

UK REAL NATIONAL INCOME, 1950–1998: SOME GROUNDS FOR OPTIMISM

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It has been claimed using the concept of the Index of Sustainable Economic Welfare (ISEW) that there has been an absolute decline in sustainable living standards in the UK since the mid-1970s. Revisions to ISEW are proposed to make it more nearly a measure of utility-based real national income. In particular, ISEW should be revised to take account of much-improved life expectancy. Implementing any of the suggested revisions reverses the finding of absolute decline while implementing all of them results in a growth rate higher than that of real GDP per head in the national accounts.

Introduction

Many of those interested in sustainable growth have taken a very pessimistic view of recent UK experience. Douthwaite (1993, p. 3) states that “economic growth has made life considerably worse for people in Britain since 1955” and a widely quoted recent estimate has claimed that for the past quarter century or so the Index of Sustainable Economic Welfare (ISEW) has been in absolute decline in the UK (Jackson *et al.*, 1997). By contrast, economic growth as measured by the UK national income accounts has been maintained throughout the postwar period at a steady if not spectacular rate with an average growth rate of real GDP/head at 2.5 per cent per year from 1950–73 and 1.8 per cent per year from 1973 to 1998 (Maddison, 2001).

GDP is certainly not an adequate estimate of the level of sustainable economic welfare but this also applies to the ISEW adjustments to the national accounts, as critics have been quick to point out. ISEW has a number of features which make it unacceptable. In particular, the allowances that are made for environmental damage and depletion of natural capital lack a sound theoretical foundation, multiple-count the costs of climate change and exaggerate the value of reductions in energy reserves, while the adjustments made for changes to the distribution of income are not justified if the aim is to measure the economy’s productive potential in terms of ability to provide future welfare (Neumayer, 1999).

The standard national accounts measure of national income is net national product (NNP). The rationale for this was set out by Hicks (1939) as the maximum amount which can be consumed while maintaining the

capital stock intact.¹ Thus, investment expenditures to make good depreciation are subtracted from GNP and national income is equal to consumption plus net capital accumulation. In general, however, this is not a measure of sustainable consumption. The most obvious reason for this is that the national accounts only consider depreciation of physical capital whereas a more general measure would need to include depletion of natural resources and human capital. In a growing economy, NNP per person needs still more refinement to reflect sustainable consumption. On the one hand, more of gross product needs to be set aside to maintain capital per head in the face of growing population. On the other hand, technological progress permits consumption to be sustained with somewhat lower capital per person.

But even with these refinements we do not have a measure of real national income in terms of sustainable living standards; as Nordhaus (2000) points out, for that income must be defined in utility terms. Utility-based national income is the maximum amount that a nation can consume while ensuring that members of all future generations can have lifetime utility (be on an indifference curve) at least as high as that of the current generation. It is clearly a net income concept in the sense that the productive potential of the economy per person has to be maintained by setting aside sufficient saving to permit utility levels to be sustained in the face of capital depreciation, demographic pressure and environmental damage. But Nordhaus (2000) also emphasizes that it should also take account of life expectancy. The key point is that the same annual NNP per person with long

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life should be recognised as a higher living standard than that income with a short life.

This also implies that a particularly important omission from ISEW is the improvement over time in life expectancy. This is very unfortunate because the evidence suggests that people greatly value reductions in risks of mortality and also because one of the most dramatic achievements of the twentieth century was the rise in life expectancy at birth to almost 80 years from a level about half that in 1870. As Eisner (1994, p. 105) remarked in his critique of the ISEW methodology: "I do not share ISEW's reluctance to put a value on human life; indeed, I should think it vital in any measure of welfare".

