# Measuring Regional Progress: A Regional Index of Sustainable Economic Well-Being (R-ISEW) for all the English Regions

## A report funded by the Regional Development Agencies

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10 July 2008





east midlands development agency

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# Executive summary

The English Regional Development Agencies (RDAs) are tasked with the challenge of encouraging sustainable development in their regions, with the ultimate aim of achieving high levels of social and economic well-being within environmental limits. Measuring progress towards that vision is no simple matter.

Recognising this, a consortium of RDAs led by that for the East Midlands (emda) commissioned **nef** (the new economics foundation) to construct an adjusted economic measure based on the framework piloted previously for East Midlands and some other English regions. This framework, in turn, is based on a range of attempts to construct an adjusted measure of GDP – the Index of Sustainable Economic Welfare (ISEW) – at the national level.

This report describes the development and application of a Regional Index of Sustainable Economic Well-Being (R-ISEW), and calculates it for all English regions.

The results for England as a whole (Figure 1) reveal that, during the period of the study, the R-ISEW rose by approximately 44%, from £7,400 per capita in 1994 to £10,700 per capita in 2005. Meanwhile, the Gross Value Added (GVA) was considerably higher throughout the period, growing (by 31%) from just under £14,000 per capita in 1994 to just over £18,000 per capita in 2005.

In absolute terms, the growth in R-ISEW still lags behind the growth in GVA. The difference between R-ISEW per capita and GVA per capita increases from just under £6,500 in 1994 to over £7,400 in 2005. It is concluded that the gap between conventional economic output and sustainable economic well-being is still widening.

The rising trend in R-ISEW over the period is driven primarily by strong growth in consumption, increased public expenditure on health and education, and significant reduction in air pollution. The most important countervailing forces (tending to keep the R-ISEW depressed well below GVA) are the costs associated with resource depletion, the growing impact of income inequality, and the costs of failing to provide for long-term environmental damage from climate change.

Within the overall picture there are some significant regional differences. Some regions do significantly better than others in terms of R-ISEW. Figure 2 illustrates the range of results found in this study. The region with the highest R-ISEW (in 2004) was the South West, while the region with the lowest R-ISEW was Yorkshire and the Humber. The gap between R-ISEW and GVA also varies widely between regions. London and the South East exhibit the largest gap between R-ISEW and the conventional measure, while the North West and the South West show the smallest. The fastest growing gaps are in the South East and West Midlands, growing at 35% and 36% respectively.

