future, they must rise in order to prevent too rapid exploitation. Natural resources *should* grow in relative scarcity—otherwise they are an inefficient way for society to hold and transmit wealth compared to productive physical and human capital. Price appreciation protects resources from premature exploitation.

How would an excessive rate of exploitation show up? We would see rates of relative price increase that are above the general real rate of return on wealth. This would indicate that society had in the past used precious resources too profligately, relative to the tastes and technologies later revealed. The scattered evidence we have indicates little excessive price rise. For some resources, indeed, prices seem to have risen more slowly than efficient use would indicate ex post.

If this reasoning is correct, the nightmare of a day of reckoning and economic collapse when, for example, all fossil fuels are forever gone seems to be based on failure to recognize the existing and future possibilities of substitute materials and processes. As the day of reckoning approaches, fuel prices will provide—as they do not now—strong incentives for such substitutions, as well as for the conservation of remaining supplies. On the other hand, the warnings of the conservationists and scientists do underscore the importance of continuous monitoring of the national and world outlook for energy and other resources. Substitutability might disappear. Conceivably both the market and public agencies might be too complacent about the prospects for new and safe substitutes for fossil fuels. The opportunity and need for fruitful collaboration between economists and physical scientists has never been greater.

Possible abuse of public natural resources is a much more serious

problem. It is useful to distinguish between *local* and *global* ecological disturbances. The former include transient air pollution, water pollution, noise pollution, visual disamenities. It is certainly true that we have not charged automobile users and electricity consumers for their pollution of the skies, or farmers and housewives for the pollution of lakes by the runoff of fertilizers and detergents. In that degree our national product series have overestimated the advance of welfare. Our urban disamenity estimates given above indicate a current overestimate of about 5 per cent of total consumption.

There are other serious consequences of treating as free things which are not really free. This practice gives the wrong signals for the directions of economic growth. The producers of automobiles and of electricity should be given incentives to develop and to utilize "cleaner" technologies. The consumers of automobiles and electricity should pay in higher prices for the pollution they cause, or for the higher costs of low-pollution processes. If recognition of these costs causes consumers to shift their purchases to other goods and services, that is only efficient. At present overproduction of these goods is uneconomically subsidized as truly as if the producers received cash subsidies from the Treasury.

The mistake of the antigrowth men is to blame economic growth per se for the misdirection of economic growth. The misdirection is due to a defect of the pricing system—a serious but by no means irreparable defect and one which would in any case be present in a stationary economy. Pollutants have multiplied much faster than the population or the economy during the last thirty years. Although general economic growth has intensified the problem, it seems to originate in particular technologies. The proper remedy is to correct the price system so as to discourage these technologies. Zero economic growth is a blunt instrument for cleaner air, prodigiously expensive and probably ineffectual.

As for the danger of global ecological catastrophes, there is probably very little that economics alone can say. Maybe we are pouring pollutants into the atmosphere at such a rate that we will melt the polar icecaps and flood all the world's seaports. Unfortunately, there seems to be great uncertainty about the causes and the likelihood of such occurrences. These catastrophic global disturbances warrant a higher priority for research than the local disturbances to which so much attention has been given.

POPULATION GROWTH

Like the role of natural resources, the role of population in the standard neoclassical model is ripe for re-examination. The assumption is that population and labor force grow exogenously, like compound interest. Objections arise on both descriptive and normative grounds. We know that population growth cannot continue forever. Some day there will be stable or declining population, either with high birth and death rates and short life expectancies, or with low birth and death rates and long life expectancies. As Richard Easterlin argues in his National Bureau book,[4] there surely is some adaptation of human fertility and mortality to economic circumstances. Alas, neither economists nor other social scientists have been notably successful in developing a theory of fertility that corresponds even roughly to the facts. The subject deserves much more attention from economists and econometricians than it has received.

On the normative side, the complaint is that economists should not fatalistically acquiesce in whatever population growth happens. They should instead help to frame a population policy. Since the costs to society of additional children may exceed the costs to the parents, childbearing decisions are a signal example of market failure. How to internalize the full social costs of reproduction is an even more challenging problem than internalizing the social costs of pollution.

During the past ten years, the fertility of the United States population has declined dramatically. If continued, this trend would soon diminish fertility to a level ultimately consistent with zero population growth. But such trends have been reversed in the past, and in the absence of any real understanding of the determinants of fertility, predictions are extremely hazardous.

The decline may be illustrated by comparing the 1960 and 1967 net reproduction rates and intrinsic (economists would say "equilibrium") rates of growth of the United States population. The calculations of Table 3 refer to the asymptotic steady-state implications of indefinite continuation of the age-specific fertility and mortality rates of the year 1960 or 1967. Should the trend of the 1960s continue, the intrinsic growth rate would become zero, and the net reproduction rate 1.000, in the 1970s. Supposing that the decline in fertility then stopped. The actual population would grow slowly for another forty or fifty

[4] *Population, Labor Force, and Long Swings in Economic Growth: The American Experience*, New York, NBER, 1968.

TABLE 3
U.S. Population Characteristics in Equilibrium

	Intrinsic Growth Rate (per cent per year)	Net Reproduction Rate	Median Age
1960 fertility-mortality	2.1362	1.750	21–22
1967 fertility-mortality	0.7370	1.221	28
Hypothetical ZPG	0.0000	1.000	32

years while the inherited bulge in the age distribution at the more fertile years gradually disappeared. The asymptotic size of the population would be between 250 million and 300 million.

One consequence of slowing down the rate of population growth by diminished fertility is, of course, a substantial increase in the age of the equilibrium population, as indicated in the third column of Table 3. It is hard to judge to what degree qualitative change and innovation have in the past been dependent on quantitative growth. When our institutions are expanding in size and in number, deadwood can be gracefully bypassed and the young can guide the new. In a stationary population, institutional change will either be slower or more painful.

The current trend in fertility in the United States suggests that, contrary to the pessimistic warnings of some of the more extreme anti-growth men, it seems quite possible that ZPG can be reached while childbearing remains a voluntary private decision. Government policy can concentrate on making it completely voluntary by extending the availability of birth control knowledge and technique and of legal abortion. Since some 20 per cent of current births are estimated to be unintended, it may well be that intended births at present are insufficient to sustain the population.

Once the rate of population growth is regarded as a variable, perhaps one subject to conscious social control, the neoclassical growth model can tell some of the consequences of its variation. As explained above, sustainable per capita consumption (growing at the rate of technological progress) requires enough net investment to increase the capital stock at the natural rate of growth of the economy (the sum of the

rate of increase of population and productivity). Given the capital-output ratio, sustainable consumption per capita will be larger the lower the rate of population increase; at the same time, the capital-widening requirement is diminished.

This is, however, not the only effect of a reduction of the rate of population growth. The equilibrium capital-output ratio itself is altered. The average wealth of a population is a weighted average of the wealth positions of people of different ages. Over its life cycle the typical family, starting from low or negative net worth, accumulates wealth to spend in old age, and perhaps in middle years when children are most costly. Now a stationary or slow-growing population has a characteristic age distribution much different from that of a rapidly growing population. The stationary population will have relatively fewer people in the early low-wealth years, but relatively more in the late low-wealth

TABLE 4

Illustrative Relationship of Sustainable Per Capita Consumption to Marginal Productivity of Capital and to Capital-Output Ratio

Marginal Productivity of Capital					Index of Consumption Per Capita (c)		
Gross (R) (1)	Net of Depreciation ($R-\delta$) (2)	Ratio of Capital to GNP (μ') (3)	Ratio of Capital to NNP (μ) (4)	Index of NNP per Capita (y) (5)	1960 Pop. Growth (6)	1967 Pop. Growth (7)	ZPG (8)
.09	.05	3.703	4.346	1.639	1.265	1.372	1.426
.105	.065	3.175	3.637	1.556	1.265	1.344	1.386
.12	.08	2.778	3.125	1.482	1.245	1.309	1.343
.15	.11	2.222	2.439	1.356	1.187	1.233	1.257

Note: A Cobb-Douglas production function is assumed for GNP, with constant returns to scale, with an elasticity of output with respect to capital (α) of $\frac{1}{3}$, and with the rate (γ) of labor-augmenting technological progress 3 per cent per year. The depreciation rate (δ) is assumed to be 4 per cent per year. GNP per capita (Y) is $ae^{\gamma t}k^{\alpha}$ and NNP per capita (y) is $Y-\delta k$, where k is the capital-labor ratio.

Column 3: Since $Rk=\alpha Y$, $\mu'=k/Y=\alpha/R$.

Column 4: $\mu=\mu'/(1-\delta\mu')$.

Column 5: $y=(1-\delta\mu')Y$. For the index, $ae^{\gamma t}$ is set equal to 1.

Columns 6, 7, and 8: $c=[1-(n+\gamma)\mu]y$. Given $\gamma=0.03$, $n+\gamma$ is 0.0513 for 1960, 0.0374 for 1967, 0.0300 for ZPG.

TABLE 5
Desired Wealth-Income Ratios Estimated for Different Rates of Population Growth (and for Different Equivalent Adult Scales and Subjective Discount Rates [a])

Net Interest Rate $(R - \delta)$	Desired Wealth-Income Ratio (μ)		
	1960 Pop. Growth (.021)	1967 Pop. Growth (.007)	ZPG
Teenagers, 1.0; Children, 1.0; Discount, 0.02			
.05	−1.70	−1.46	−1.24
.065	0.59	0.91	1.16
.08	2.31	2.70	2.90
.11	4.31	4.71	4.95
Teenagers, 0.8; Children, 0.6; Discount, 0.01			
.05	0.41	0.74	0.97
.065	2.36	2.75	3.00
.08	3.74	4.16	4.41
.11	5.17	5.55	5.75
Teenagers, 0.8; Children, 0.6; Discount, 0.02			
.05	−1.17	−0.95	−0.75
.065	1.08	1.38	1.60
.08	2.74	3.11	3.34
.11	4.61	4.98	5.18
Teenagers, 0.0; Children, 0.0; Discount, 0.02			
.05	−0.40	−0.15	0.02
.065	1.93	2.20	2.36
.08	3.56	3.85	4.01
.11	5.20	5.47	5.61

Note: The desired wealth-income ratio is calculated for a given steady state of population increase and the corresponding equilibrium age distribution. It is an aggregation of the wealth and income positions of households of different ages. As explained in Appendix C it also depends on the interest rate, the typical age-income profile and the expected growth of incomes ($\gamma = 0.03$), the rate of subjective discount of future utility of consumption, and the weights given to teenagers (boys 14–20 and girls 14–18) and other children in household allocations of lifetime incomes to consumption in different years. See Appendix C for further explanation.