This paper provides a revision of the ISEW estimates for the UK undertaken with a view to making them more nearly approximate a utility-based real national income measure. The next section explores several revisions to the estimate of ISEW. These include removing the adjustment for inequality, allowing for technological progress in estimating sustainable consumption, eliminating the multiple-counting of environmental damage, and assuming that the replacement cost of primary energy consumption is constant rather than increasing steadily over time. The growth rate for ISEW is computed for each of these variants singly and also for all four revisions. The third section sets out the evidence on improvements in life expectancy and the increase in lifetime consumption possibilities. It goes on to consider the impact of an imputation for improvements in life expectancy on the growth of augmented real national income and of ISEW. These imputations are based on a methodology proposed by Nordhaus (1998) which is explained in the appendix. Finally, the fourth section concludes that the claim that sustainable economic welfare has been declining since the mid-1970s is simply not plausible.

ISEW revisited

In this section of the paper the definition of ISEW is reviewed and criticisms are presented of the implementation of the concept. Revisions are suggested to the ISEW methodology with a view to making it a better approximation of utility-based real national income but, at this stage, no adjustment is made for longer life expectancy. The empirical impact of the proposed changes is set out so as to highlight the sensitivity of ISEW to each of them.

The Index of Sustainable Economic Welfare (ISEW) is defined as follows:

Personal consumption – losses from unequal distribution + domestic labour services + non-defensive public expenditures + net capital growth - defensive private expenditures – costs of environmental degradation – depreciation of natural capital.

Table 1 reports a summary of the main elements of ISEW per person for the UK on a consolidated basis for benchmark dates marking the so-called 'Golden Age' in the early postwar period and the subsequent period of slower growth. Components are signed according to whether they add to or subtract from ISEW. Row (1) is not part of the total since personal consumption enters only after an adjustment for inequality. The outstanding feature of table 1 is not a dramatic slowdown in personal consumption growth after 1973 but rather that the negative components become much larger. Included among these is the impact of greater inequality of income in more recent years.

ISEW adjusts personal consumption to allow for its unequal distribution using the Atkinson index which is defined as the equally distributed income that would have delivered as much utility as the actual total (inegalitarian) income. In this approach a parameter is subjectively assigned to reflect the proposition that income is less valuable to the well off.² This has many

Table 1. Components of ISEW (£1995 per person)

	1950	1973	1998
Personal consumption	2960	4904	8246
Inequality adjusted consumption	2716	4524	7064
(+)			
Household labour services	1153	1788	2755
(+)			
Public health and education	108	233	439
(+)			
Net capital	0	535	0
(+)			
Consumption deductions	368	790	2054
(-)			
Pollution & environmental damage	1022	1825	2908
(-)			
Natural capital depreciation	445	1194	2447
(-)			
Total	2142	3271	2849
Growth rate (% p.a.)		1.9	-0.6

Sources: derived from Jackson *et al.* (1997), see text. Consumption deductions are the sum of their columns I, J, K, L and M; pollution & environmental damage are the sum of their columns N, O, P, T and U; natural capital depreciation is the sum of their columns Q, R and S. 1998 estimates extrapolated from 1996 estimates in original.

precedents in the context of how policymakers of a particular degree of inequality aversion might look at actual economic outcomes in terms of contemplating trade-offs between equity and efficiency (Crafts, 1993). Nevertheless, in this context, it confuses a dislike for growth which actually has favoured higher income deciles with the potential to sustain consumption for all. The ISEW inequality adjustment is not warranted in terms of the definition of utility-based national income since the distribution of income *per se* does not directly impact on the capacity for future consumption (Neumayer, 1999).

The net capital adjustment is to allow for demographic growth by only counting as net investment, and thus part of maximal consumption, investment over and above that needed to maintain capital per head. This is also consistent with utility-based national income but the calculation is incomplete because it fails also to take account of technological progress and thus exaggerates the amount of consumption that needs to be foregone now to maintain future consumption standards.