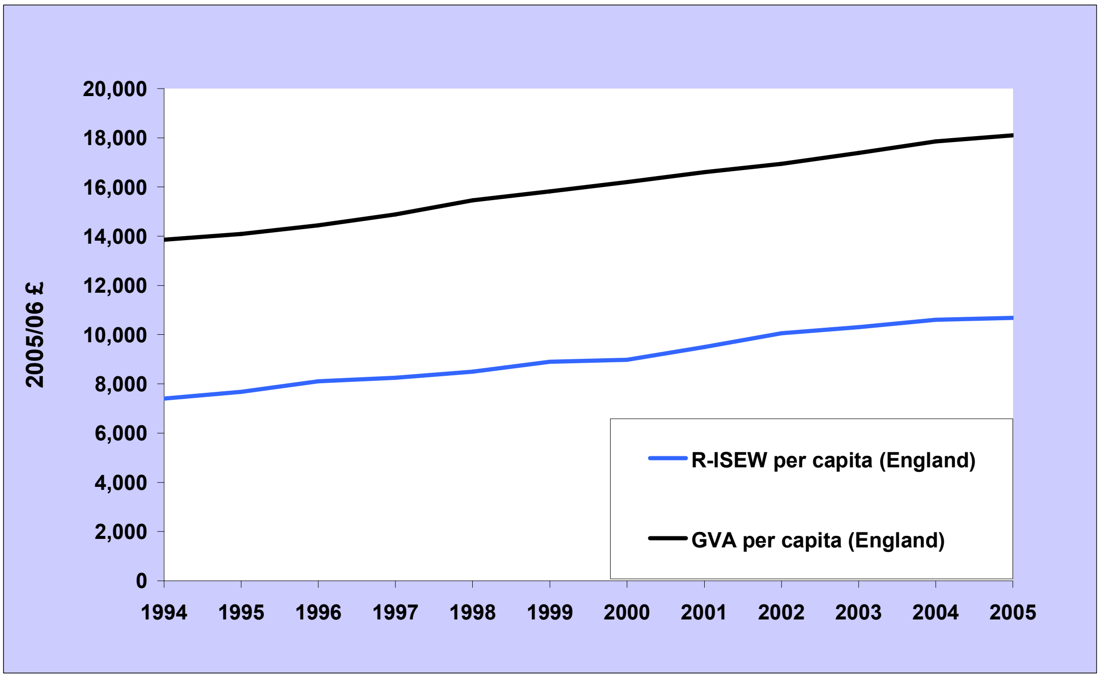



**Figure 1: The English R-ISEW 1994–2005, plotted against GVA.**

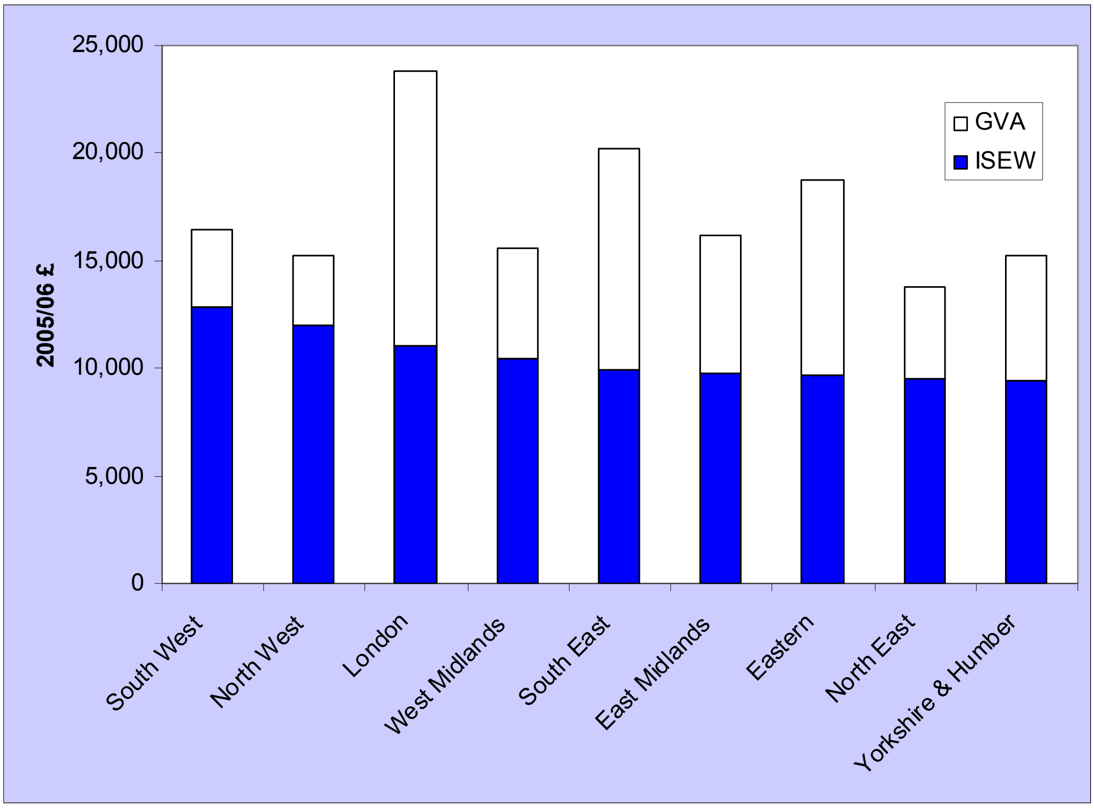



**Figure 2: Regional Variations in R-ISEW per capita.**

Variations across regions are, of course, determined by all the components of the R-ISEW. The key explanatory factors, however, were found to be the difference between GVA and inequality adjusted consumer expenditure, net international position, the costs of resource depletion, long-term environmental damage, air pollution and commuting, and the uneven distribution of public expenditure on health and education.

Interestingly, this study also found that regional disparities[1] in R-ISEW are declining (Figure 3), in spite of increasing disparities in GVA and consumer expenditure, suggesting that, overall, environmental and social trends are tending to 'equalise' the English regions. Importantly, however, this equalisation is not always in a positive sense. Some regions with lower environmental costs a decade ago are now becoming less sustainable in certain ways.