[a] Shown in boldface.

TABLE 6
Estimated Equilibrium Capital-Output Ratios and Per Capita Consumption Rates [a]

Population Growth Rate	Interest Rate $(R-\delta)$	Capital-Output Ratio (μ)	Consumption Index (c)	Per Cent Increase in c over 1960
	Teenagers, 1.0; Children, 1.0; Discount, 0.02			
1960	.089	2.88	1.23	
1967	.085	2.99	1.30	5.62
ZPG	.082	3.07	1.34	9.04
	Teenagers, 0.8; Children, 0.6; Discount, 0.01			
1960	.074	3.28	1.25	
1967	.071	3.38	1.33	6.23
ZPG	.069	3.47	1.37	9.74
	Teenagers, 0.8; Children, 0.6; Discount, 0.02			
1960	.084	3.00	1.24	
1967	.080	3.11	1.31	5.82
ZPG	.078	3.16	1.35	8.97
	Teenagers, 0.0; Children, 0.0; Discount, 0.02			
1960	.077	3.22	1.25	
1967	.074	3.28	1.32	6.42
ZPG	.073	3.33	1.36	9.99

Note: Estimated by interpolation from Tables 4 and 5. See Figure 1.
[a] Equivalent adult scales and subjective discount rate are shown in boldface.

years. So it is not obvious in which direction the shift of weights moves the average.

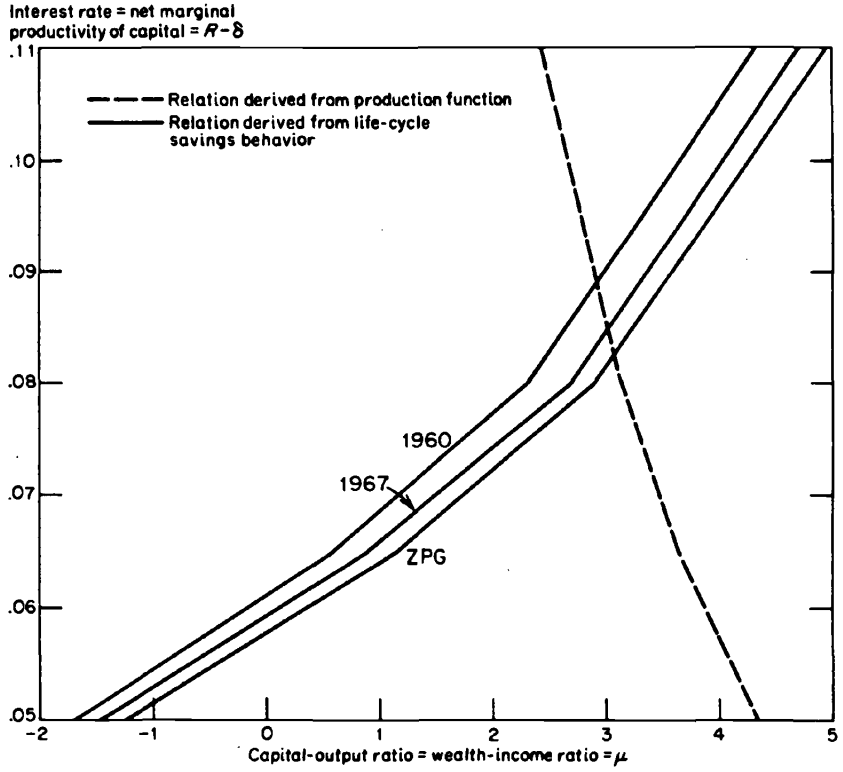
We have, however, estimated the shift by a series of calculations described in Appendix C. Illustrative results are shown in Tables 4–6 and Figure 1. Evidently, reduction in the rate of growth increases the society's desired wealth-income ratio. This means an increase in the capital-output ratio which increases the society's sustainable consumption per capita.[5]

On both counts, therefore, a reduction in population increase

[5] Provided only that the change is made from an initial situation in which the net marginal productivity of capital exceeds the economy's natural rate of growth. Otherwise the increased capital-widening requirements exceed the gains in output.

FIGURE 1

Determination of Equilibrium Capital-Output Ratio and Interest Rate
(*equivalent adult scale for teenagers and children = 1.0; subjective discount rate = 0.02*)



Source: Tables 4 and 5.

should raise sustainable consumption. We have essayed an estimate of the magnitude of this gain. In a ZPG equilibrium sustainable consumption per capita would be 9–10 per cent higher than in a steady state of 2.1 per cent growth corresponding to 1960 fertility and mortality, and somewhat more than 3 per cent higher than in a steady state of 0.7 per cent growth corresponding to 1967 fertility and mortality.

These neoclassical calculations do not take account of the lower pressure of population growth on natural resources. As between the 1960 equilibrium and ZPG, the diminished drag of resource limitations is worth about one-tenth of 1 per cent per annum in growth of per cap-

ita consumption. Moreover, if our optimistic estimates of the ease of substitution of other factors of production for natural resources are wrong, a slowdown of population growth will have much more important effects in postponing the day of reckoning.

Is growth obsolete? We think not. Although GNP and other national income aggregates are imperfect measures of welfare, the broad picture of secular progress which they convey remains after correction of their most obvious deficiencies. At present there is no reason to arrest general economic growth to conserve natural resources, although there is good reason to provide proper economic incentives to conserve resources which currently cost their users less than true social cost. Population growth cannot continue indefinitely, and evidently it is already slowing down in the United States. This slowdown will significantly increase sustainable per capita consumption. But even with ZPG there is no reason to shut off technological progress. The classical stationary state need not become our utopian norm.

COMMENT

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1. In December 1970, I was asked to give my reaction to an earlier version of the Nordhaus-Tobin paper. I quote from my letter: [1]

It is an outstanding, pioneering paper. It sets out to do something that we have long wanted to do (see, for example, the express remarks by Preston Cloud and Garrett Hardin at the AAAS Symposium on Optimum Population), namely, to transform the GNP into an index which measures more directly what would correspond to quality of life. This paper is an admirable effort in that direction and combines sound and original thinking with a very fine style of writing. There are six different kinds of corrections that are made to the GNP, or rather to the NNP (Net National Product). I have to withhold judgment on how well they have succeeded until I have a chance to study the appendices in detail. It is clear that what they have done is much more than just a bookkeeping job, i.e., pushing items from one category to another. They have incorporated a good deal of judgment, some educated guesses, and some interesting and original analyses.

Their most striking conclusion is that MEW (Measure of Economic Wel-

[1] The symposium of the American Association for the Advancement of Science that is mentioned in the letter was held in 1969. The papers and discussion are contained in S. F. Singer, ed., *Is There an Optimum Level of Population?*, New York, McGraw-Hill, 1971.

fare) has grown faster than the NNP. One word of caution, though; their corrections to the NNP are not small. In many cases they are larger than the NNP itself so that their final result is very sensitive to the goodness of the correction.

An area in which their analysis is weak is the exhaustion of natural resources and the evaluation of the diseconomies of pollution. . . .

Although I would take issue with many points in detail, and perhaps some other major points, the study is immensely valuable and breaks new ground. It is of particular value to me because it complements what I am trying to do and therefore helps me very directly. Even the title of their paper "Is Growth Obsolete?" resembles mine, which is "When Does Growth Become Too Expensive?" The factors which they have not handled or handled well are precisely the ones that I am covering. . . .

I have now given it one reasonably careful reading; it deserves at least three more. . . .

2. I have now done my three readings and have no reason to change my mind. It is indeed an "outstanding, pioneering" paper. However, I will take issue in detail, in the expectation that constructive criticism will help us arrive at a better approximation to an index of economic welfare. If I am a little diffident in putting forth my views on the paper, it is because of John Meyer's admonition to "let a hundred flowers bloom." Perhaps he recalls that this pronouncement was made by Chairman Mao who then promptly chopped off the heads of all those flowers.

George Jaszi has admonished us not to construct indexes on a wholesale basis. One should have a particular purpose in mind, because this in turn conditions the index. Another important thing to keep in mind is the time scale of our examination. We are definitely interested in time scales of ten to twenty years rather than one to two years. This allows important simplifications for the determination of an index.

My own purpose is to answer a very simple-sounding question, namely: Would we be better off or worse off in the future if we had more people or fewer people? [2] This requires a rather different kind of

[2] This problem, however, is not addressed by Nordhaus and Tobin, although it may appear so on a superficial reading of their Appendix C (the appendixes may be found in *Economic Growth*, Fiftieth Anniversary Colloquium V, New York, National Bureau of Economic Research, 1972). Instead they address a second-order effect, namely, how does age distribution of a population (or rate of growth, which is equivalent) affect welfare. Although they show that zero population growth rate, i.e., a specific age distribution corresponding to a net reproduction ratio of one, gives a higher index than a growing population, I would hazard that a negative population growth rate may give an even larger value to the quality index MEW.

examination than that in the Nordhaus-Tobin paper. In particular, I believe that the exhaustion of natural resources and the increasing use of "free" goods, such as air and water, have to be closely examined because they may play a primary role.

3. In their Appendix B, Nordhaus-Tobin arrive at the surprising conclusion that welfare will increase as growth continues in spite of the exhaustion of natural resources. Closer analysis shows that they assume the ready substitution of one resource for another. This of course is the key problem, and I rather doubt whether this assumption will be valid. The word *ready* has to be emphasized; and an appreciable time lag in substitution will affect growth through price increases. To gain some perspective on this problem, we should note that currently about 3 to 4 per cent of the GNP is spent on fossil fuels, and that fossil fuel prices have been rising rather steeply. Increased fuel costs will reflect themselves in increased costs of all goods and most services. In particular, the necessities of life, including food, will become more costly and thus affect the welfare of the poorer section of the population even more strongly. (I purposely choose fossil fuels because they play such an important role in our economy. Nonrenewable fuel resources are not easily replaceable, and they certainly cannot be exchanged for land, as in neoclassical growth analysis. Computer simulations, as in Appendix B, do nothing to support the correctness of Nordhaus and Tobin's basic assumptions.)

It can of course be argued that exhaustion of natural resources will raise the price of manufactured goods, leading to a reduced emphasis on growth in that direction and more emphasis on services. This is a current trend, but it cannot continue all the way and is not caused by resource shortages. On the other hand, costs associated with manufactured goods may rise even more steeply, because of the associated environmental costs. This matter is discussed in more detail below.

4. Most of the Nordhaus-Tobin paper (Appendix A) is of course given over to the calculation of a new welfare index. There is a great deal of room for subjective views on both the imputations and amputations which they perform. I will review my known predilections rather briefly, but then spend more time on a major omission, i.e., the one dealing with environmental externalities and social costs.