ISEW has some similarities to utility-based national income in that it starts from personal consumption measured in terms of the value consumers assign to goods and services. It adds to this the value of non-market work and some public spending on education and health. However, a substantial part of public expenditure (for example, on law and order and military activity) is seen as ‘defensive’, i.e., inputs into producing income that should not be regarded as final consumption, and are therefore not included in ISEW, although part of conventional GDP. Similarly, some private expenditures, for example costs of commuting, are deducted from personal consumption as ‘defensive’. In principle, leaving aside issues of implementation, this all makes sense in terms of a utility-based national income concept.

However, the notion that (an arbitrary fraction of) public expenditure on education and health should be added in as ‘non-defensive’ is a highly imperfect way of taking account of the value that this has to consumers. It would be much more appropriate to incorporate the value that consumers place on the results of these expenditures – such as the consumption equivalent of the life expectancy gains that they deliver. Not only is this undoubtedly a large number but such an approach is already part of government policymaking if not national accounting. Thus, in the analysis of road-building schemes the Department of Transport values an ex-

pected death averted at about £0.8 million and a working group at the Department of Health (1999) proposed a value of £2 million for a death averted by reduction of air pollution risks.

Broadening of depreciation to include damage to the environment and losses of natural capital is, of course, an essential ingredient in addressing the deficiencies of traditional national accounts and moving towards utility-based national income. Unfortunately, the methods adopted by Jackson *et al.* (1997) are seriously flawed. Neumayer (2000) notes that the correct way to value the environmental damage of a tonne of carbon emissions is at marginal social cost which the ISEW calculation quite reasonably takes to have been £11.4 at 1990 prices in 1990. But then this amount is set aside not only in the year of emission but in each subsequent year as well because the damage is allowed to accumulate over time; as Neumayer points out this procedure entails multiple-counting of the costs and is tantamount to assuming an extraordinarily high present value of damage from emissions.

The depletion of non-renewable resources is also estimated inappropriately. The concept employed is to estimate the replacement costs of primary energy consumption. It might be argued that, in terms of utility-based national income, a preferable approach would be to calculate what proportion of the resource rents obtained from extraction needs to be reinvested to sustain consumption when the non-renewables are exhausted. This would clearly be a very small number relative to UK GDP in any of our benchmark years (Vaze, 1996). Even if the replacement cost approach is favoured, however, the implementation by Jackson *et al.* (1997) is not acceptable because it uses a high value of a barrel of oil equivalent (\$75 in 1988) and assumes that costs are rising steadily at 3 per cent per year. As Neumayer (2000) points out, the life expectancy of proven reserves of non-renewable energy sources is long, solar energy is the obvious replacement and its costs can be expected to fall over time as technology advances.

The remainder of this section examines the implications of revising four of the objectionable components of ISEW identified above, namely, the inequality adjustment, the net capital formation estimate, the long-term environmental damage estimate, and the replacement costs assumed for consumption of non-renewable energy resources. A revised ISEW is presented in table 2, in which each of these components has been amended.

Table 2. A revision of ISEW (£1995 per person)

	1950	1973	1998
Personal consumption (+)	2960	4904	8246
Household labour services (+)	1153	1788	2755
Public health and education (+)	108	233	439
Net capital (+)	105	612	1259
Consumption deductions (-)	368	790	2054
Pollution & environmental damage (-)	675	757	547
Natural capital depreciation (-)	420	590	572
Total	2863	5400	9526
Growth rate		2.8	2.3

Sources: see text. Rows (1)–(3) and (5) are as in table 1. The assumptions for the net capital entry in row (4) are as follows: for 1950, expected population growth was assumed to be 0.3 per cent, TFP growth 0.7 per cent, and the capital to GDP ratio was 1.8; for 1973, expected population growth was 0.5 per cent, TFP growth 1.25 per cent, and the capital to GDP ratio was 2.6. The pollution and environmental damage entry in row (6) removes the cumulative component and assumes marginal social costs of carbon emission were £13.86 in 1990 and grew at 2 per cent per year from 1950–90. The natural capital depreciation in row (7) uses a constant replacement cost per tonne of oil equivalent non-renewable energy consumption of £136; it should be noted that the higher this constant figure is assumed to be the higher is the growth rate of revised ISEW in each period.