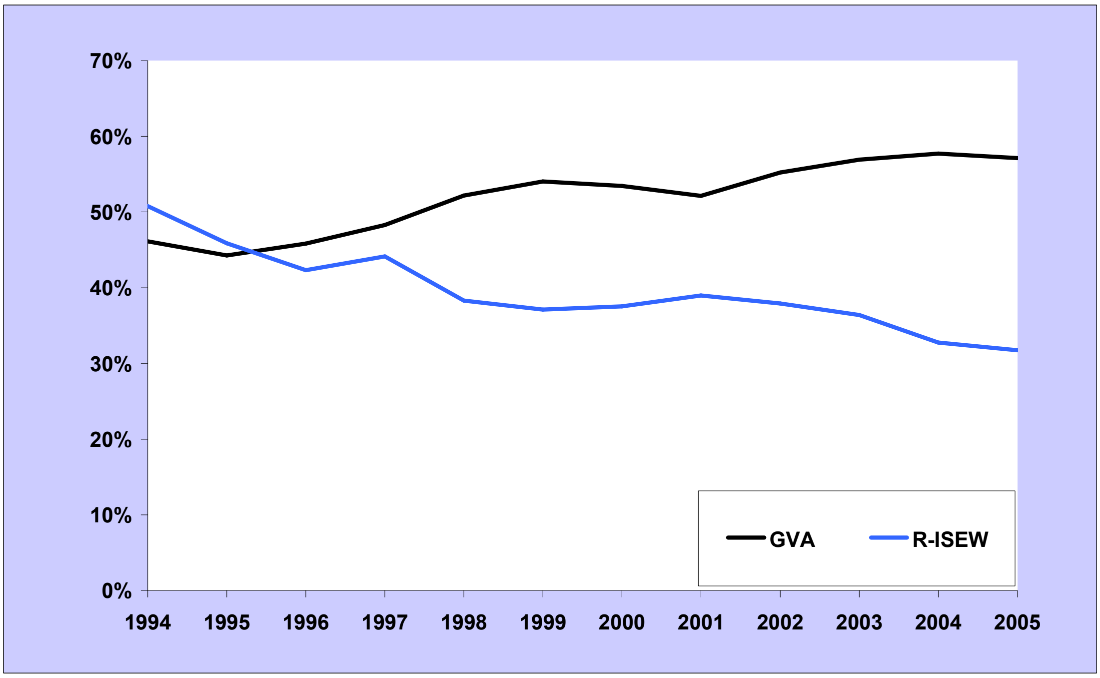



**Figure 3: Regional Variation in R-ISEW compared against GVA.**

Even at national level, constructing adjusted economic indicators of progress is a formidable task. At regional level, the task is compounded by limitations in the availability of regional data, although this is improving all the time. As more and better data become available, and as new revisions of the ISEW are developed in other countries and regions, the theory and practice behind the R-ISEW evolves.

The results reported here should still be viewed as a 'best estimate' at the present time, to be refined and revised in future iterations. Indeed, a comparison between this version of the R-ISEW and those calculated previously for some English regions will show some, not-insignificant changes. Subject to these inevitable caveats, we submit that the R-ISEW represents a valuable step in meeting the requirement for robust tools for measuring progress towards the long-term vision of sustainability.

Overall, the results of this exercise suggest that there is little room for complacency in any region. The R-ISEWs are all much lower than GVA in absolute terms and during the last few years the absolute gap between GVA and R-ISEW has tended to widen. Sensitivity analyses reveal that on less optimistic assumptions, this gap could be wider still. A robust effort to tackle income inequality, climate change and resource depletion will be necessary if the long-term vision of sustainable economic well-being is to be achieved across the English Regions.

# 1. Introduction

> *'Government Offices aim to use their policies, programmes and influence to enable their regions and localities to become better communities in which to live through the effective alignment of national, regional and local priorities.'*[2]

There is a growing impetus behind the search for better ways of measuring 'progress' than simple economic indicators based on market transactions: in the twenty-first century we know that 'it's not *just* the economy, stupid.' Over the last few decades, industrialised countries have achieved unprecedented levels of prosperity and material comfort, and are now taking stock of what all this wealth actually means, and how it is related to underlying goals of personal and societal welfare. And, over the same period, we have also developed a keener awareness of how dependent we are on limited resources, of our impact on those resources, and that we need real structural change if we are to make those resources last for more than the next generation or two.

We know that we need to develop 'sustainably', that we need to take urgent action in relation to climate change and pollution, that 'hyper-consumption' is not consistently delivering personal happiness and may even be undermining social cohesion and community. But where do we start to address these issues? How do we prioritise these and other factors? What are the trade-offs between economic, environmental and social goals and how do we weight them? How do we achieve 'effective alignment of national, regional and local priorities' as the Government Offices aim to do, when these priorities overlap, compete and are measured on incompatible axes?

The first step has to be to know what we are dealing with. When the issues of interest and importance are so diverse, we need to establish a common and commensurable basis for quantifying impacts. The R-ISEW is an adjusted economic indicator which attempts to monetarise costs and benefits which are not traditionally measured in monetary terms. It brings together a wide range of economic, social and environmental issues into one analytic framework to allow fair comparisons between them.

In recognition of the challenges of measuring progress, emda commissioned a 'think-piece' from **nef** in late 2004 on the relationship between quality of life, well-being and regional development.[3] The report identified a number of different concepts of well-being that might guide regional development and also suggested a number of different approaches to the task of measuring regional progress in well-being.

Following discussions stimulated by that document, emda asked **nef** to develop a pilot R-ISEW for the East Midlands. The objective was to develop an 'adjusted' measure of economic progress at the regional level, based substantially on attempts to develop similar indicators at the national level in the UK and elsewhere. The R-

ISEW was incorporated into the targeting and reporting structure of emda's Regional Economic Strategy, and has since been applied in several other cases: the English regions of the South East and Yorkshire and the Humber, Scotland, and as far afield as Lombardy in Italy.[4]

Now for the first time, the R-ISEW is being calculated simultaneously for all the English regions, which will enable regions to identify their relative strengths and weaknesses in securing sustainable economic well-being for their communities, and perhaps use this information to share successful strategies, or coordinate policy. The resources devoted to this larger project, and the economies of scale gained by researching and calculating all the regions together, have allowed us to review and improve the methodology underpinning the results.