Before starting on a detailed discussion, I need to explain the difference between what I call intrinsic and extrinsic items. Intrinsic items are those directly connected with and traceable to economic growth: items such as exhaustion of natural resources, pollution control costs,

disamenities due to crowding, etc. Extrinsic items are not necessarily related, or at least not strongly related, to economic growth, and include expenditures for defense, space research, and science generally. Since relative (rather than absolute) welfare measures are of real importance in relation to governmental policies, i.e., would we be better off or worse off if we do something and follow a certain path, we can in many cases neglect or sidestep extrinsic factors and the corrections which they produce to the GNP.

The big Nordhaus-Tobin corrections are for leisure (on the order of 200 per cent of market consumption) and for nonmarket activities, on the order of 100 per cent. On the other hand, their disamenity correction for urban congestion and all other urban problems is less than 5 per cent, which is surprisingly small; and they have no correction at all for pollution control. Since leisure and nonmarket activities are so large, this means that the corrections have to be done with great care: a small difference can distort the over-all result. Unfortunately, these corrections are rather arbitrary. With respect to the Nordhaus-Tobin discussion on leisure, three points could be made. One is that eating is a necessity; it should not be counted as a leisure-time activity. Another is that leisure-time value might be established by observing what people actually do. After all, working involves not only a benefit, i.e., wages, but also disutility. How much of a premium are people willing to pay, say, to save travel time and have more leisure? And finally, their key assumption is that leisure time can in fact be traded for working hours and additional wages. This may not be true; perhaps the economy cannot accommodate increased working hours without increasing unemployment. In that case, the basis for using opportunity costs for leisure disappears.

The urban disamenity correction calculated by Nordhaus and Tobin on the basis of higher urban incomes is interesting but it may be an underestimate.[3] The reason is that many urban diseconomies are subsidized by nonurban residents, i.e., by the general taxpayer. One would like to see additional analyses, using as a basis the costs for urban services or the urban cost-of-living index. It would be interesting to see if these methods arrive at the same result as Nordhaus-Tobin.[4]

[3] On the other hand, the increased urban salaries may be closely tied in to the increased costs and time of commuting to work which they subtracted under "regrettables." Also, to what extent are urban salaries higher just because there are more job opportunities in urban areas for people of higher education?

[4] It is necessary to subtract here all costs, direct or indirect, that are based on the higher value of land in the city. Unlike the real costs of traffic snarls and

5. The correction for environmental protection is a major one, I believe. Pollution control costs should rise more rapidly even than GNP. This nonlinear relationship is easy to explain if we consider that the natural environment has a limited but finite assimilative capacity.[5] Once the effluent level exceeds this capacity, then expenditures must be provided. In order to maintain a fixed level of environmental quality, the degree of clean-up has to increase, and unfortunately, the costs rise steeply with the degree of clean-up. This is the approach that I have taken in my work: by holding environmental quality fixed I do not have to consider the benefits or damages of environmental quality or pollution. Most of the costs are connected with the production or use of various forms of energy, but through the input-output table, these costs will reflect themselves also in the costs of intermediate and consumer goods, principally, aluminum, fertilizers, paper, etc. In the final analysis, the prices of food and other items that play an important part in the cost of living index will rise and diminish welfare.

6. In conclusion, it is possible to apply various corrections to the GNP to arrive at a better measure of welfare, including some imputations and some amputations. There is one item, however, which deserves more careful attention and that is the distribution of welfare. Intuitively, one would think that a narrow distribution leads to a more stable society, and therefore contributes greatly to societal welfare. It would be important to know how to assign a welfare value to changes in income *distribution* as well as to changes in the *average* income.

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In my view it is very significant that the major adjustments Nordhaus and Tobin have made in the national accounts in order to allow for welfare considerations did *not* lead them to the conclusion that growth was obsolete, or that the progress indicated by conventional national accounts was just a myth. However, I cannot see why they take the defensive attitude about growth which is indicated by their remarks: "at

other impediments to intra-urban transportation, land rents (and the price increases they cause) are transfer payments. For the same reason, urban salaries are subject to a large correction when used to measure urban disamenities.

[5] As a matter of interest, it should be noted that if people were perfectly distributed, according to the available surface water, then the United States could accommodate 250 million people without requiring any sewage treatment.

present there is no reason to arrest general economic growth . . . ," or "even with zero population growth there is no reason to shut off technological progress." I believe that economic growth and technological progress are not only *possible* but also *necessary* for the betterment of human welfare.

The disagreement is probably due to the general confusion about the meaning of growth, and an attempt to clarify it might serve a useful purpose. Why is it that the same policymakers who are the staunchest advocates of the protection of the environment and who often criticize economic growth on the basis that it might be detrimental to our natural resources and to the quality of life take the strongest measures to stimulate expansion as soon as the growth of the gross national product tends to slow down? What leads to this apparent *growth dilemma?*

I think the explanation of the problem is historical. It was observed that over the centuries the might and wealth of nations was associated with the size of their populations, and even today we see that those nations and industries prosper which find large numbers of customers for their products and services. These observations have led to the widespread, and erroneous, assumption that growth necessarily means population growth, together with the environmental problems it may cause.

To find the true meaning of economic growth, we must look at what the economy is all about: people producing goods and services to satisfy their wants. The wants are individual wants, even if they are satisfied collectively. As Nordhaus and Tobin themselves emphasized it correctly, it is "per capita rather than aggregate consumption [that] is the welfare objective." Progress in welfare is, therefore, growing in per capita consumption and, in order to provide for this increasing per capita consumption, economic growth must mean increasing per capita production (unless it comes from self-generating free resources).

The latter is determined by the productivity of the labor force engaged in production, and economic growth cannot originate from any other source than increased over-all labor productivity (whatever the factors may be that bring about this productivity increase). It is true that society may choose increased leisure time as a preferred welfare objective but this is then proportionately traded off against economic growth in the per capita production (and consumption) of goods and services. It may also be chosen as a welfare objective to divide at least part of the national real output among all members of the society rather than in accordance with the contribution of the individual to total output, as is in the case of many public services and of the various

forms of guaranteed annual income or similar income-sharing plans. This is only a question of income distribution and all must come out of the productivity of the employed labor force.

As our real income increases, it is just human nature to want more and/or a better quality of goods and services. In addition, it takes only simple arithmetic to show that if we can produce the goods and services we want at a lower environmental cost or from fewer resources than before through better technology, it is also economic growth. If we can produce a nonpolluting car tomorrow instead of today's polluting car, that is economic as well as welfare growth.

Summing up this point, I see the true chance for economic growth in the increasing per capita demand for (and production of) goods and services and in the improving quality of these, rather than in population growth. And I believe that this per capita growth potential is much greater than estimated by Nordhaus and Tobin.

The second point I wish to make refers to the contribution of national accounts to the measurement of welfare growth.

Although gross national product is not a welfare measure, the Nordhaus-Tobin paper supports the view that, in spite of its shortcomings, it does correctly indicate the direction of progress. How could it be otherwise? We cannot have better health without doctors and medicines, hospitals, and modern equipment; enjoy outdoor life without roads, transport equipment, skis, boats, proper clothing, or prepared foods; concerts without musicians or musical instruments (and nowadays without amplifiers); or arts without artists, metals, or paints; and so on. All of these *are* measured in the national accounts. Although GNP does not measure welfare, many if not most elements of welfare are, in fact, measured by it.

At this conference numerous suggestions were made toward the development of an integrated framework of social indicators which would be distinct from the national accounts. With these I agree. I also believe, however, that the national accounts can be improved further, particularly in the measurement of quality change and in the sectors where output is now measured by inputs. I think that through detailed studies of principal characteristics of a carefully selected sample of products and services, productivity indicators can be developed, through which progress can be made toward better output measures in these areas.

In the field of quality measurement I think there is scope in cross-sectional analyses because it is easier to measure the differences between a $3 steak served in one restaurant and an $8 steak served in another

at the same time, than changes over time. Other useful suggestions about the direction such studies could take have been presented in Jaszi's note in the August 1962 issue of the *Review of Economics and Statistics,* and still apply.

In the field of government output, two approaches toward improvement appear to be particularly feasible. Impact or output measures, which are usually very complex, can be subdivided into measurable elements. For instance, instead of "industrial development" we can strive toward measuring the elements of this over-all objective, such as progress in productivity, profitability, wage level, employment, distribution of employment, industrial structure and concentration, the ratio of technically trained labor force, etc. At the performance level, specific productivity indexes can be developed, which can be applied through careful analysis, to adjust governmental output. In the United States, John Kendrick has clearly illustrated the feasibility of such measures, while in Canada some successful experiments have been made in this direction by the National Output and Productivity Division of Statistics Canada (formerly Dominion Bureau of Statistics). Since productivity does not just happen but is brought about by various factors, and since these factors, including better management, better education, better methods and equipment, are more or less keeping pace in the public service with the private sector, it just does not make sense to keep the productivity measure constant in the public sector. Furthermore, ignoring productivity changes in the public sector leads to noncomparability of national accounts on an international basis.

With the growing importance of *quality* in the production of both goods and services, and with the rapid growth of the *public sector,* I believe that improvements in these areas are much more promising avenues toward a better measurement of economic, or even welfare, progress then imaginative (but for the time being unworkable) attempts at turning the national accounts into social welfare measures. I think that a number of points raised by George Jaszi in his comments on the Juster paper apply equally to the Nordhaus-Tobin study too.

In conclusion, I would like to make two brief observations concerning the Nordhaus-Tobin paper. First, I do not understand why the authors exclude defense services from national output (or more precisely, from their measure of economic welfare) when these can hardly be considered as anything else but *freedom* as output, measured by the relevant inputs. Freedom is, as the authors pointed out, one of the basic welfare goals even according to Paul Erlich. Secondly, I tend to disagree with the

authors when they consider health services as intermediate output and exclude them from national output. I realize that good health contributes to one's productivity but I cannot help taking medical services as final output because when I buy them I do so, and I believe that there are others who share my views, because I simply enjoy living and being healthy.

DAN USHER, Queen's University

The effect of Nordhaus and Tobin's imputation for leisure is to reduce the rate of economic growth despite the fact that consumption of leisure is increasing over time. I would like to contrast their imputation with an alternative according to which more leisure implies more growth, not less.