Table 3 reports the rate of growth of the revised ISEW per person together with the rate of growth that would result if each of these amendments was carried out separately.

The first row of table 2 simply removes the inequality adjustment and enters personal consumption from the national accounts unaltered. When this is done, the consumption figure for 1998 increases considerably more than that for 1973. As table 3 shows, on its own this is sufficient to render the growth rate of ISEW per person positive in the 1973–98 period, albeit at a small number. This may seem a surprisingly large impact but, as has been widely remarked, UK income inequality rose dramatically in the late twentieth century (Atkinson, 1999).

The second amendment in table 2 in row (4) incorporates an adjustment for technological progress into the net capital formation estimate. Ex post, the extent to which output has increased independent of growth in factor inputs can be approximated by the measurement of total factor productivity growth (TFP) in a growth

Table 3. Growth rates of ISEW variants (% per year)

	1950–73	1973–98
Original ISEW	1.9	-0.6
No inequality adjustment	1.9	0.4
Revised net capital	1.8	0.8
Revised environmental damage	2.4	0.8
Revised natural capital depreciation	2.6	0.8
All 4 revisions	2.8	2.3

Sources: derived from table 2.

accounting methodology. Estimates for the UK since 1950 can be found in Crafts and O'Mahony (2001); these show that TFP growth was close to 1.25 per cent per year in both the pre- and post-1973 periods. How much the capital accumulation requirement is alleviated by this productivity improvement depends on the elasticity of output with respect to capital stock growth. Estimates for the UK suggest that this is about 0.3 (Oulton and Young, 1996), i.e., if 3 per cent more output per year is to be obtained the capital stock has to rise by 10 per cent.

Based on the estimates of depreciation of physical capital in O'Mahony (1999) and of the net capital stock in the national income accounts, the situation would have been as follows in 1998. With a capital stock of about 3.2 times GDP and a depreciation rate of 6.3 per cent about 20 per cent of GDP would need to be invested. With trend TFP growth of 1.25 per cent and an output to capital elasticity of 0.3, however, the capital stock can fall by about 4.2 per cent without reducing sustainable consumption. Thus the reinvestment requirement is only 2.1 per cent of the capital stock or about 6.7 per cent of GDP. When allowance is made for population growth at the 1973–98 rate of 0.2 per cent per year, this translates into a permissible fall of 3.5 per cent in the capital stock and an investment requirement of 9.0 per cent of GDP. Thus, since in 1998 18.64 per cent of GDP was invested, an extra 9.64 per cent could have been consumed on a sustainable basis.

Similar calculations were made for 1950 and 1973, in each case taking the previous period as a guide to reinvestment needs. For 1973 TFP growth was taken to equal that of 1950–73 and for 1950, the interwar period of 1924–37, as defined by Matthews *et al.* (1983), was used. When these revised estimates of net capital accumulation over and above the amount needed to sustain consumption are added to ISEW in row (3) of table 3,

once again this amendment on its own is enough to place post-1973 growth performance in a very different light. The original estimate of -0.6 per cent per year goes to $+0.8$ per cent.

Two revisions to the ISEW environmental damage estimates have been made in row (6) of table 2. First, damage is valued at marginal social cost in the year of the emissions and the damage no longer accumulates as in Jackson *et al.* (1997) and, second, marginal social cost is assumed to increase over time at 2 per cent per year throughout the postwar period, as in Neumayer (2000). The data for emissions are retained as in the original ISEW. The outcome is a much lower deduction for pollution and environmental damage in row (6) of table 2 for 1973 and, especially for 1998, than in the corresponding entry in table 1. Row (4) of table 3 shows that this boosts the growth rate quite considerably in both periods. It also underlines Neumayer's finding that assuming a steadily rising marginal social cost of environmental damage is not sufficient to generate a declining ISEW from the 1970s.