In Section 2 of this report, we summarise the theoretical issues involved in measuring well-being and briefly outline Daly & Cobb's ISEW and other 'alternative' indicators of progress. Section 3 presents the results of the R-ISEW component by component, setting out the key adjustments and describing the quantitative results and trends over the period between 1994 and 2005. Section 4 explores inter-regional differences, and concluding remarks can be found in Section 5.

Technical appendices provide further theoretical background, numerical results, methodology, and a sensitivity analysis. Appendix 1 provides further detail on the range of alternative indicators that have been considered, focussing on the historical development of the ISEW. A summary of the R-ISEW in each region is given in Appendix 2; Appendix 3 describes key changes to the methodology made in this updated model of the R-ISEW; Appendix 4 gives a detailed description of the data sources and methodology for each component; and Appendix 5 presents an analysis of the impact of some key sensitivities.

# 2. Measuring well-being

## 2.1 The Problem with GDP

Rising GDP traditionally symbolises a thriving economy, more spending power, increased family security, greater choice, richer and fuller lives, more public spending and better public services. As a measure of progress, the GDP appears initially to have much to recommend it. At the regional level in the UK, this function has in recent years been taken over by GVA, a proxy for GDP at the regional level.

There are, however, a number of reasons to view with caution the simplistic equation of national or regional income with well-being. Numerous authors have pointed to the (sometimes rising) social and environmental costs associated with rising economic output.[5] Others have pointed to the potential divergence between material gains and psychological or social well-being.[6] At the very least, it is clear that there are a number of factors – such as physical and mental health, family security, environmental quality and social cohesion – which contribute to well-being, but which are not captured by conventional measures of economic output at all.[7]

None of this has gone entirely unnoticed over the years, even by the original proponents of the GDP. The economist Simon Kuznets – one of the architects of the system of national accounts – declared that 'the welfare of a nation can scarcely be inferred from a measurement of the national income.' Robert Kennedy famously described Gross National Product with the following:

> *'Gross National Product counts air pollution and cigarette advertising, and ambulances to clear our highways of carnage. It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder in chaotic sprawl. . . . Yet the gross national product does not allow for the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to our country. It measures everything, in short, except that which makes life worthwhile.'*
>
> Robert Kennedy, March 1968

The 1993 revision of the System of National Accounts (SNA) declared categorically that 'neither gross nor net domestic product is a measure of welfare'.[8] In November 2007, the European Parliament hosted a conference entitled *Beyond GDP*, which set out to explore alternative approaches to measuring well-being.[9] At this conference, José Manuel Barroso, the President of the European Commission, declared:

> *'It is not enough for us to talk about the different global challenges, as energy, climate change, health, security and the environment. We need widely accepted communication tools that show progress in these fields. And that progress can only be measured with suitable indicators. So it's time to go beyond the tools developed for the very different world of the 1930s. (…) It's time to go beyond GDP.'*[10]

Similarly, Angela Merkel, the Chancellor of Germany, has stated:

> *'Business as usual is not an option. We do not need more and more resources and energy for a good life.'*[11]

It is even possible to find criticism of the growth project in the nineteenth-century writings of John Stuart Mill – one of the principal architects of classical economics.[12]

Concern over using GDP (or its regional proxy) as a measure of social well-being confronts national and regional policy-makers with one fundamental question: how exactly are we to assess our progress towards an improved quality of life? In terms specific to the vision of the English Regions, how are we to measure progress towards the goal of 'better communities in which to live'?

## 2.2 Alternative measures

'Alternative' measurements of well-being have generally followed one of four quite distinct approaches in attempting to answer this question.

The first of these has been to develop extended indicator sets, measuring a wide variety of 'objective' physical or socio-economic factors which are deemed to contribute to or detract from personal or collective well-being. For example, the most recent SNA includes a detailed system of Integrated Economic and Environmental Accounting (SEEA 2003) which brings together economic and environmental information in a combined framework.[13] In the UK, the Department of Environment, Food and Rural Affairs (Defra) has brought together the Sustainable Development Indicator set, which includes measures of pollution, consumption, objective well-being (e.g. poverty levels, and life expectancy), and, as of 2007, subjective well-being.[14] Meanwhile, in 2009 the Audit Commission, based on work by the Young Foundation and **nef**, will be advising local authorities across the UK on how to bring together data from the new 198 national indicators to form a coherent picture of well-being.

The disadvantage of these approaches, however, is their unwieldiness. How can large sets of indicators be brought together meaningfully? There is no framework for weighing up the inevitable trade-offs between different indicators. How can we make balanced assessment of 'overall progress' on the basis of these data?

The remaining three approaches all attempt to provide a framework for doing just this. They may be based on sets of individual indicators, which can be assessed separately. However, they make the bold step of trying to combine the indicators to provide headline indicators of some form.

