New Directions in National Economic Accounting

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Paper presented to the Annual Meetings
of the American Economic Association
Boston, Massachusetts
January 8, 2000

I. Introduction

The national income and product accounts (NIPA) are the most important measures of overall economic activity for a nation. Much as a satellite in space can survey the weather across an entire continent, so can the GDP give an overall picture of the state of the economy. Nevertheless, since their inception, there have been concerns that the accounts are incomplete and misleading because they omit vast continents of nonmarket activity such as unpaid work, the value of leisure time, and most investment in human capital. Most recently, attention has focused on extending the accounts to include natural resources and the environment. In this paper, I discuss the issues involved in extending the NIPA, particularly to non-market sectors.

The threshold question is why should we devote scarce intellectual resources to studying non-market sectors? The basic insight behind non-market accounts is that economic and social welfare does not stop at the market's border but extends to many nonmarket activities.

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Three particular areas are worth emphasizing. One important reason why we need better measures of non-market activity is because we spend increasingly fewer of our lifetime hours in market activities. A second and more speculative reason concerns the growing importance (or at least the great importance) of non-market assets or mispriced market assets such as the environment and technology. A third point is that current measures of national saving and investment are highly defective. The examples later in this paper address each of these issues. Many of these issues were reviewed in a recent report on augmented accounting by the National Academy of Sciences.[2]

II. Alternative Measures of National Income

A. Hicksian (production-based) v. Fisherian (utility-based) income

I begin with a review of the principles behind measuring national income. We can distinguish two fundamentally different approaches to measuring income – one based on production and one based on utility. The former is the basis of modern national-income accounting while the latter is more appropriate when considering sustainable income and the contribution of improvement in health status.

The modern treatment of social income dates from the writings of J. R. Hicks, who wrote, "The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves."[3] This leads to the standard definition of *Hicksian income,* "Income No. 1 is ... the maximum amount which can be spent during a period if there is to be an expectation of maintaining intact the capital value of prospective returns...; it equals

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[2] See Nordhaus and Kokkelenberg [1999].

[3] Hicks [1939], p. 172.

Consumption plus Capital accumulation."[4] Hicksian income is the standard definition of national income and product used today by all countries, where consumption and investment are limited to those legal goods and services that pass through the market place.

While Hicksian income is useful for measuring current production, is has no obvious welfare significance. Among its important shortcomings are that it omits non-market activity, that it classifies as consumption most intangible investments, such as those in human capital and technology, and that it does not incorporate the health status of the population.

An alternative approach, which I call *Fisherian income*, defines income as utility-based consumption.[5] More precisely, Fisherian (or utility-based) national income is the maximum amount that a nation can consume while ensuring that members of all current and future generations can have expected lifetime consumption or utility that is at least as high as current consumption or utility. Put simply, Fisherian income is the maximum sustainable level of consumption.

B. The Correspondence between Production and Utility Measures

A surprising result is the *output-sustainability correspondence principle,* which finds that under idealized conditions Hicksian and Fisherian income are identical.[6]

[4] Hicks [1939], p. 173, 178, emphasis added. This discussion ignores the subtlety of Hicks' discussion of price changes, interest rate effects, the difference between ex ante and ex post capital, and a number of other factors.

[5] This approach is used in an analogous manner in the theory of measuring the cost of living.

[6] This is due to Weitzman [1976].

More precisely, when the national accounts include all market and non-market stocks of capital and other dynamic features that affect production and when capital stocks are valued at the appropriate scarcity prices, net domestic product is an accurate measure of sustainable or Fisherian income.

The correspondence principle can be derived in a simple example (which was suggested to me by Martin Weitzman). The major assumption is that the economy's consumption is a stationary function of its capital stocks. Assume that full consumption is given by $C(t) = F[G(t), \Delta G(t)]$, where $G(t)$ is the "grand capital stock" composed (for concreteness) of tangible capital $K(t)$, environmental and natural-resource capital $E(t)$, educational and health capital $H(t)$, and technological or technological capital $A(t)$. Population is constant. The social shadow prices of the capital stocks are $q_j(t)$, which represent the marginal values of capital in consumption. Consumption and capital include all nonmarket activities.