Finally, in row (7) of table 2 a more modest, constant replacement cost for non-renewable energy sources has been assumed in the light of the long lifetime of energy reserves and the prospect in time of economical solar energy. An alternative would be to make adjustments in line with the user cost method of El Serafy (1989) but the data for such calculations does not exist for the whole postwar period. In any event, it is clear that once the escalation factor in the replacement cost calculation made by Jackson *et al.* (1997) is removed the increasingly large deductions for this item over time evaporate since consumption of primary energy from non-renewables in terms of millions of tonnes of oil equivalent fell from 212.7 in 1973 to 203.2 in 1998 (DTI, 2001). Row (5) of table 3 shows that this revision on its own is also capable of raising the growth rate of ISEW per person significantly in both periods and once again the finding of negative growth post-1973 disappears.

Two main messages arise from this exercise. First, as has been noted along the way, making any one of these revisions removes the finding of declining sustainable economic welfare since the mid-1970s. Given that there is a strong case for making all these revisions, this suggests that the original declinist claims are completely lacking in robustness. Second, if all these revisions are implemented, then, as table 3 shows, the end result is that ISEW per person grows faster throughout than real GDP per person. The estimates of 2.8 per cent per year

in 1950–73 and 2.3 per cent per year in 1973–98 in row (6) of table 3 compare with 2.5 per cent and 1.8 per cent for real GDP per person in the same periods.

Incorporating improved life expectancy into national income

Table 4 reports estimates of life expectancy for the benchmark years 1950, 1973 and 1998. The most commonly used measure is life expectancy at birth which rose by more than eight years for both genders over the whole period. It is also of interest, however, to consider the average life expectancy of the population (which reflects its age structure) as it is relevant to the expected future consumption of those currently alive.³ This rose by somewhat less than life expectancy at birth. Nevertheless, between 1950 and 1998 this increased by between 14.5 and 21.7 per cent depending on which year is chosen as the base for age-weighting.⁴

It was pointed out earlier that ISEW fails to take account of the high value that people place on the reductions in mortality risks which have been very important achievements of government health expenditure as well as private initiative. This section illustrates how this omission might be rectified both in principle and in practice.

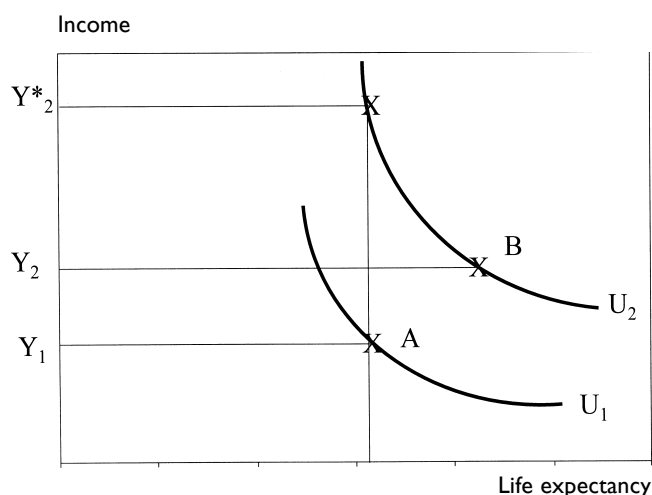
A device familiar from elementary microeconomics, namely the indifference curve diagram, can be used to illustrate the basic idea of incorporating life expectancy into measures of living standards. The representative person whose preferences are mapped in chart 1 is assumed to regard both longer life and income as goods.

Table 4. Years of life expectancy, 1950, 1973 and 1998

	1950	1973	1998
At birth			
Females	71.2	75.5	79.8
Males	66.2	69.2	74.9
Population average			
1950 age structure	40.4	42.6	46.3
1973 age structure	39.9	43.0	45.7
1998 age structure	35.7	39.9	43.5
Average as ratio of 1950			
1950 age structure		1.056	1.147
1973 age structure		1.077	1.145
1998 age structure		1.117	1.217

Sources: derived from *Annual Abstract of Statistics*, various issues.