There are three variants of Nordhaus and Tobin's imputation for leisure and nonmarket activity. Variant A is based on the assumption that there is no change over time in labor productivity of leisure and nonmarket activity. Variant B is based on the assumption that there is no change over time in labor productivity of leisure but that productivity of labor in nonmarket activity increases along with and to the same extent as labor productivity in creating ordinary goods and services. Variant C is based on the assumption that the growth over time in the productivity of labor is the same for leisure, nonmarket activity, and ordinary goods and services. In this comment I shall consider only variant A, but the points I raise are relevant with modification to variants B and C as well.

Nordhaus and Tobin impute for leisure by treating leisure over and above an assumed minimum of seven hours a day as an extra commodity which they evaluate at the wage in the base year. Suppose that output is produced with labor alone, that the wage rate is \$9 per hour in 1961 and \$36 per hour in 1971, that the consumer price index is the same in 1961 and 1971, and that people work an eight-hour day in 1961 and a six-hour day in 1971. Income as conventionally measured grows by a factor of 3.0 from \$72 per day to \$216 per day. Leisure increases from 9 hours per day (24 – 8 – 7) to 11 hours per day (24 – 6 – 7), its value at 1961 prices and wages is \$81 in 1961 and \$99 in 1971, income inclusive of the imputation for leisure is \$153 in 1961 and \$315 in 1971, and income inclusive of the imputation grows by a factor of 2.1. Notice that the ratio of incomes in 1961 and 1971 and the implied growth rate between these dates are reduced by the

imputation despite the fact that the number of hours of leisure has increased.

An alternative method of imputation would treat the reduction in hours as an extra bit of growth. To the conventional measure of income is added or subtracted each year a sum of money sufficient to compensate the representative consumer for the difference in hours worked between that year and the base year. The rationale of the alternative method is based on an analogy between real incomes in different years and the spectrum of money incomes in some given base year. If in 1961, Mr. A earns \$72 per day and Mr. B earns \$216 per day, we would say the Mr. B has 3 times the income of Mr. A. We might even be prepared to say that the ratio of their incomes is larger than 3 if Mr. B works less than Mr. A, but we would certainly not say that it is only 2.1 because both parties enjoy a substantial amount of leisure. We make a distinction among good things between those like cars, food, and clothing that we treat as part of income and those like leisure, friendship, or the love of God that we exclude from income. Normally when we speak of growth, we consider only the growth of what we choose to call income and we suppose that good things not included in income remain invariant, thus preserving the analogy between real incomes over time and the spectrum of income at a moment of time. The alternative imputation adjusts incomes to what they would have to be if existing levels of utility were preserved and if the ceterus paribus assumptions were true.

Formally, we may impute for changes in amounts of leisure in the same way that I have imputed for changes in life expectancy in my essay in this volume. The representative consumer is assumed to have a utility function $U[C(t), L(t)]$, where $C(t)$ is the value in the year t of real income as conventionally measured, and $L(t)$ is the amount of leisure in the year t. Define $\hat{C}(t)$, real income inclusive of an imputation for leisure, by means of the equation

$$U[\hat{C}(t), L(1961)] = U[C(t), L(t)], \tag{1}$$

where 1961 is the base year. We can solve for $\hat{C}(t)$ explicitly if we know the exact form of the utility function; otherwise we can use the evidence about wage rates to approximate $C(t)$. Expand $U[\hat{C}(t), L(1961)]$ in a Taylor series around $U[\hat{C}(t), L(t)]$ and ignore all but the first three terms:

$$U[\hat{C}(t), L(1961)] = \tag{2}$$
$$U[C(t), L(t)] + U_C[\hat{C}(t) - C(t)] + U_L[L(1961) - L(t)].$$

Since $U[\hat{C}(v), L(1961)] = U[C(t), L(t)]$ by definition, and since U_L/U_C is the real wage, we have

$$\hat{C}(t) \simeq C(t) + \text{wage } (t)[L(t) - L(1961)], \tag{3}$$

all terms of which may be estimated from market data. This formula may be contrasted with Nordhaus and Tobin's formula variant A which is

$$\hat{C}(t)_{N.T.} = C(t) + \text{wage}(1961)\ [17 - L(t)]. \tag{4}$$

The contrast between the imputations represented by formulas (3) and (4) may be seen in an extension of the example used above. Suppose we are measuring economic growth between 1951 and 1971 using 1961 as the base year. Real wages per hour were \$4 in 1951, \$9 in 1961, and \$36 in 1971, hours worked were 10, 8, and 6 and incomes per day were \$40, \$72, and \$216.

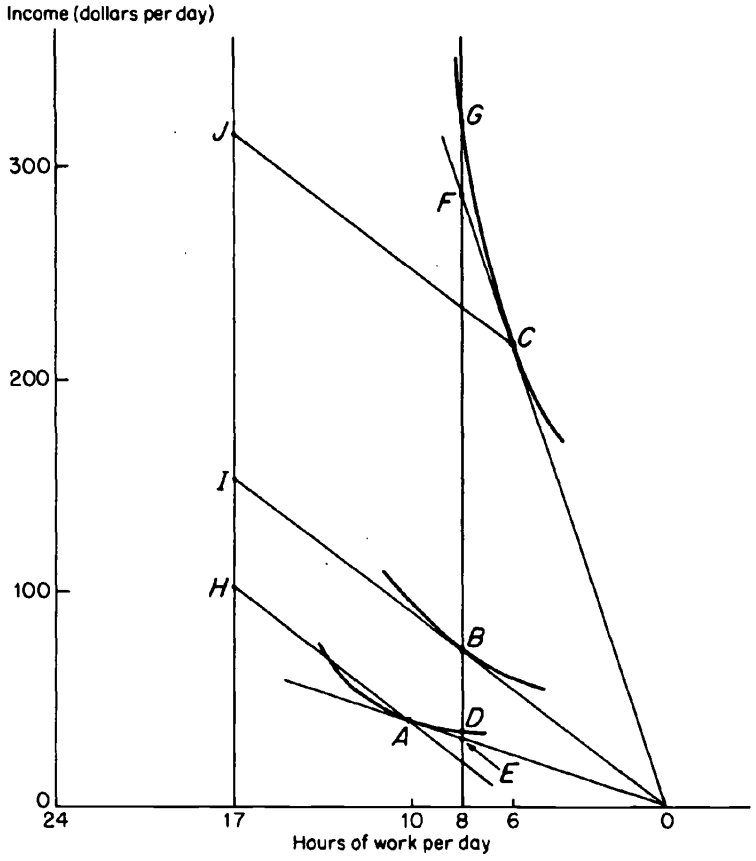
Without any imputation for leisure the ratio of incomes in 1971 and 1951 is about five $(216 \div 40)$. Nordhaus and Tobin's imputation reduces the ratio to about three $[216 + (9 \times 11)] \div [40 + (9 \times 7)]$. The alternative imputation of equation (3) increases the ratio of incomes to nine $[216 + (2 \times 36)] \div [40 - (2 \times 4)]$.

The Nordhaus and Tobin imputation, the exact form of the alternative imputation, and the approximate form of the alternative imputations are illustrated in Figure 1. The figure shows the representative consumer's choice between income (without the imputation) and leisure. Through the point on the leisure axis representing 0 hours of work are drawn three straight lines the slopes of which are equal to the real wages in 1951, 1961, and 1971. The representative consumer, three of whose indifference curves are illustrated, chooses points A, B, and C in 1951, 1961, and 1971. Nordhaus and Tobin's imputation amounts to projecting A, B, and C onto a line representing an assumed minimum of seven hours of leisure or an assumed maximum of 17 hours of work. Their measure of the ratio of incomes in 1951 and 1971 is J/H, where each letter stands for the distance of the corresponding point from the horizontal axis. The exact form of the alternative measure is G/D, where G is indifferent to C and D is indifferent to A, and G and D correspond to 8 hours of work. The approximate form of the alternative measure is F/E, where F and E are incomes that the representative consumer would have had in 1951 and 1971 if he worked eight hours in both years. One cannot say a priori which of the ratios G/D and F/E is the larger, but F/E is necessarily larger than J/H.

The effect of the alternative imputation on Nordhaus and Tobin's re-

FIGURE 1

Imputations for Leisure



	1951	1961	1971
Wage ($ per hour)	4	9	36
Work (hrs. per day)	10	8	6
Income ($ per day)	40	72	216

(All sums of money are corrected for changes in the price level.)
Estimates of the ratio of incomes per head in 1971 and 1951:

a. According to Nordhaus and Tobin,

$$J/H = [216 + (9 \times 11)] \div [40 + (9 \times 7)] = 3.06.$$

b. According to the approximate form of the alternative imputation,

$$F/E = [216 + (2 \times 36)] \div [40 - (2 \times 4)] = 9.00.$$

c. According to the exact form of the alternative imputation,

$$G/D = \text{(as indicated by the diagram) } 320/35 = 9.15.$$

sults is shown in Table 1, which is intended as an addition to their Table 1. The alternative imputation should be read into Table 1 as variant D of lines 6 and 16. As I have made no distinction between leisure and nonmarket work, Table 1, line 7, variant D would be zero in all years. All of the data in the accompanying table are from Nordhaus and Tobin's paper, as explained in the notes on sources. No imputation is required in variant D for housekeeping or for schoolwork because it has been assumed that hours of work of people engaged in these occupations have remained constant over time. The table itself should be self-explanatory, and the point to emphasize is the contrast in the growth rates of MEW between variants A and D, which are directly comparable in their assumptions about the productivity of labor in nonmarket activity and leisure. Variant A of Nordhaus and Tobin, Table 1, line 16a, entails a ratio of real incomes per head in 1965 and 1929 of only 1.14 while variant D in the accompanying table entails a ratio of 1.98. A comparable difference would be found between the alternative imputation and the Nordhaus and Tobin imputations variant B or C if an alternative were constructed embodying the assumptions of variant B or C about labor productivity in nonmarket activity and leisure.

To sum up, we have contrasted two ways of imputing for leisure in a measure of economic growth. One way is to treat leisure as an additional commodity, and the other is to say the leisure itself is not part of income but that there should be imputed to income each year a sum sufficient to compensate the representative consumer for changes in leisure since the base year. The latter method requires no imputation if hours of work have remained unchanged, that is, if the ceterus paribus assumption we make in ignoring leisure is true.

The alternative imputation preserves the analogy between real incomes of the representative consumer at different periods of time and the spectrum of personal incomes at a moment of time. In abandoning that analogy, the Nordhaus and Tobin imputation opens the measure of economic growth to more speculation than most of us would find acceptable. For, if new commodities are to be introduced, why stop at leisure? Why not reduce the growth rate still further by imputing for friendship, or the love of God? The alternative measure gets around this problem by lumping all these intangibles into the ceterus paribus of utility analysis and by supposing that the love of God, for instance, is about the same in each year in the income comparison. Only if God has come to love us more (or less) would an imputation be in order.