We assume that the society maximizes a preference function, $W(t)$, which is the discounted value of utility and can be represented by a recursive equation $W(t) = U[C(t)] + (1+r)^{-1} W(t+1)$. Taking the local approximation to this and setting output units equal to the marginal utility of current consumption, we obtain $rW(t) = C(t) + \{q_K \Delta K + q_E \Delta E + q_H \Delta H + q_A \Delta A \}$, where the time subscripts have been omitted from the investment terms. The left hand side is the consumption annuity that has the same present value as the maximized consumption stream and is therefore Fisherian income; the right hand side equals consumption plus the value of the change in net capital stocks and is therefore full Hicksian income.

The operational point is that, under idealized conditions, extending the national accounts to include comprehensive measures of consumption and net investment would make output and income more accurate indexes of sustainable income.

IV. Important Examples of Non-Market Activity

Because there are no comprehensive data sets on non-market activities, constructing non-market accounts has proven to be a version of “house-to-house combat” in empirical economics. This section reviews some of the findings in this area.

A. Natural Resources and Environmental Assets

One of the major criticisms of conventional accounts is that they omit natural resources and the environment. Environmentalists argue that America's wasteful consumptionist society is squandering our precious “natural capital.” This issue was partially addressed when the Bureau of Economic Analysis (BEA) unveiled its Integrated Environmental and Economic Satellite Accounts (or IEESA), designed to estimate the contribution of natural and environmental resources to the nation's income. The first step, published in 1994, was a set of accounts for subsoil assets like oil, gas, and copper.[7]

Many were surprised by the results of this first assay into green accounting. BEA’s estimates take into account that discovery adds to our proven reserves at the same time that extraction subtracts from or depletes these reserves. In fact, these two activities have been almost exactly offsetting. The net effect of both discoveries and depletion from 1958 to 1991 was between minus $2 billion and plus $1 billion, depending on the method used, as compared to an average GDP over this period of $4200 billion (in 1992 prices).

The larger step involves investigating renewable resources (such as timber

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[7]See BEA [1994].

and water) and environmental assets (such as clean air or a pleasant and productive climate). Although a great deal of work has been done on valuing components of air quality, to date there have been no comprehensive accounts that include air and water quality for the United States. However, a recent study by the U.S. Environmental Protection Agency suggests that, in contrast to the minerals accounts, environmental accounts might produce large numbers.[8] This study estimated the economic benefit of actual air pollution relative to a counterfactual baseline that assumed no controls imposed after 1970. The EPA study estimated the economic benefits of reduced air pollution in 1990 were worth $1,248 billion. Reduced mortality benefits ($1,004 billion) account for 80 percent of this total; together, avoided human health effects account for 99 percent of the total. One of the ironies of this study is that the most beneficial regulations over the 1970-90 period (such as those reducing lead and PM-10) were not original targets of clean-air regulations. This study has many drawbacks that may exaggerate the economic benefits, but it does suggest that the economic impacts of air quality on human health are highly significant.[9]

B. Time Use

The most precious of all our endowments is time, the 24 hours each day that we have to "spend" in work or play. Compared to many other relatively trivial areas, such as monthly sales of Roasted Regular Peanuts in 12 ounce cans, we know relatively little about how Americans use their time. Unlike most other civilized countries, the United States does not collect regular data on time use by the population. This is in my opinion the single most important gap in the federal

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[8] See EPA [1997].