Standard composite indicators typically use atheoretical methodologies for bringing together a set of well-being indicators into a single index. Perhaps the best known example of this is the United Nations Development Programme's Human

Development Index (HDI).[15,16] The HDI is composed of three elements: GDP per capita, life expectancy at birth, and education levels, assessed in terms of literacy and school enrolment rates.[17] The three elements are normalised and brought together so that the overall HDI represents an average of performance on each one. Reported annually for 177 countries, the HDI has been very successful in raising the level of debate about the relationship between income growth and well-being. Other measures are more complex. For example, the Italian Regional Quality of Development Index (QUARS) brings together 45 variables in 7 domains.[18]

A more radical approach has been to recognise the problems in attempting to quantify the relative importance of different environmental, economic and social factors in determining well-being, and focus instead on attempting to measure well-being itself, through self-report. The most direct approach is to ask a single question on happiness or 'life satisfaction'. For example, Defra's headline indicator for well-being is a single question:

> *'All things considered, how satisfied are you with your life as a whole nowadays?'*[19]

On its own, however, a single question such as this has little use for policy-makers. Obviously, no single figure can offer fine-grained information or recommend specific policies. There is no immediately apparent 'theory of change' at hand when low levels of life satisfaction are found. Secondly, whilst life satisfaction does appear to correlate with interesting measures at the individual level, there is evidence that it lacks sensitivity when taken at the aggregate national level.[20,21,22] In other words, we may find that overall life satisfaction does not respond to policy changes in a useful manner. Given these problems, **nef** has begun exploring more textured measures of subjective well-being. For example, the Caerphilly Sustainability Index survey has recently been developed, which includes questions on not just hedonic well-being, but also the Aristotelian concept of *eudaimonic*[23] well-being. Meanwhile the European Foundation for the Improvement of Living and Working Conditions runs a European Quality of Life Survey which brings together data to explore levels of 'deficit' across Europe. Four types of deficit are considered – having deficits, loving deficits, being deficits and time deficits.[24] Both these approaches have the potential to provide policy-makers with more textured information on well-being. As with objective indicators, however, the problem of aggregation remains – for example does reducing 'having deficits' justify an increase in 'loving deficits'?

The fourth approach which we shall consider here attempts to deal with aggregation issues by converting all components into a single unit – currency. By converting social and environmental costs and benefits into a common unit, this approach allows trade-offs to be calculated transparently, and in a format that policy makers and economists are already familiar with.

## 2.3 The Index of Sustainable Economic Welfare (ISEW)

The ISEW, is the best-known example of this approach. It starts from the premise that consumer expenditure is, all things being equal, an acceptable proxy for economic welfare. However, it incorporates several adjustments that attempt to deal with the criticisms faced by GDP and standard economic measures. The original ISEW developed by Daly & Cobb (1989)[25] follows the following algorithm:

- First, total personal consumption is adjusted to account for the reductions in welfare associated with inequalities in the distribution of incomes.[26]

- Secondly, an account is made of the non-monetarised contributions to welfare from services provided by household labour.[27]
- Thirdly, account is taken of the environmental costs arising from the annual emission of certain types of air and water pollution and noise pollution.
- Fourthly, account is taken of certain ‘defensive’ expenditures: specifically private expenditures on health, education, commuting and car accidents are subtracted from the account, and government expenditures are included in the index only to the extent that they are regarded as *non*-defensive.[28]
- Next, the index makes several adjustments to account for changes in the sustainability of the capital base. Specifically, it includes a ‘net capital growth’ adjustment to account for changes in the stock of human-made capital.[29] It also includes the net transactions in overseas assets and liabilities in order to provide an indication of the robustness (and sustainability) of the economy in international terms.[30]
- In addition, the index attempts to account for the difference between annual *expenditure* on consumer durables and the *services* flowing in each year from the stock of those goods.
- Finally, the index attempts to account for the depreciation of natural capital as a result of the depletion of natural resources, the loss of habitats and the accumulation of environmental damage from economic activity.

Taken together the adjustments which comprise the Daly and Cobb ISEW can be expressed in the following equation:[31]

**ISEW = Personal consumer expenditure**
**- adjustment for income inequality**
**+ public expenditures (deemed non-defensive)**
**+ value of domestic labour**
**+ economic adjustments**
**- defensive private expenditures**
**- costs of environmental degradation**
**- depreciation of natural capital.**

The results of applying this methodology to the United States revealed a trend in sustainable economic welfare which differed markedly from the trend in GDP over the period examined (1950–1990). While GDP in the United States increased substantially over the period, the ISEW began to level out, and even decline slightly from about the mid-1970s onwards (Figure 4).