TABLE 1

Adjustments to Nordhaus and Tobin Table 1

	1929	1935	1945	1947	1954	1958	1965
1. Labor force (millions)	49.4	53.1	65.3	62.0	67.9	71.2	78.1
2. Extra hours of leisure per worker per year (over and above hours of leisure in 1958)	−478.1	−161.2	−286.0	−150.8	−52.0	0	−26.0
3. Real wage per hour in 1958 dollars	1.01	1.21	1.55	1.56	1.92	2.11	2.40
4. Value of extra leisure (Table 1, line 6, variant D), billions of dollars, 1958 prices	−23.8	−10.4	−28.9	−14.6	−6.8	0	−4.9
5. Index of per capita MEW (Table 1, line 15, variant D), 1929 = 100	100	94.4	118.8	136.9	154.8	168.0	198.4

NOTE: Tables A-9, A-10, A-11, and A-12 are appendix tables to the Nordhaus-Tobin paper. For availability of these tables, see the note on the first page of the Nordhaus-Tobin paper.

SOURCE: Line 1—Table A-9, employed and unemployed. Line 2—Table A-10, employed and unemployed. From each year's figure is subtracted the hours of leisure and nonmarket work in 1958, and the resulting figure is multiplied by 52. Line 3—Tables A-11 and A-12. The wage in 1958 was 2.11 per hour. Real wages in other years were estimated by multiplying the figure of 2.11 by the ratio of the wage deflator and the consumption deflator [A-12, (2) divided by A-12, (3)]. Line 4 = line 1 × line 2 × line 3. Line 5—From Table 1, line 15B, subtract the sum of line 6B and line 7B, and add the value of extra leisure (this table, line 4). Divide the result by the population (Table 1, line 14) to obtain Table 1, line 15, variant D.

EDWARD F. DENISON, The Brookings Institution

Nordhaus and Tobin introduce leisure into their measure of economic welfare (MEW) but make no explicit allowance for the real cost of work. They introduce leisure by adding its value in 1958 prices to net national product valued in 1958 prices. They provide two alternative measures of the value of leisure in 1958 prices.

Variant A is relatively straightforward. It regards the value of an hour of leisure in 1958 prices as always equal to the hourly wage in 1958. This value is multiplied by the number of hours of leisure each year to obtain the total value of leisure in 1958 prices. Once the 1958 value is established, leisure is thus treated as an output component just like loaves of bread or numbers of haircuts. Since the per capita quantity of leisure has scarcely changed, the effect is to add a large constant value to per capita NNP, which reduces the growth rate of an index of per capita welfare.

Variant C uses the same procedure for 1958, but in every other year the value of an hour of leisure in 1958 prices is different. It is the amount of goods valued in 1958 prices that could have been bought each year by the hourly wage (in current prices) that year. This seems analogous to measuring the bread component of NNP in, say, 1929 not by the number of loaves of bread purchased in 1929 but by the number of haircuts that could have been purchased in 1929 by the expenditure that was made for loaves of bread in 1929. Nordhaus and Tobin prefer this variant, justifying its use by introducing the assumption that efficiency in the enjoyment of leisure has risen at the same rate as efficiency in the production of marketable goods and services as a whole. The basis for such an assumption is flimsy, and I prefer a method, such as their method A, that assigns the same value to an hour of leisure every year. When leisure is valued as in variant C, its addition to marketed output scarcely changes the growth rate.

The point of this comment is not to express a preference for variant A. Rather it is to ask whether the approach adopted even in variant A does not start from a wrong premise and yield the wrong results. To pose the question in its bluntest terms, have not Nordhaus and Tobin added when they should have subtracted or divided?

Their calculation assumes that the hourly wage measures the price that was required to induce an individual to give up one hour of leisure and

to work one hour instead. But if this is so, the wage cannot measure the value of an hour of leisure. Rather, it is the sum of the values of two amounts. One is the utility of one hour passed in any way except working in gainful employment—not just any hour, but the nonwork hour with the smallest utility of all such hours, since that is the hour that would rationally be given up. The second is the disutility of one hour passed in gainful work—not just any hour, but the work hour with the greatest disutility. It is the last hour of work, which our nineteenth century predecessors aptly called "the most onerous hour" because fatigue and boredom have reached their peak.

Suppose we find a man working for pay 45 hours of the week, and consequently not so working the remaining 123 hours. We might ask him two questions. (1) "Suppose we could shorten the week from 168 to 167 hours and cut your nonworking hours from 123 to 122 while leaving your work time unchanged at 45 hours. You are free to take the lost hour from time you spend sleeping, doing housework, playing, or anything you like, or to subtract a few minutes from each activity. What would you pay us not to do this?" (2) "Suppose we could shorten the week by one hour and cut one hour from your work time, reducing it from 45 to 44. What would you pay us to do so?" The answer to the first question would value the marginal utility of an hour of nonworking time while the answer to the second question would value the marginal disutility of one hour of working time. The sum of the man's answers to the two questions should equal his hourly wage if he were in equilibrium (and if, in addition, he were free to choose his hours, and if his output per hour were unaffected by the number of hours he works).

The value of the utility of the marginal nonworking hour so obtained in 1958 could then be multiplied by the number of nonworking hours to obtain the value of nonworking hours in 1958 prices, a calculation similar to the Nordhaus-Tobin variant A calculation for leisure. But it is probable that this value, per hour, is small and that the addition would be only a small fraction of the variant A addition. It is my impression that the bulk if not all of the wage rate has traditionally, and rightly, been regarded as recompense for the disutility of the most onerous hour.

MEW must take account of the disutility of work, or more generally, of real costs, in addition to the value of leisure. The total value of the disutility of work in 1958 prices is the product of its 1958 value per hour and the number of hours worked each year. To complete a calculation of real costs, we might follow Jevons and add the cost of abstinence from consumption, perhaps obtained as the product of the capital stock and

the 1958 rate of return. We might then proceed to obtain MEW by subtracting real costs from positive welfare items.[1] But this is not very convenient because total real costs in 1958 would approximate the value of marketable output so that MEW in the base year would approximate zero, except for values placed on nonmarketed output. In later years, to be sure, we would obtain a positive number (because of rising productivity) and in earlier years a negative number, so this procedure is not nonsensical. But the results do not lend themselves to transformation into index form and are difficult to interpret. A more interesting procedure would be to divide real costs into output, rather than to subtract them, in order to obtain a measure of output in constant prices per unit of real cost. Either procedure would yield results very different from those Nordhaus and Tobin obtain.

This comment refers, of course, only to the starting point for a calculation. I have ignored all the real problems, such as those associated with the fact that switching an hour from work to nonwork involves different values when working hours are 44 than when they are 45, and that most people do not work at all in gainful employment and hence have no wage to subdivide as a starting point for a calculation.

JOHN R. MEYER, National Bureau of Economic Research and Yale University

In many ways it is difficult to play the role of constructive critic or discussant of these papers. Among other difficulties—as this conference has amply shown—the topics do tend to generate emotions. And to be only critical would be to miss what is basic in these papers: posing extremely important questions and, even more to their credit, providing at least partial answers to some.

There is, moreover, more than a little element of boldness, or even courage and heroism, in these undertakings. In recent years our profession often has tended to address its professional talents more to questions that were fairly easily answered by the existing or established tools, rather than addressing those which seemed most relevant. Even more disturbingly, certain of our numbers have come dangerously close of late to suggesting that even to be intellectually curious about certain difficult

[1] Most of this subtraction, representing the real cost of labor, would correspond to the amount which Nordhaus and Tobin now *add*, because per capita hours of work are not far from a constant.

questions, in particular measurement, constitutes a grave disservice to economics as a science.

These worries, I feel, represent a gross misunderstanding of what the real issues are. For example, the issue has sometimes been posed as: "Should GNP measure social welfare?" To my knowledge, no responsible professional has even suggested anything of the kind. Insofar as determining the potential contribution of GNP to improved social measurement, the usual issue, rather, has been whether we can derive from GNP certain indexes or concepts that might better measure economic welfare. Accordingly, Nordhaus and Tobin do not speak about constructing a measure of social welfare but rather of the possibility of constructing one of macroeconomic welfare.

Once posed properly, certain other false issues also quickly disappear. For example, I again know of no competent professional who seriously advocates early, prompt, or, in most cases, even long-term abandonment of GNP measures. Nor do many competent professionals even suggest ignoring GNP! Rather, the prevailing or almost unanimous opinion, as Nordhaus and Tobin take great pains to point out, is that GNP clearly has an established position and is a useful measure "for short-run stabilization policy and for assessing the economy's long-run progress as a productive machine." As I read this, this is a strong appeal to keep the GNP accounts, more or less as now constituted, separate and available. Or, another way of putting much the same point is to observe that a multiplicity of measures may well be needed to meet modern policy requirements. And why should that surprise us as our economy and policy concerns become ever more complex?

Indeed, about the closest that any professional critics have come to suggesting some major alteration in GNP for traditional purposes is to point out (as do also those insisting that GNP should not be changed) that the really strong aspect of GNP is its use as a measure of market-oriented activity. Accordingly, some critics have suggested that certain GNP imputations now made for nonmarket sectors might be usefully excluded. Certainly it is a suggestion worth consideration. Among other possibilities it might reduce the confusion about the meaning and intent of GNP as a measure. On the other hand, I can see strong arguments for not undertaking this kind of a "purification" quickly or lightly since GNP as now measured, even with all of its acknowledged imperfections or even minor inconsistencies, is a measure that is well-established and reasonably well-understood. Furthermore, GNP is often the only reasonably good aggregate number "in town" and as such certainly has a claim

to an important or even paramount role for macroeconomic policy decisions.

Indeed, it is these very qualities—of availability, reliability, and acceptance—that lead Nordhaus and Tobin to an analysis of how these numbers might be rearranged, modified, or augmented so as to provide better insights on other (i.e., nonstabilization) issues of considerable concern to society, specifically whether and to what extent the *economic* welfare of our society has been improving or deteriorating over recent years. Certainly, this is not a question without considerable interest. Furthermore, it does not take a seer of unusual talents to predict that it is likely to be an issue of increasing concern.