[9] The issues are reviewed in Nordhaus and Kokkelenberg [1999], from which this paragraph is drawn.

statistical system.[10]

Better data on time use is critical for many areas in augmented accounting. We need time use data for building household accounts, for estimating the relative importance of non-market investment and consumption, for estimating trends in leisure time, and for understanding the activities of that third of the population that is retired. Indeed, current measures of work time used in productivity measures could be sharpened with focused time-use studies.

One unique feature of time budgets is that they provide a comprehensive budget that includes all activities – non-market as well as market. Because time inputs are likely to be the most valuable economic input, a time budget will also allow a rough estimate of the relative importance of market and non-market activities. Figure 1 shows an estimate of the fraction of lifetime hours engaged in work, leisure, and other activities for the U.K. population over the period 1856 to 1998. If we equate work with market activity, we can see that non-market activity is becoming a dominant part of human activity. Only 20 percent of disposable lifetime hours of the adult population is currently devoted to market work. One interesting result of recent research is that the fraction of adult time devoted to work appears to have stabilized after having declined continuously for at least 150 years.

C. Human Capital

A large and growing share of the economy's resources is devoted to investments in education and health. Because of faulty accounting, however, their contribution to economic welfare is misclassified, underestimated, and omitted. The misclassification occurs because they are largely treated as consumption rather than

[10] The Bureau of Labor Statistics is considering conducting a regular time use survey that would be appended to the Current Population Survey.

investment. The underestimation occurs because we routinely mismeasure the output of these activities. The omission occurs because we omit much those parts of the activities, particularly important for education, which occur outside the marketplace.

Work of Eisner [1989] and Jorgenson and Fraumeni [1992] have shown how misleading is the current treatment of investments in education. Recent work indicates that current approaches significantly underestimate the output of the health-care sector. I will summarize a recent study in Nordhaus [1999] that asks how standard measures of income would change if they adequately reflected improvements in the health status of the population. Traditional income accounting looks at the flows of consumption and income but does not consider the length of life or the quality of the population's health. I propose measuring *health income* by correcting income measures for mortality and morbidity changes. The approach is to ask how much consumption the individual would be willing to trade off for improved health status. If, for example, an individual would pay 10 percent of market consumption each year to gain an additional life-year, then we use that value to account for improvements in health status.

An example will illustrate the methodology. From 1975 to 1995, the population-weighted average decline in the mortality rate was 2.25 per year per thousand persons. Using standard estimates of the willingness to pay to reduce mortality risk, this decline in mortality would have a value of $5,980 per person per year over this period. The average per capita consumption over this period was $14,700 per year. Hence the economic value of improvements of living standards due to reduced mortality is estimated as 40 percent of consumption over this period, or about 2 percent per year.

Figure 2 shows calculations for the period 1900-1995 using actual data on life expectancy, population distribution, and consumption. (These estimates omit valuation for changes in morbidity for which data are relatively poor.) We use two alternative techniques, one based on mortality and the other based on life-years. The major result that comes through using all techniques is that the value of improvements in life expectancy is about as large as the value of all other market consumption goods and services put together. Over the period from 1900 to 1995, the value of improved health or health income grew at between 2.2 and 3.0 percent of consumption per year whereas consumption grew at a rate of about 2.1 percent of consumption per year.

D. Technological Capital and the True National Investment Rate

A final application considers technological capital and the national investment rate. It is well-established that the conventionally measured national saving and investment rates in the United States have dropped sharply over the last two decades. For example, the personal savings rate has shrunk from 9.6 percent in the 1970s to 2.6 percent in 1999. These numbers are, however, highly misleading because they omit virtually all market investments in education, research and development, and health and omit all non-market investments.