Chart I. Indifference curves map: income and life expectancy



Each indifference curve maps combinations of life expectancy and income which are regarded as equally preferable; a move to a higher indifference curve represents a rise in standard of living. A person is observed initially at point A on curve U_1 and subsequently at point B on U_2 . Income as conventionally measured has risen from Y_1 to Y_2 . However, to maintain a U_2 living standard with the original life expectancy requires an income of Y_2^* . Thus, the gain from longer life is equivalent to an income gain of $(Y_2^* - Y_2)$ and the gain in real income is $(Y_2^* - Y_1)$ rather than $(Y_2 - Y_1)$. Confining our attention to money income, as would be the approach of the national income accounts, would omit part of the welfare gain. This approach would measure the increased income from longer life expectancy by the consumption-equivalent of the greater longevity, as in chart 1.

Nordhaus (1998) set out a method of operationalising an estimate of growth of utility-based national income that takes account of mortality risks. This values improvements in life expectancy by taking the change in the population-weighted average of age-specific mortality rates multiplied by the estimated value of a death averted. This can either be taken as constant at all ages or, probably more appropriately, age-weighted. The formal basis of this is given in the appendix.

The starting point here is to review estimates of the ‘value of a statistical life’, the term used in British policymaking circles for the value of a death averted. This is defined as the total price that the population is willing to pay to reduce its expected death toll by one.

Thus if 60 million people are each willing to pay 1.667 pence for a public health improvement that saves one life, the value of a statistical life is £1 million. 1.667 pence is then the value placed by the average person on this reduction of the mortality rate by 1 per 60 million.

A recent survey of the international evidence on the value of a statistical life concluded that a good rule of thumb is that it is around 120 times GDP per person. For the UK the best guess was a multiple of 132 times per capita GDP with a range from 101 to 154 (Miller, 2000). The same survey found that results of studies for countries at a wide range of income levels over the recent past appear to be consistent with an income elasticity for this value of about 1 or slightly less. The best guess proposed by Miller (2000) is about twice the value adopted by the Department of Transport in 1988 for the cost benefit analysis of road schemes and subsequently increased in line with growth of real GDP per person. It is, however, consistent with the review of the evidence in Jones-Lee (1989) and the suggestion in a recent government report that for involuntary risks (such as those resulting from air pollution) an appropriate value might be two or three times higher than that used for road deaths averted (Department of Health, 1999).

The best guess of a multiple of 132 times GDP/person would imply the following calculation for the years 1950–98. As reported in table 5 below, the population-weighted average reduction in the mortality rate was 7229 per million persons and real GDP per person in 1998 at 1995 prices was £13,055 (ONS, 1999; Maddison, 2001). The value of a statistical life is taken to be $(132 \times £13,055) = £1.72$ million. The decline in mortality in this period is then estimated to be worth $1.72 \times 7229 = £12,434$ per person.

Table 5. Value of decline in the mortality rate (£1995)

	Fall in death rate	Value of death averted (£1995m)		Value of lower mortality per person (£1995)	
		Un-weighted	Age-weighted	Un-weighted	Age-weighted
1950–98	7229	1.72	1.15	12434	8313

Sources: based on mortality approach of Nordhaus (1998) as described in the text, col (4) = col (1) x col (2) and col (5) = col (1) x col (3). The age -weights based on Murray (1996) in col (3) are as follows: 0–4: 0.3; 5–14: 1.0; 15–34: 1.5; 35–44: 1.3; 45–54: 1.1; 55–64: 1.0; 65–74: 0.7; 75–84: 0.5; 85 and over: 0.4. Mortality rates and population weights from Mitchell (1988) for 1950 and ONS (2000) for 1998.