The essential question, therefore, to pose about the Nordhaus-Tobin effort is: Have they succeeded in constructing a measure of macroeconomic welfare that is superior to those implicit or explicit in existing accounts, particularly that of net national product per capita? My own view would be that the jury should still be out. Following the lead of the authors and using admittedly quite subjective considerations, I would suggest focusing on periods when MEW per capita and NNP per capita go in opposite directions. I thus find it encouraging that their index (using actual MEW per capita and their "preferred" variant B) rose (from 121.4 to 123.2) between 1945 and 1947 even though per capita NNP declined (on an index basis from 155.4 to 131.9) in those years. On the other hand, I find it somewhat disconcerting by my lights that their measure of per capita economic welfare remains very stable or even rises between 1929 and 1935 (the index of MEW variant B actually goes from 100.0 to 108.0) while the NNP per capita index declined by roughly one-quarter (from 100.0 to 78.0) during those same years.

As for the years since 1947, which are recent and therefore also of special interest, I am not quite sure which measure is better, per capita MEW or per capita NNP. The differences are actually slight (at least between NNP and most of the MEW series). My subjective guess would be that NNP is slightly the better welfare index over this period. The actual MEW variant B index rises from 123.2 in 1947 to 141.8 in 1965 while the NNP per capita index goes from 131.9 to 187.5. My "feel" or intuition would be that the truth is somewhere in between, i.e., that the postwar years were rather better than suggested by the MEW index.

Quite obviously, the next question to ask is why the Nordhaus-Tobin MEW fails when it does (at least by my subjective valuations). For the thirties I suspect that the answer is fairly obvious. In those depression

years, MEW overvalues leisure or undervalues the deterioration in human capital. Much of the leisure of the thirties perhaps merited a negative entry. A considerable improvement in MEW might be achieved by incorporating current research aimed at better measuring human capital, say along lines being pursued by Jacob Mincer or the Ruggleses. In short, Nordhaus and Tobin have focused the issue well, but a good deal still needs to be done on refining the actual measures.

As for my suspicion that MEW per capita may have been a slightly inferior measure to NNP of economic welfare after 1947, one might attribute this to increased defense expenditures. On defense, the Nordhaus-Tobin argument is that these are regrettables because increased outlays over the years have not clearly bought us more security. If true, this argument would seem to hold best for the post-1947 years. Certainly, it seems easier to accept the argument for the years after 1947 than for the years between 1929 and 1947.

Alternatively, I would suggest that the explanation for the post-1947 "softness" in MEW may reside in the treatment of disamenities. Specifically, the Nordhaus-Tobin regressions may overestimate any post-1947 increase in disamenities of urban life, mainly because of structural misspecification. For one thing the selection processes of migration normally result in younger, more energetic, and more intelligent members of the work force drifting from rural to urban areas. Thus, a potentially important missing variable from their county income regressions may be a measure of IQ or intelligence qualities. To very crudely check for this possibility I reran some very simple, but quite standard, income determination equations using the NBER-Thorndike-Air Force sample, which is the only one that I know of which provides an opportunity to control for intelligence differentials by geographic area. My preliminary results show that those in this sample who *originated* in large (over 1 million) cities do have significantly higher incomes than those who did not. (The t-ratio for the city size dummy is 2.8.) I also hope to check for the relationship between *current* place of residence and income using this same sample, but time was not sufficient to do the necessary coding. Actually, place of origin may be a better control for quality of education or of opportunity than a measure or proxy of the urban disamenity effects that Nordhaus-Tobin seek; thus, without a size measure for current residence, it probably measures both disamenity and opportunity influences. I should add that the intelligence measure variable is indeed significant as a determinant of income (the highest t-ratio of any included variable) and is positively correlated with the large city dummy; accord-

ingly, some room for improvement in the Nordhaus-Tobin specification almost surely exists.

In general, my own hypothesis about the so-called disamenities of urban living would be rather different from that implicit in Nordhaus and Tobin. Specifically, I would guess that the relationship between urban density or population to well-being is nonlinear. Specifically, people may prefer living in urban centers of small to medium size and density rather than living at either extreme, e.g., very small towns, farms, or very large cities. Also, as a first approximation, I would hypothesize that substantial disamenities of urban living do not appear sharply until relatively high net densities and a total conurbation population of more than 2 or 3 million is achieved. This, in turn, suggests that some measure of maximum "point" (e.g., a census tract) density in a county might be a useful additional variable in the Nordhaus-Tobin regressions. Actually, there is some accumulating evidence that Americans seem to prefer living in cities of approximately 50,000 to 500,000 population and, correspondingly, some recent trend for new work opportunities to locate in such cities.

In addition, one might hypothesize that suburban living and working are deemed more attractive than doing either in the central city. Certainly, suburban wages are commonly somewhat lower than in the central cities of many SMSA's, thus suggesting less disamenity by the Nordhaus-Tobin test. Accordingly, the substantial increase in suburban work opportunities during the 1950's and 1960's could have led to some decrease in total disamenities experienced if Nordhaus and Tobin had differentiated between suburbs and central cities as well as, more grossly, between rural and urban areas. Furthermore, the rise in suburban living opportunities may have made the rural-urban disamenity premium less in 1960 than in earlier years so that the Nordhaus-Tobin assumption of a constant disamenity premium over the period could well misstate the changes over time, particularly from 1947 on.

Indeed, my guess would be that there may have been an over-all decrease in urban disamenities during the postwar period. This would mean that the urban "disamenities" correction (line 5c in Table A-17) should well have been less in 1965 and rather more in 1947. The disamenities correction is, of course, relatively small (about −$19.1 billion in 1947 and −$34.6 billion in 1965) but it is not trivial. For example, if these disamenities corrections were simply reversed for these years, the actual MEW variant B index per capita would have been more expansive and thus behaved more like NNP in the postwar period.

The Leontief paper deals with some of the same issues as Nordhaus and Tobin but is less concerned with valuation as such. Leontief concentrates instead on constructing a tool to better characterize and analyze relationships between ordinary or regular market activities and pollution. However, he does suggest a highly imaginative interindustry framework for evaluating or attaching costs to antipollution efforts at the margin. As such, he provides us with at least a primitive tool for attaching "shadow prices" to antipollution programs. The major limitation, as recognized by Leontief, is not uncommon to interindustry tables: their implicit technological rigidity. In the particular case of pollution this is somewhat disturbing since there is much to suggest that various kinds of antipollution policies, such as effluent charges or more rigid regulation of permissible levels of pollution, would induce industry to use production techniques that result in less pollution per unit of product or service rendered.

There are, of course, some fairly straightforward means of meeting these difficulties. As Leontief points out, one would be to add alternative columns of input-output coefficients to represent alternative production possibilities. This, in turn, suggests mathematical programming to investigate the relative efficiency of these alternatives. Indeed, a programming approach would seem to be potentially quite useful in investigating the implications of such basic policy alternatives for dealing with pollution as those of subsidy vs. effluent charges or regulatory standards. These alternatives, moreover, should be readily representable in a programming approach, e.g., effluent charges would suggest different prices or costs associated with different activities while the regulatory standard might be represented by different constraints.

In sum, these papers focus on important questions and even if they do not give us all the answers, they certainly suggest some of the research that will be needed to achieve better answers. As such, they represent a very considerable improvement over much previous public or even professional discourse. Certainly, professional economists should not be tolerant of misguided public criticism of GNP because GNP does not do what it was never intended to do, i.e., measure social welfare. On the other hand, I also believe that our tolerance should not be terribly high for those who suggest, even by implication, that we should not investigate, as intensively and open-mindedly as our resources and intellectual qualities permit, the extent to which the tools of economics might be applicable or inapplicable to questions of welfare measurement. We should not be concerned, moreover, that this curiosity may sometimes

challenge long-established traditions or measures, though we surely should not abandon these lightly either.

REPLY BY NORDHAUS AND TOBIN

DENISON AND USHER

Both Denison and Usher direct their comments to the valuation of leisure. Their emphasis is natural, because difficult conceptual issues are involved and substantial quantitative differences are at stake.

We regard all our quantitative estimates as extremely tentative, and especially the leisure components. To begin with, the data on allocation of time are inadequate. We derived them from a single benchmark survey. What is needed is a periodic sample survey of household uses of time. What is happening to hours spent in preparing meals, laundering, and cleaning; in do-it-yourself repair and construction; in child care; in commuting? Is it really true, as we assumed, that the number of hours in nonmarket productive activity, as distinguished from recreational leisure, has remained constant? Or has the increase in the household capital-labor ratio released time for leisure activities? A careful survey might enable us to distinguish better among leisure, home production, and uses of time that do not contribute to household utility either directly or indirectly.

Even with improved data, difficult conceptual issues will remain. In discussing them here, we will ignore the distinction of our paper between household work and leisure proper and refer to both as "leisure." Incidentally, Denison is incorrect in attributing to us a preference for variant C, our most optimistic procedure. Our expressed preference was for variant B, which assumes that the productivity of work at home has increased with the real wage while the yield of leisure proper has remained constant.

One conceptual issue is how to count leisure in estimating the *absolute* increments of total consumption between two dates. The contribution of leisure is obviously greater if technical progress is assumed to have augmented leisure time (variant C) than if an hour of leisure time is assumed always to be the same hour, no more, no less (variant A). Denison seems to believe it is more likely less than more. Unfortunately no one can marshal arguments much above the level of anecdote and casual empiricism on either side of this debate. Perhaps careful detailed surveys of time allocation, repeated periodically, could enable us to do better.

An even more difficult conceptual issue arises in estimating the *relative*

growth of total consumption between two dates. Once we agree on how to estimate the absolute increment in total consumption, we have the numerator. But what is the right denominator? What is the proper estimate of total consumption in the base period? Both Usher and Denison think that the procedures of our paper overstate base-period consumption and therefore understate the rate of growth.

Usher objects to the fact that if, as in variant A, the value of an hour of leisure is assumed not to have increased, inclusion of leisure in a consumption index is almost bound to diminish the estimated rate of increase. This will happen whenever the percentage increase in leisure is smaller than the percentage increase in consumption. The greater the amount of nonwork time assigned to leisure, rather than to maintenance items such as sleep, the more likely is this result. Usher correctly points out that this assignment is arbitrary. His solution is extreme—do not count leisure in base-period income. On the other hand, our estimates of percentage growth in leisure, and in consumption inclusive of leisure, would have been even smaller if we had used 24 hours instead of 18 hours as the day to allocate among welfare-generating activities. We chose 18 hours as the available time simply because this was the way the sample study was designed.

Usher's preferred procedure is to add to the increment in market consumption the value—imputed at the wage rate—of any increase in leisure at the expense of work. We have no quarrel with this estimate of the *absolute increase* in total consumption. But Usher uses only the base-year value of market consumption as the denominator in calculating the *percentage increase* in total consumption. His exclusion of leisure from base-period income is not a procedure that could logically be repeated in successive calculations. Once the year 1950 has been credited with leisure equal to reduction in hours of work since 1929, it is hardly possible to pretend that there was no leisure in 1950 in calculating the relative gain of 1965 over 1950.