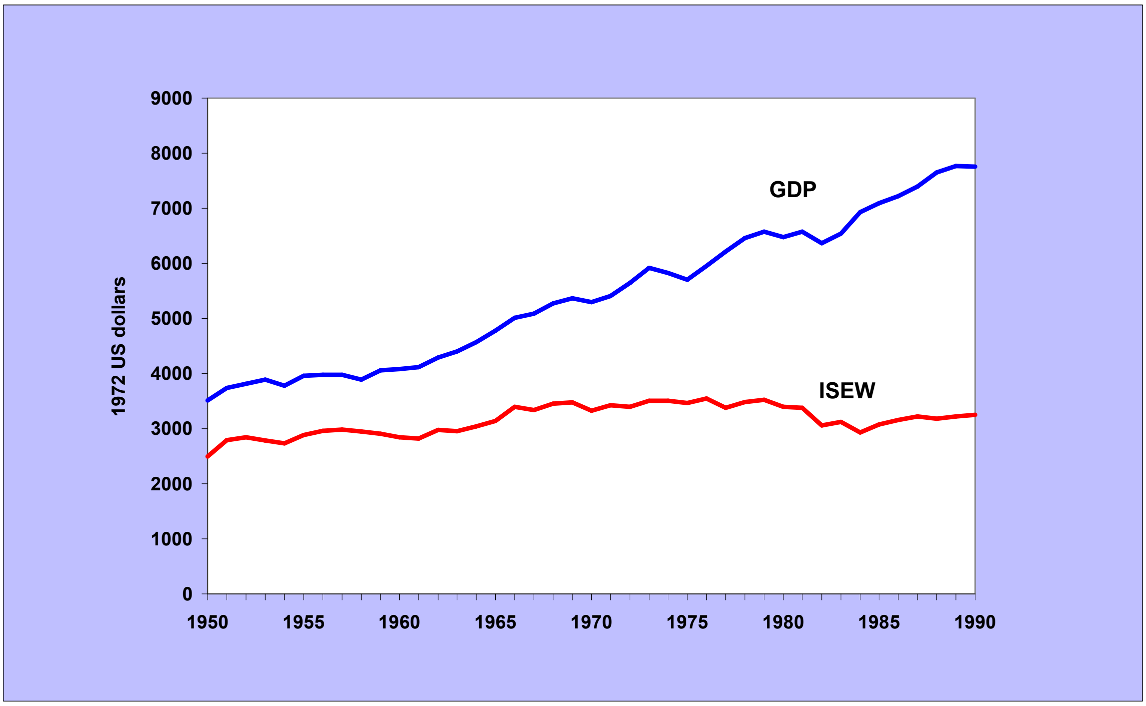



**Figure 4: US Index of Sustainable Economic Welfare (ISEW) 1950–1990.**[32]

In 2004, **nef** published an updated ISEW variant for the UK, re-branded as a *Measure of Domestic Progress – MDP*[33,34] (Figure 5). The results followed a similar pattern, with the ISEW remaining relatively static over a 50-year period.

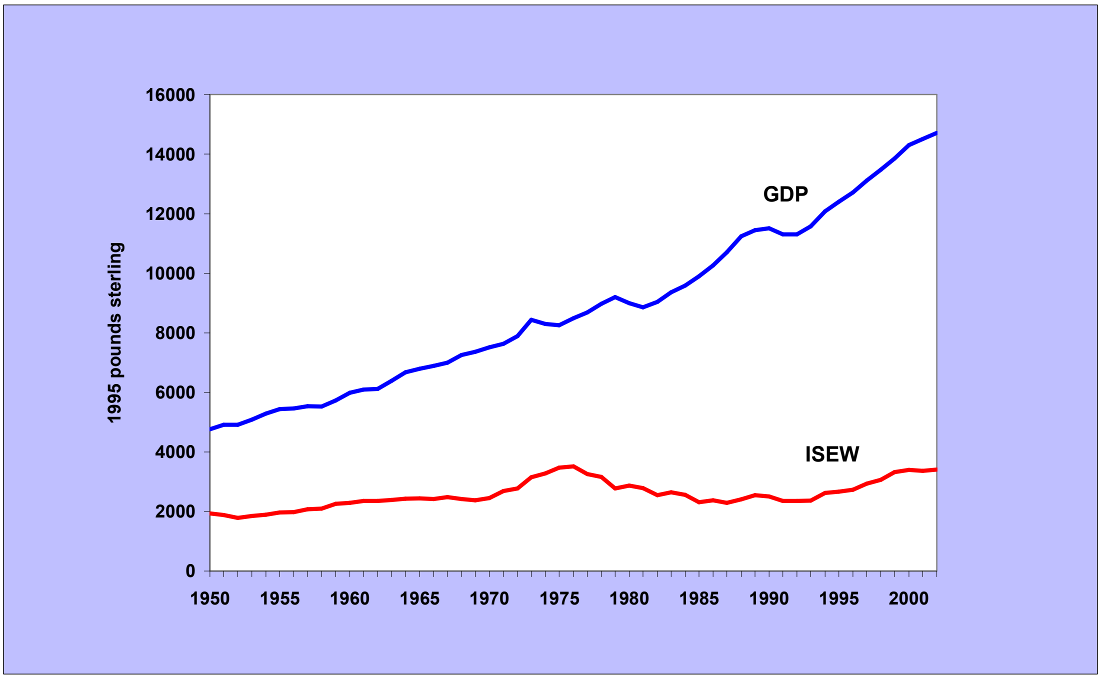



**Figure 5: MDP and GDP per capita in the UK 1950–2002.**

ISEWs (and Genuine Progress Indicators – which follow the same approach) have been calculated for several other rich OECD nations now, including Australia,[35] Austria,[36] Belgium,[37] Germany,[38] Italy,[39] the Netherlands[40] and Sweden.[41] The ISEW for Chile appears to be the first case of the methodology being taken outside this group,[42] and an ISEW for Thailand has also been estimated.[43]