We can address this omission through an estimate of the value of "technological capital," A(t), which is yet another omission from our economic accounts. Assume that all productivity growth is generated by generalized capital that includes both conventional capital and technological capital, which consists of valuable new knowledge, business practices, patents, copyrights, software, etc. Currently, only a tiny fraction of technological capital is appropriated and owned, but we assume for this example that we can measure and value all technological capital. We write the economy's production function as $Y(t) = F[K(t), A(t), L(t)]$. The novel feature of this specification is that all growth in labor productivity is generated by either tangible or technological capital.[11]

The first question concerns the size of technological capital that is associated with U.S. economic growth. Technological capital is estimated using the production function described in the last paragraph assuming that all changes in total factor productivity are due to improvements in technological capital;[12] that technological capital has a rate of return of 10 percent per year; that the value of specific technologies grows with the economy; and that there is no depreciation. Figure 3 shows our estimate of the value of technological capital along with the value of tangible capital (in 1996 prices). Technological capital is estimated to be about four times as large as tangible capital in the business sector.

The dominance of technological capital in total capital raises many important issues. One intriguing question is whether recent changes in intellectual property rights – with an effective broadening of patent and business practice appropriability – means that more of the previously inappropriable technological capital is being captured by firms today. This might be added to the long list of reasons for the high market value of high-tech U.S. firms today.

A second question involves the true national investment rate when technology is included. The production function assumed here includes the "grand capital" stocks for marketed output, so market Hicksian income should equal market Fisherian income. Figure 4 shows the estimated investment rate of tangible capital in the business sector, *S(K)*, as well as that on technological capital, *S(A)*, and the total investment rate, *S(Tot)*. Technological investment is in fact the dominant

[11] The methodology and data behind this calculation are described at http://www.econ.yale.edu/~nordhaus/homepage/webpub.htm, item 105.

[12] Total factor productivity is from the Bureau of Labor Statistics at http://stats.bls.gov/top20.html.

source of investment. The overall investment rate was underestimated by a factor of 9 in the first period and a factor of 7 in the 1990s because technological capital is excluded.

Additionally, we see that the tangible investment rate in the business sector declined from around 5 percent in the 1960-79 period to around 3 percent in the 1980-97 period. But the more dramatic change was the decline in the technological investment rate, from 39 percent from 1960 to 1979 to 16 percent in the 1980-97 period.

V. Conclusion

The purpose of this discussion has been to give a flavor of the exciting developments and prospects for extending the national economic accounts in new directions. The tentative forays in this field suggest that a full set of non-market accounts would provide a richer description of the totality of economic life and will challenge conventional wisdom in many areas.

A broader set of accounts would also help put the market economy in proper perspective as but one small and declining part of life. This point is recalled by Keynes's appraisal:

> Do not let us overestimate the importance of the economic problem, or sacrifice to its supposed necessities other matters of greater and more permanent significance. It should be a matter for specialists – like dentistry. If economists could manage to get themselves thought of as humble, competent people, on a level with dentists, that would be splendid.

My only qualification to this is that I wish he had lauded accountants rather than dentists. To fill is human, but to account divine.