Denison also regards our base-period consumption as too large, but for a different reason. He raises the interesting and difficult question of the disutility of work itself, a question we explicitly finessed. The real wage measures the sum of the marginal disutility of work and the marginal utility of leisure, both relative to the marginal utility of market consumption. There is no observed variable that enables us to decompose the real wage into these two components. We explicitly assumed the marginal disutility of work was zero. If it is really positive, then at least part of the market consumption purchased from wages simply offsets the

unpleasantness of work, and the net contribution to welfare from working is smaller than wage income. The procedure of our paper, therefore, by exaggerating the value of base-period consumption, understates the percentage growth of welfare.

Denison comes close to asserting that the wage rate represents exclusively the marginal disutility of work, or at least did so in some base year, like 1958. We do not see the empirical basis for this assertion, or for Denison's evident belief that traditional economic theory regards the wage wholly as compensation for the unpleasantness of work rather than for leisure foregone.[1]

We now realize that the estimation of percentage gains and rates of growth is even more arbitrary than we originally understood. We have two unobservable strategic quantities—the rate of augmentation of leisure time, and the marginal disutility of work. Here is the algebra of the problem:

Let R_t, L_t, and W_t be total hours, leisure hours, and work hours, all during period t. Let v_t be the wage rate, and λ_t the leisure-augmentation factor. Take $\lambda_0 = 1$. Note that $R_t = R_0 = R$. In each period the consumer is to maximize, with respect to W_t, his utility $V(v_tW_t, L_t, W_t) = U(v_tW_t, R - W_t, W_t)$. The condition for the maximum at time 0 is:

$$v_0U_1 - U_2 + U_3 = 0, \text{ or } v_0 = \frac{U_2}{U_1} - \frac{U_3}{U_1}, \tag{1}$$

where U_2/U_1 is the marginal utility of leisure in terms of goods and $-U_3/U_1$ the marginal disutility of work in terms of goods. Here is the linear approximation of the gain in utility, time t compared to base-period 0:

$$\begin{aligned}\Delta U &= U[v_tW_t, (R - W_t)\lambda_t, W_t] - U[v_0W_0, (R - W_0), W_0] \\ &= U_1(v_tW_t - v_0W_0) + U_2[(R - W_t)\lambda_t - (R - W_0)] \\ &\quad + U_3(W_t - W_0).\end{aligned}$$

[1] Denison goes even further—or one might say further backward in the history of economic thought toward "real cost" doctrine—in suggesting a symmetrical proposition for capital incomes, that they represent compensation for the pain of abstinence, rather than the opportunity cost of current consumption. In this way Denison reaches the conclusion that the net utility value of all production and exchange is zero. Wages just pay for the pain of work, property incomes for the pain of waiting. At least this was so in 1958. Denison intimates that productivity gains may have made positive contributions since then, though he does not discuss the implication that net welfare was negative before 1958.

Some manipulation shows that:

$$\Delta U = U_1 W_t(v_t - v_0) + U_2(R - W_t)(\lambda_t - 1) + v_0 U_1(W_t - W_0) - U_2(W_t - W_0) + U_3(W_t - W_0).$$

By (1) the last three terms sum to zero. Hence the gain in utility is

$$\Delta U = U_1 W_t(v_t - v_0) + U_2(R - W_t)(\lambda_t - 1). \tag{2}$$

To convert this into an equivalent amount of market consumption we divide by the marginal utility of such consumption, U_1, and we obtain

$$\frac{\Delta U}{U_1} = W_t(v_t - v_0) + \frac{U_2}{U_1}(R - W_t)(\lambda_t - 1) \tag{3}$$

$$= W_t(v_t - v_0) + \left(v_0 + \frac{U_3}{U_1}\right)(R - W_t)(\lambda_t - 1).$$

Now we have several cases:

a. No Augmentation of Leisure; No Marginal Disutility of Work. Then (3) becomes:

$$\frac{\Delta U}{U_1} = W_t(v_t - v_0). \tag{3a}$$

The denominator, base-period consumption, inclusive of leisure, is unambiguously the equivalent of Rv_0 of market consumption. Therefore the proportionate gain is, as in our variant A:

$$\frac{W_t}{R} \cdot \frac{v_t - v_0}{v_0}. \tag{4a}$$

b. Augmentation of Leisure; No Marginal Disutility of Work.

$$\frac{\Delta U}{U_1} = W_t(v_t - v_0) + v_0(R - W_t)(\lambda_t - 1), \tag{3b}$$

and the proportionate gain is:

$$\frac{W_t}{R} \cdot \frac{(v_t - v_0)}{v_0} + \frac{(R - W_t)}{R}(\lambda_t - 1). \tag{4b}$$

If $\lambda_t - 1 = (v_t - v_0)/v_0$, we have the result of variant C of our paper. The proportionate increase in welfare is equal to the increase in the real wage rate.

c. No Augmentation of Leisure; Positive Marginal Disutility of Work. The absolute gain, measured in market consumption, is the same as (3a):

$$\frac{\Delta U}{U_1} = W_t(v_t - v_0). \tag{3c}$$

But now it is not obvious what the denominator should be. One candidate, as before, is Rv_0. But another candidate is the "net" consumption:

$$W_0v_0 + (R - W_0)\frac{U_2}{U_1} + W_0\frac{U_3}{U_1}$$

$$= W_0v_0 + (R - W_0)\left(v_0 + \frac{U_3}{U_1}\right) + W_0\frac{U_3}{U_1} = R\left(v_0 + \frac{U_3}{U_1}\right).$$

The first candidate values all the time available at the market wage of the base period. The second candidate values the time at the *net* wage, i.e., the market wage minus the marginal disutility of work. The first procedure gives the result (4a). The second procedure gives a larger relative gain:

$$\frac{W_t(v_t - v_0)}{R\left(v_0 + \frac{U_3}{U_1}\right)}. \tag{4c}$$

d. Augmentation of Leisure, Positive Marginal Disutility of Work.

$$\frac{\Delta U}{U_1} = W_t(v_t - v_0) + \left(v_0 + \frac{U_3}{U_1}\right)(R - W_t)(\lambda_t - 1). \tag{3d}$$

This is smaller than (3b). Thus the assumption of our paper that marginal disutility of work is zero may exaggerate the absolute increment of welfare. Technological progress has the effect of giving the representative consumer additional leisure. He gets it even if he does not reduce his hours of work. How should this extra leisure be valued? The wage rate, used in (3b), overvalues the gift to the extent that the wage is compensation for disutility of work. Indeed, if that is *all* the wage represents, the augmentation of leisure has no value at all.

Moreover, we have the same ambiguity about the denominator as in the previous case. If Rv_0 is used, relative gain is greater than (4a), smaller than (4b). If $R[v_0 + (U_3/U_1)]$ is used, relative gain is

$$\frac{W_t}{R}\left(\frac{v_t - v_0}{v_0 + \frac{U_3}{U_1}}\right) + \frac{(R - W_t)}{R}(\lambda_t - 1). \tag{4d}$$

This is the largest of the several estimates. Although the marginal disutility of work scales down the value of the incremental leisure, it scales down the value of base-period time even more.

A summary comparison of alternatives is shown in Table 1. The table shows the value of the growth of welfare for the different assumptions

TABLE 1

Summary of Alternative Measures of Growth of Consumption Including Leisure

Assumption [a]	Rate of Growth of Welfare	Rank
(4a) } (4c-I) } (variant A)	$\frac{(v_t - v_0)}{v_0}\frac{W_t}{R}$	5
(4b) [b] (variant C)	$\frac{v_t - v_0}{v_0}$	2 or 3
(4c) II	$\frac{v_t - v_0}{v_0}\left\{\frac{W_t v_0}{R[v_0 + (U_3/U_1)]}\right\}$	2 or 3
(4d) [b] I	$\frac{v_t - v_0}{v_0}\left[\frac{W_t}{R} + \frac{v_0 + (U_3/U_1)}{v_0} \cdot \frac{R - W_t}{R}\right]$	4
(4d) II	$\frac{v_t - v_0}{v_0}\left\{\frac{R - W}{R} + \frac{W}{R}\left[\frac{v_0}{v_0 + (U_3/U_1)}\right]\right\}$	1

[a] Assumption I used the gross wage, thus setting initial consumption at v_0R. Assumption II uses the net wage, with consumption being $R[v_0 + (U_3/U_1)]$.

[b] Assumes rate of augmentation, λ, is equal to rate of growth of real wage rate, v.

discussed above and shows how the magnitudes are ranked (1 showing the most rapid growth, and so forth). Our preferred variant was variant A for leisure, which is indeed the most pessimistic, and variant C for home production. It should be noted that all other variants require knowledge of the marginal disutility of work.

It will be helpful to visualize the two candidates for denominator. Imagine indifference surfaces in three-dimensional space with axes representing work, leisure, and market consumption. Given the constraint on time, the consumer is confined to the plane Work + Leisure = Total hours available. Within this plane he is further constrained by the relationship: Work $\times$ Wage = Market consumption. We would like to obtain the market consumption equivalent of the indifference surface he reaches. One procedure is to stay within both constraining planes, and follow the tangent line to the maximum market consumption, obtained by setting leisure equal to zero and work equal to R. This gives the conventional measure, Rv_0. The other procedure is as follows: There is a plane tangent to the attained indifference surface at the chosen point. The plane does not represent choices effectively open to the consumer, since it departs from the clock constraint on leisure and work. Nevertheless we can follow this tangent plane to the market consumption

axis, where both work and leisure are hypothetically zero, and read off the height of the intersection. This gives to the denominator the value $R[v_0 + (U_3/U_1)]$. Measuring along an axis which the consumer cannot reach may seem farfetched. But we see no compelling logic in favor of one approximation over the other.

In Figures 1 to 4 we illustrate graphically the four measures just discussed. In Figure 1, E_0 and E_t are the chosen work, leisure, and consumption points in the two periods. N_a is the estimate of the increment of consumption, or the numerator. D_a is the estimate of the equivalent market value of the base-period consumption, the denominator.