For further reviews of ISEWs across the world see Niccolucci et al. (2006) and Pulselli et al. (2008).[44,45] Also see Lawn (2003) for a theoretical exploration of the ISEW.[46]

## 2.4 Regionalisation

Several isolated examples of sub-national ISEWs have been calculated, including for Alberta, Canada,[47] parts of Vermont State in the USA,[48] the Province of Siena in Italy,[49] and, most recently, four cities in China.[50] Often, these have had to rely heavily on approximate scaling-down from national datasets due to the difficulties in sourcing suitable regional data.

In the UK, ISEWs have also been calculated for Wales and Scotland.[51,52] It is, however, the establishment of the Government Offices for the English Regions, along with RDAs and Regional Observatories, that has really spurred a rapid improvement in the quantity and quality of regional data available. While it is still not possible to construct regional ISEWs (R-ISEWs) which stretch back to much before the mid-1990s, we can now produce quite robust R-ISEWs for the last decade or so. The first work in this field was carried out by **nef** for emda in 2006,[53] and the methodology has since been applied to four other English regions, as well as taking it back to country-level for Scotland.[54] All of these indices used a new approach to the costs of climate change which attempts to strike a balance between the two methods generally used (and bitterly debated). Wales also saw a new ISEW in 2007, though this did not adopt the **nef** model in its entirety.[55]

This report takes the **nef** R-ISEW model and updates it slightly to accommodate some of the shifts in the landscape of regional data availability, as well as criticisms of and suggested improvements in methodology. For instance, it incorporates some new factors, such as the cost of industrial accidents and pollution abatement costs (in addition to the environmental costs previously counted); and drops the less robust 'personal pollution control' costs. It also refines the calculations of several factors, such as noise pollution, commuting, resource depletion and climate change.

The overall effect on the index is not huge; rather these changes represent a consolidation of R-ISEW theory and practice. In calculating an R-ISEW for all the English regions on exactly the same basis, this work allows like-for-like comparison between regions for the first time. It is hoped that this will help pave the way for wider acceptance and uptake of a standardised R-ISEW model across the UK and beyond.[56]

# 3. The English R-ISEW – by component

The idea behind adjusted measures of economic well-being is to start from an account of economic consumption (as for GDP). This basis is then adjusted to incorporate various economic, social or environmental factors which are not included in the conventional measure. In the following sections we discuss key findings and trends over time in each of the component factors of the English Regions R-ISEW, as calculated for the period 1994–2005.

A full discussion of all the results for all regions is beyond the scope of this report; instead we present the *range* of results in each component, citing the regions with the highest and lowest figures in each, and the headline results for England as a whole. We also note any interesting results – for example where two regions which are similar in some respects see a large difference in others.  In Section 4 we explore differences between regions in terms of the overall ISEW in further detail.

Regions which have had previous R-ISEWs calculated for them will notice that the results given here are not simply an extension of the previous R-ISEW from 2004 to 2005. This is partly due to methodological changes, but also due to changes in the underlying datasets. Some datasets used in the R-ISEW calculations are subject to annual revisions, and these revisions filter through to many R-ISEW components. A full impact analysis of methodological changes is given in Appendix 3.

In this section, we provide short descriptions of each component – more detailed descriptions are provided in Appendix 4.

## 3.1 Economic factors

The baseline or starting point of the R-ISEW is regional consumer expenditure. This is imperfect as a proxy for well-being for a number of reasons, but it at least provides an indication of the value of goods and services consumed and is therefore a reasonable estimate of the 'standard of living' during the period. From this basis, the R-ISEW makes several economic adjustments to account for factors which are vital to the long-term sustainability of the regional economy.

### *Consumer expenditure*

*Household final consumption expenditure. National figures from the ONS Blue Book, which is based primarily on information from retailers.  Regional figures derived using data from the Expenditure and Food Survey.*

Regional consumer expenditure across the regions grew by an average of 38% in real terms over the period 1994–2005, from £470 billion in 1994 (total expenditure in all regions) to £650 billion in 2005, while GVA increased by an average of 34% from

£668 billion to £913 billion. As might be expected, there is considerable disparity between the regions: consumer expenditure per capita in the North East was £8,186 in 1994, compared to £11,172 in London. In 2005, the North East figure was up 31% to £10,755. London's increased by 24% to £13,864, but was overtaken by the South East's growth of 35% to £14,791. The East of England, meanwhile, added a full 50% to baseline expenditure, growing from £9,145 to £13,749. Interestingly, this surge in the East is not matched by a corresponding increase in GVA: this grew only 28% from £14,788 per capita to £18,931.