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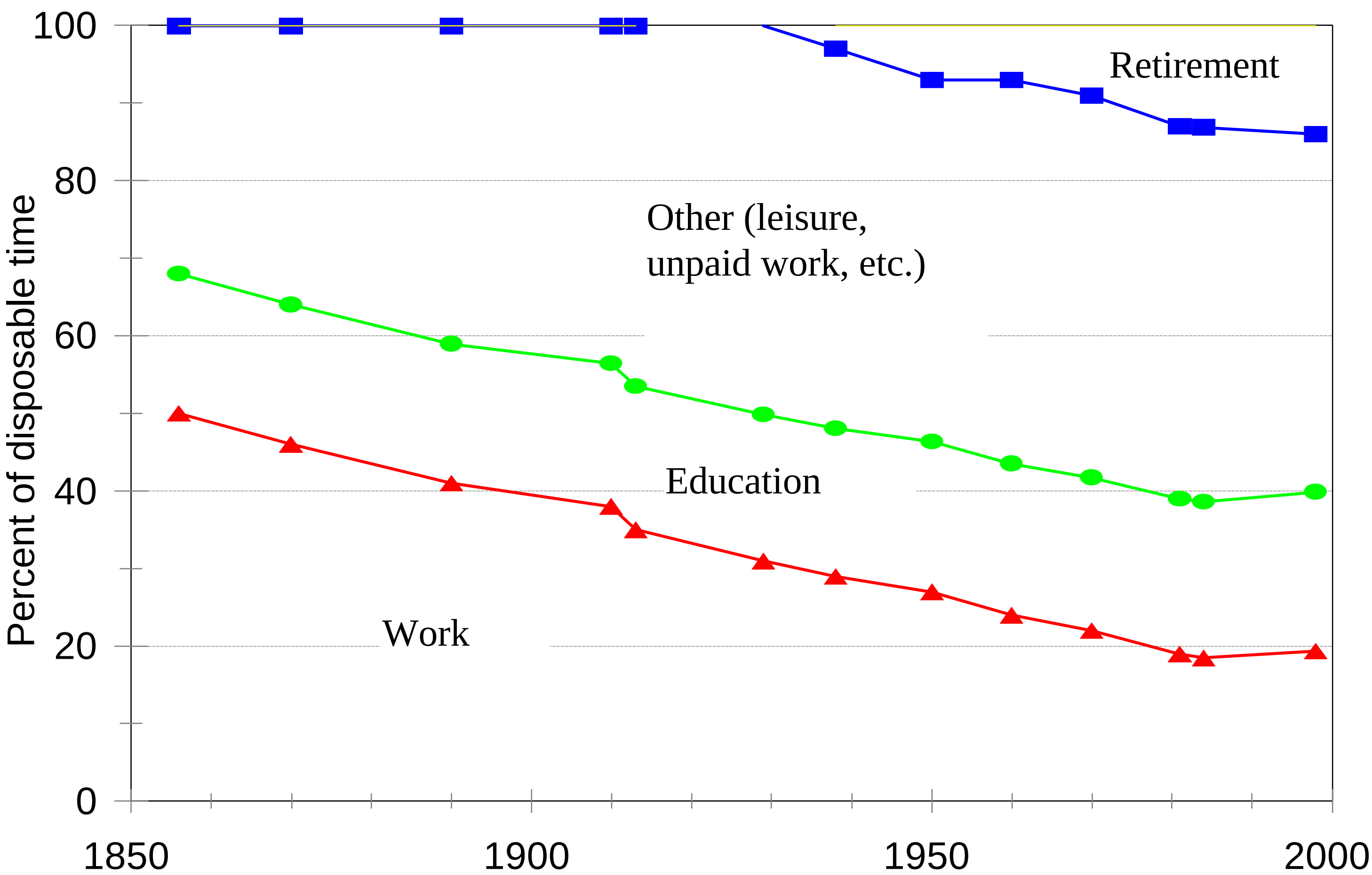