In Figure 2, the augmentation of leisure is represented by shifting

FIGURE 1

No Disutility of Work; No Time Augmentation

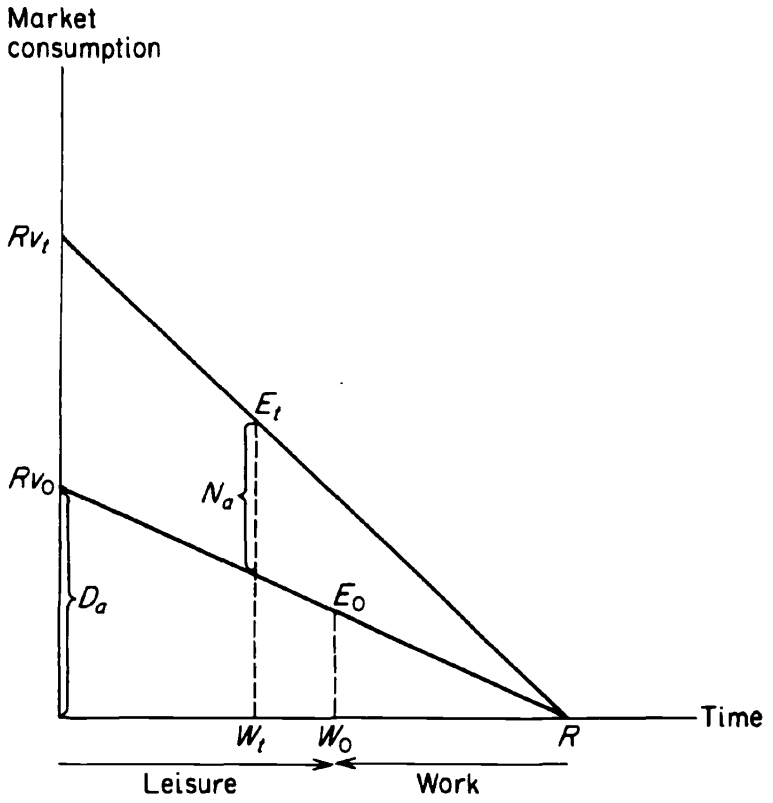
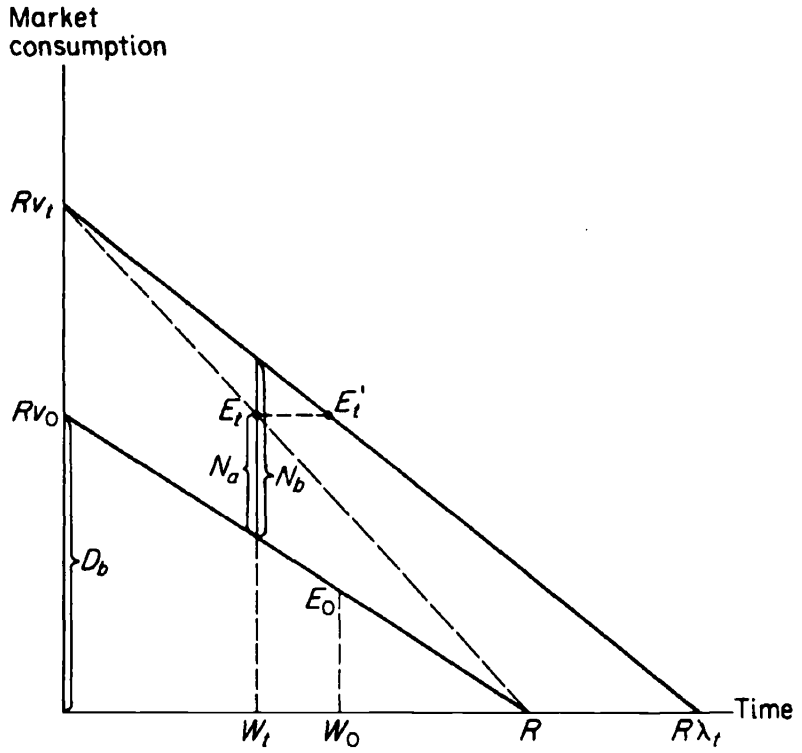


FIGURE 2

No Disutility of Work; Positive Time Augmentation



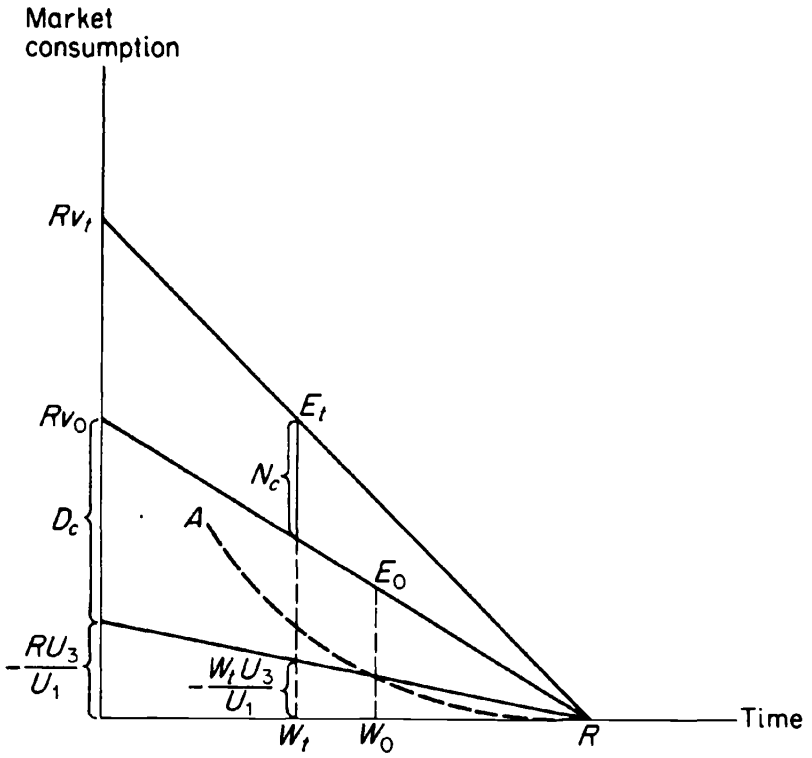
point R out to $R\lambda_t$. The observed point E_t is the equivalent of E'_t in base-period hours. The market consumption value of this augmentation is added to N_a. Therefore, the numerator, N_b, is larger than in Figure 1, while the denominator is the same.

In Figure 3 the dashed curve RA represents the marginal disutility of work (in market consumption units) times the hours of work, $-W(U_3/U_1)$. The slope of a line from R to the dashed curve at $W = W_0$ is the marginal disutility of work in the base period. Subtracting an allowance for this disutility reduces the denominator to D_c.

In Figure 4, the calculation of the denominator follows Figure 3. The augmentation of leisure from point E_t to E'_t is the same as in Figure 2, but in the valuation of this leisure the wage rate used in Figure 2 is diminished by the marginal disutility of labor.

FIGURE 3

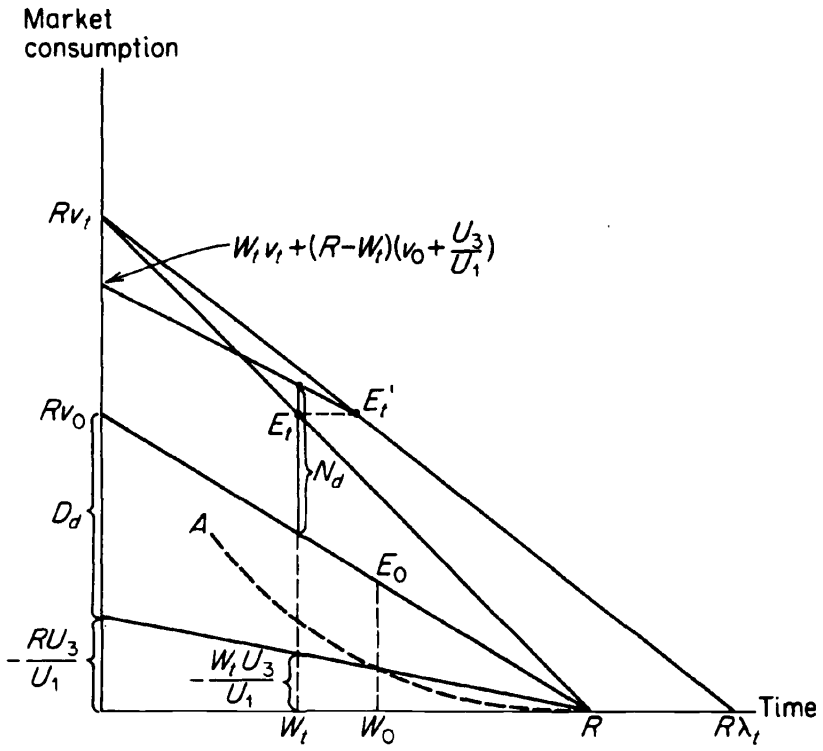
Positive Disutility of Work; No Time Augmentation



The upshot of this is that many alternative measures of welfare are plausible, and that there is no unambiguous answer to the question, how fast has welfare grown? Nevertheless, until some reasonable method for measuring utility or the disutility of work has been devised, we see no plausible alternative to the variants we presented in the original paper.

FIGURE 4

Positive Disutility of Work; Positive Time Augmentation



MEYER

John Meyer's comments refer mainly to other aspects of our paper, and call for a separate response. We certainly concur with the main thrust of his remarks, that much remains to be done.

Meyer does make one point on the valuation of leisure, namely, that overvaluation of leisure is responsible for our finding that MEW (variant B) was 8 per cent higher in 1935 than in 1929, a finding which Meyer regards as counter-intuitive. The 22 per cent decline in NNP per capita corresponds better to his impression. We did not, of course, count unemployment as leisure. But we did attribute positive value to time out-

side normal working hours, for the unemployed as well as the employed. It might be argued that the opportunity cost of time is effectively zero for people who cannot find jobs. We thought it more reasonable to assume that the unemployed would have chosen the normal amounts of work and leisure if they could have found jobs at the prevailing wages. But we stressed in the original paper, and we stress again now, that MEW is designed for secular rather than cyclical comparisons.

Meyer also suggests that allowance should be made for depreciation of human capital during the Depression, nonuser cost, so to speak. We accept in general the point that experience as well as education should be reckoned in human capital. But this cannot affect the NNP-MEW comparison, because neither concept makes such an allowance.

As Meyer points out, the disamenity calculations need to be refined in a number of directions: (1) Cross-sectional regressions should be run for various census dates; the disamenity premium of urban living may have changed. (2) At least some of the variables in the regressions should refer to finer geographical areas than our counties. (3) Nonlinear relationships and threshold effects should be examined. Meyer also suggests that higher incomes in cities may reflect the higher intelligence of urban residents rather than any compensation for disamenities. It would indeed be desirable to add intelligence to the variables we used to control for nongeographical sources of income differentials. The calculations Meyer reports do not tell us whether controlling for intelligence would increase or decrease our disamenity estimates.