Table 6. Imputations for improved life expectancy in real national income

	Real GDP/head (£1995)	Mortality imputation	Adjusted GDP/head	Traditional growth (% p.a.)	Adjusted growth (% p.a.)
1950	4755				
1973	8408	1606	10014	2.5	3.3
1998	13055	5587	18642	1.8	2.5

Sources: Derived using methodology and sources as in table 5, see text. The mortality imputation uses age-weighted mortality gains.

There is some evidence that the value of a statistical life is not constant across all ages but tends to be higher in the middle of the life span than in infancy or old age. Murray (1996) suggests weights with which to calculate an age-weighted value of a death averted; the weighting is very similar to that proposed in Department of Health (1999). For the years 1950–98, as reported in table 5, this would give an age-weighted value of a statistical life of £1.15 million and a decline in mortality worth $1.15 \times 7229 = £8313$ per person. The lower valuation reflects the relatively greater falls in mortality for older age groups.

Table 6 reports the results of implementing the Nordhaus methodology for measuring the contribution of gains in life expectancy to the growth of real national income per person in the UK. It uses calculations similar to those of table 5 to create ‘best guess’ imputations for improved life expectancy to be added to conventional real GDP per person growth in order to create a first approximation to the growth rate of real utility-based national income per person. The methodology is implemented separately for each period. As noted above, there is a wide range of estimates of the value of a statistical life. Based on the range of 101 to 154 times GDP per person reported in Miller (2000), lower and upper bound estimates for the estimates in column (5) would be 3.1 and 3.45 per cent per year for 1950–73 with 2.35 and 2.9 per cent for 1973–98. Clearly, the imputations for lower mortality are quite sizeable.

In the first section it was argued that a major weakness of ISEW is its failure to acknowledge the value of reduced mortality risks. This omission can be addressed by incorporating into the revised ISEW of table 3 the estimates of life expectancy gains already made in table 6. At the same time, it is now clearly appropriate to remove from ISEW the positive component assigned on the basis of public spending on education and health. These expenditures can be regarded as inputs which

Table 7. Incorporating mortality gains into revised ISEW, 1950, 1973 and 1998

	1950	1973	1998
Revised ISEW (+)	2863	5400	9526
Mortality imputation (+)	n/a	1606	5587
Public health & education (-)	108	233	439
Total	2755	6773	14674
Growth rate (% p.a.)		4.0	3.1

Sources: Revised ISEW from table 2; mortality imputation as in table 6; public health and education from table 1.

may have a payoff in raising life expectancy, or indeed, TFP but should not be seen as final consumption goods valued on the basis of willingness to pay.

As one would expect, inclusion of the gains from rising life expectancy makes a substantial further difference to ISEW per person. Compared with table 2, table 7 shows growth rising from 2.8 to 4.0 per cent per year in 1950–73 and from 2.3 to 3.1 per cent per year in 1973–98. Once welfare gains from an improved mortality environment are taken into account, the revised ISEW calculation suggests growth of real GDP per person substantially underestimates rather than overestimates growth of utility-based real national income per person.

The policy implications of these results are intriguing but unclear. Much more needs to be discovered about the costs and benefits of interventions that would potentially reduce mortality, cf. Department of Health (1999). Nevertheless, the possibility that arises is that rethinking our concept of national income in utility terms would lead to a different view of the growth implications of alternative fiscal strategies, for example, in terms of the choice between lower taxes and higher public health expenditures.

Conclusions

Conventional national income accounts do not provide estimates of sustainable economic welfare nor of utility-based national income. It is important to recognise that there are biases that go in the direction of under-estimation as well as over-estimation. Yet most critics seem to have proposed adjustments that are intended to justify claims that economic growth, at least in the recent past, is simply an illusion, an artefact of the statistics.