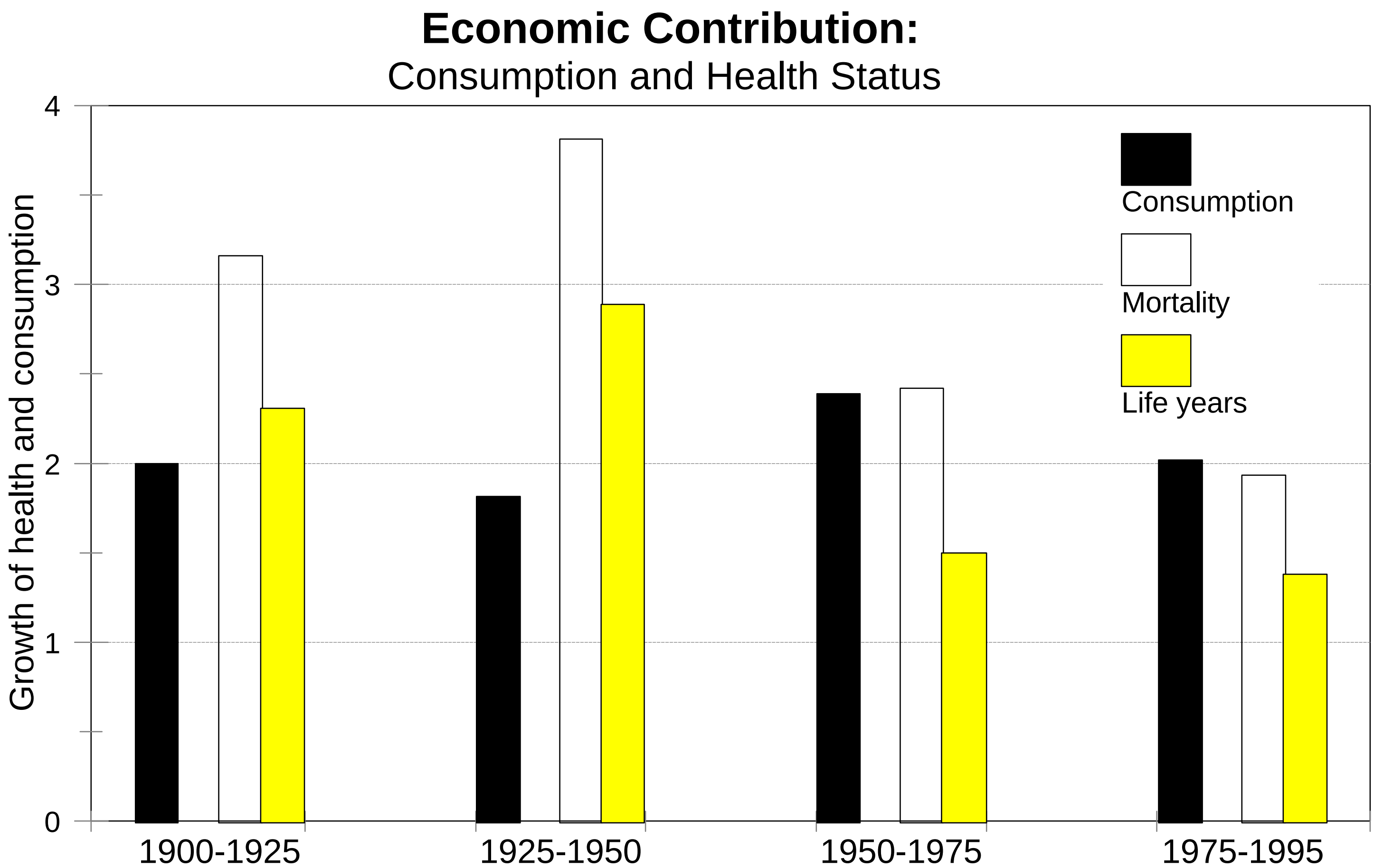
Figure 1. Time Use of Population in United Kingdom, 1856-1998



Source: Ausubel and Gruebler [1995], updated by author. Estimates apply to population over 10 years and subtract 10 hours per day for maintenance.

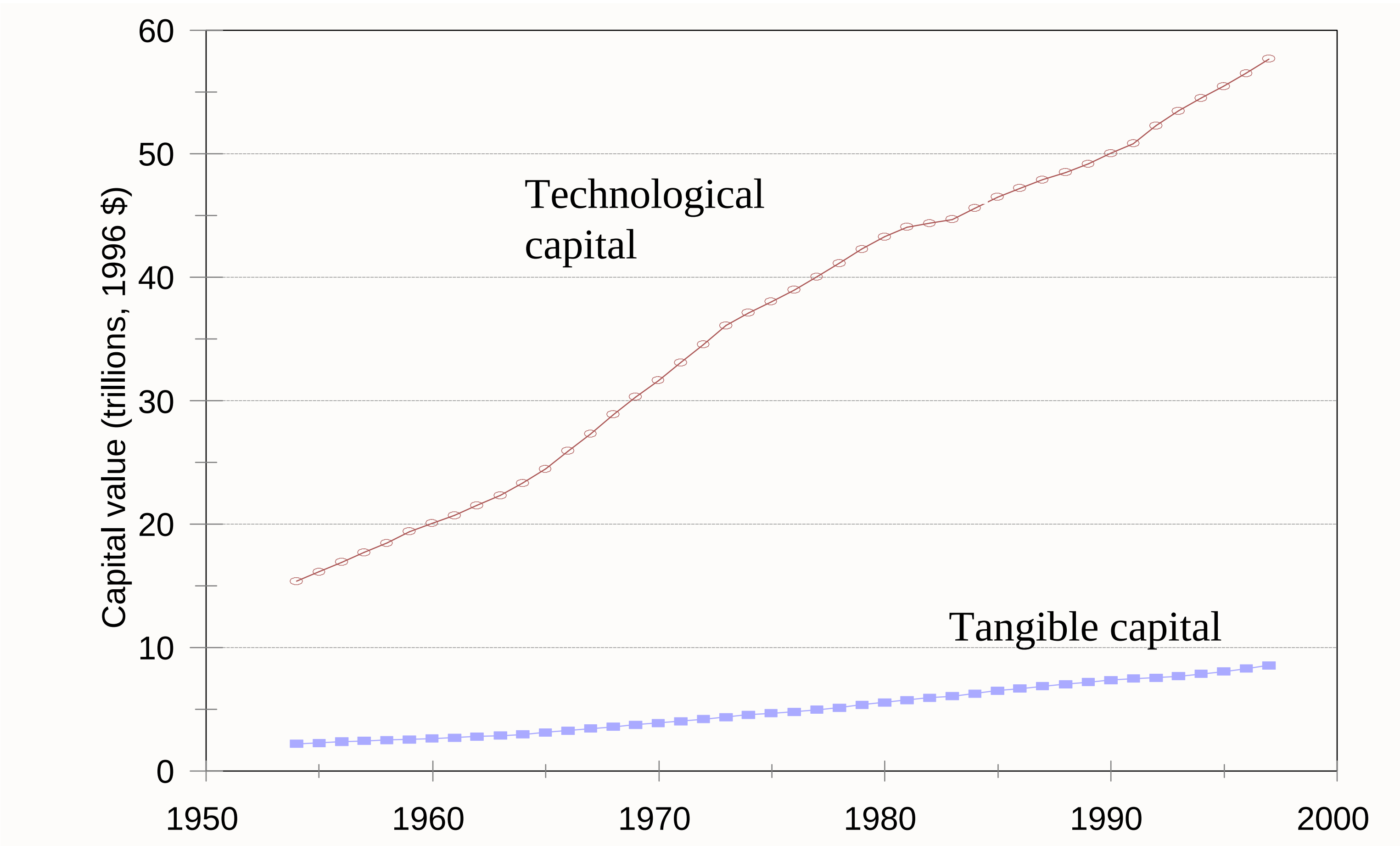
Figure 2.



Bars show the average increase in conventional consumption and of “health income” divided by the level of conventional consumption. Health income measures the value of improvements in life expectancy of the population valued at $3 million per fatality saved or $95,000 per life-year extended.

Source: Nordhaus [1999].