The best known of these exercises for the UK is the ISEW proposed by Jackson *et al.* (1997). Close examination of this index suggests that the claim of declining sustainable economic welfare that its authors make is not robust. Any one of several revisions justified in this paper would remove this finding. If all the revisions suggested here are adopted, the result would be that, throughout the postwar period, the growth of real GDP per person in the UK turns out to be a considerable under-estimate of utility-based real national income per head.

Further revisions to ISEW may well be desirable if it is to become a closer approximation to utility-based national income, some of which may well make for less optimistic conclusions. For example, rather than simply deducting public expenditure on defence and law and order from GDP it might be desirable to attempt an estimate of the consumption equivalent utility losses from rising crime risks and personal insecurity. Nevertheless, such further revisions will need to be substantial if they are to rehabilitate the hypothesis that sustainable economic welfare in the UK has declined in the recent past.

APPENDIX

An individual has a stream of expected income and faces a constant real interest rate equal to the mortality adjusted rate of time preference $(\rho + \mu)$ where μ is the set of mortality rates and the survival function is exponential. This person chooses an annuity that yields constant consumption, $c = c^*$, through his/her lifetime. The value of this consumption stream is

$$V = u(c^*) / (\rho + \mu) \quad (1)$$

so that the trade-off between consumption and mortality is

$$dV / dc^* = u'(c^*) / (\rho + \mu) \quad (2)$$

$$dV / d\mu = -u(c^*) / (\rho + \mu)^2 \quad (3)$$

$$dc^* / d\mu = -u(c^*) / [u'(c^*)(\rho + \mu)] \quad (4)$$

Normalising by setting $u'(c^*) = 1$, i.e., a unit of utility is worth one extra unit of the consumption good, and by setting the pure rate of time preference to zero gives

$$dc^* / d\mu = -u(c^*) / \mu \quad (5)$$

This implies that a uniform change in mortality rates at

every age will produce a welfare change equal to the number of years of life times the goods value of life.

The mortality approach in Nordhaus (1998) which is implemented in this paper to obtain utility national income values improvements in life expectancy by taking the change in the population weighted average of age specific mortality rates multiplied by the estimated value of a death averted, i.e., by using a generalisation of (5).

An alternative approach based on life-years is also set out in Nordhaus (1998). The economic value of improved health is equal to the population-weighted increase in life expectancy times the value of an additional life-year. The main problem with this approach lies in estimating the value of a life-year. There is no obvious way to do this and any solution relies on strong assumptions. A simple way to proceed is to suppose that the value of a statistical life applies to a male aged 40 with no discounting. In 1998 this implies that the capital value of £1.72m is spread over 36.6 years (male life expectancy at 40) implying a capital value of £46,995 per life year which is equivalent to a flow of £1284 per year. The 1998 population-weighted increase of life expectancy of 7.8 years between 1950 and 1998 would be worth £10,015, somewhat smaller than the £12,434 in table 5 using the mortality approach. If, however, the discount rate is assumed to be greater than zero, the value of a life-year might increase markedly, cf. Nordhaus (1998).

NOTES

- 1 This definition is in general not correct for a growing economy in which net investment is taking place, see Sefton and Weale (1996).
- 2 It would be more appropriate, data permitting, to make such an adjustment on the basis of the present discounted value of lifetime consumption. The inequality of income at a point in time does not take account of life-cycle effects.
- 3 It is also the basis of the life-years approach to estimating the value of reductions in death rates, see the appendix.
- 4 This comparison allows alternatives to the methodology for valuing improvements in mortality that is set out in this section. If it is assumed that planned per capita consumption is constant and there is no discounting, life expectancy is also the value of lifetime utility as a multiple of instantaneous utility. The ratios of the life expectancies reported in table 4 represent the multiples of the 1950 level of utility with 1950 survival probabilities which would be attained with 1973 or 1998 survival probabilities. This can then be valued using an assumed utility function. I am indebted to an anonymous referee for this suggestion.

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