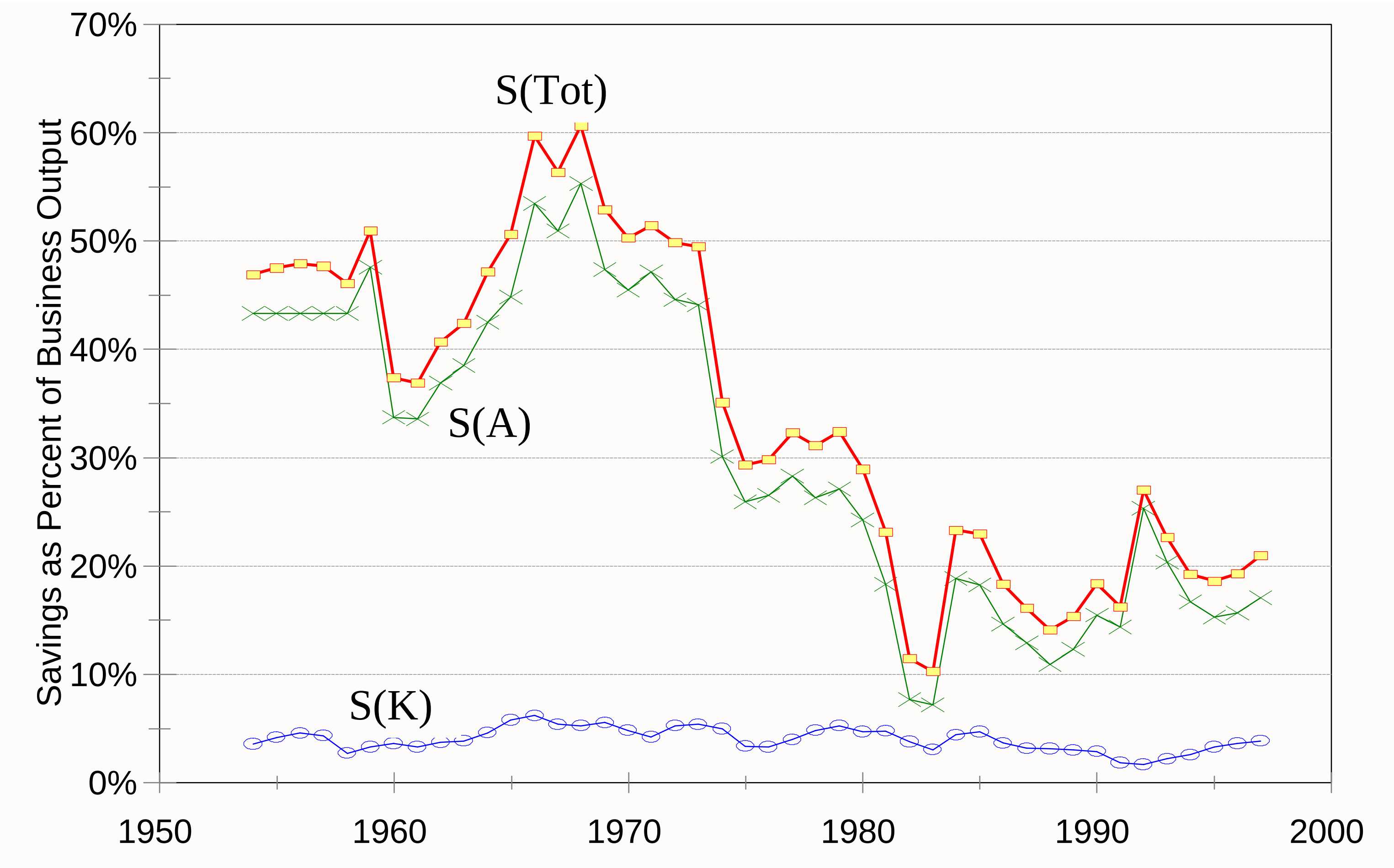
Figure 3
Value of Tangible and Technological Capital in U.S. Business Sector



Note: Value of technological capital is value of total factor productivity estimated at rate of return of 8 percent per year with zero depreciation. Tangible capital from Bureau of Economic Analysis. Output is corrected for 1999 revisions.

Figure 4

Investment Rate in Tangible Capital and Technological Capital in U.S. Domestic Business Sector



Legend:

S(K) = net investment in fixed capital / gross domestic business product

S(A) = net investment in technological capital / gross domestic business product

S(Tot) = total net investment / gross domestic business product