### *Net capital growth*

*Growth in capital stocks net of labour force growth.*

The net effect of this adjustment can vary substantially, depending on the balance between capital investment and workforce growth in the region. Overall, England saw a 57% rise in net capital growth from £8.5 billion in 1994 to £13.3 billion in 2005. This was driven by large rises in some regions such as Yorkshire and the Humber (up £3.6 billion to £6.2 billion in 2005), and the North West (up £2.5 billion to £4.5 billion). The South West also turned a £1.2 billion deficit into a modest surplus of £493 million by 2005. These gains were offset by large decreases in other regions, notably London (down £3.3 billion to minus £5 billion) and the North East (down £1.3 billion to minus £1.5 billion).

Note that a negative figure here does not *necessarily* mean a net loss of capital stocks, but that the growth in stocks did not keep pace with the growth in the workforce (see Appendix 3 for details of this component of the methodology). In both the cases above however, net capital expenditure *did* fall over the period, at the same time as the workforce increased.

### *Net international position*

*For a nation, this is the balance of payments, adding exports and income, subtracting imports, and adjusting for current account transfers.  Regional estimates determined using a combination of regional trade data, consumer expenditure on services, and GVA.*

The overall balance of payments for England improved by around 18% from a deficit of £37.8 billion in 1994 to £31.1 billion in 2005. But as with capital growth, this modest change masks strong regional variations: London reduced its £22.2-billion deficit in 1994 to just £2.7 billion by 2005, while the West Midlands went from a £2.4 billion surplus into a deficit of £2.3 billion over the same period. The East of England and the South East started the period in the red, and both saw their deficits grow further (by £5.9 billion and £5.1 billion respectively). Meanwhile, the East Midlands started with a small deficit and went into a healthy £3.3 billion surplus. The North West, leading the table in 1994 with a £3.5-billion surplus, had lost almost £2 billion of this by 2005.

### *Adjustment for consumer durables*

*The baseline consumer expenditure figures include all expenditure on consumer durables; in welfare-theoretic terms this has been criticised for failing to treat durables as household capital. The purchase of durable goods such as washing machines provides a household with a flow of valuable services for some years. To* *adjust for this, we estimate the difference between expenditure on and the service flow from consumer durables, accounting for depreciation and obsolescence.*

No rigorous accounts of the stock of consumer durables exist for the UK, and such estimates of both stock and service flow which do exist have not been updated for some years now. We have used a generally accepted method to estimate stocks and flows from the annual expenditure on consumer durables. This turns out to be a net negative adjustment to the index which varies between 1.2% and 3.6% of total consumer expenditure over the period.

As this component is driven by consumer expenditure on durables over the period, one would expect it to follow trends in consumer expenditure as a whole. Indeed, this is largely what we see: the North East and Yorkshire have the smallest adjustments here, while London and the South East see larger ones; and the East of England shows a sharp increase in the adjustment from minus £613 millio in 1994 to minus £2.2 billion in 2005. Deviations from the consumer expenditure trends would represent a shift in purchasing patterns between durables and non-durables. This happens to some extent in the North West and in London, where spending on durables as a proportion of all spending has increased; and in the East Midlands, where this proportion has fallen over the period.

### *Effect of economic adjustments*

It is now possible to calculate the impact of all three of the ‘economic’ adjustments to the base indicator of consumer expenditure. The result is shown in Figure 6 on a per capita basis to allow meaningful comparison between regions and against the English average.

At this stage of construction – before social and environmental factors are accounted for – the indicator shows the South West enjoying the strongest performance in 2005, and the West Midlands suffering the weakest performance.

The net impact on England as a whole is a fairly consistent reduction of around 5–7% of the baseline consumer expenditure, but as the preceding sections will have made clear, the distribution across regions and over time is far from uniform. In some regions (North East, North West, Yorkshire and the Humber, and the East Midlands), the net impact is generally positive, pushing the adjusted indicator above consumer expenditure at this stage of construction. Over time, the size of the adjustment in these regions varies: the North East's £1,023 per capita increase is whittled down to just £35 by 2005, whereas Yorkshire and the Humber turns a small negative adjustment of £97 into a positive £742.

In most other regions, the net impact is generally negative, except for the West Midlands, where the adjustment shifts from a £400 boost in 1994 to a £720 decrease in 2005. The South East keeps a fairly constant adjustment of minus 16–19% (around £2,000–£2,500); London reduces the net impact from minus £2,812 to just under £1,359 over the period; while the East of England's reduction of £930 per capita is increased to £2,130.

Although there is no reason why this should necessarily be so, it is interesting to note that after these adjustments, the regional disparities across England are reduced from around 30% of average consumer expenditure[57] to around 20% of the mean adjusted index, in per capita terms.

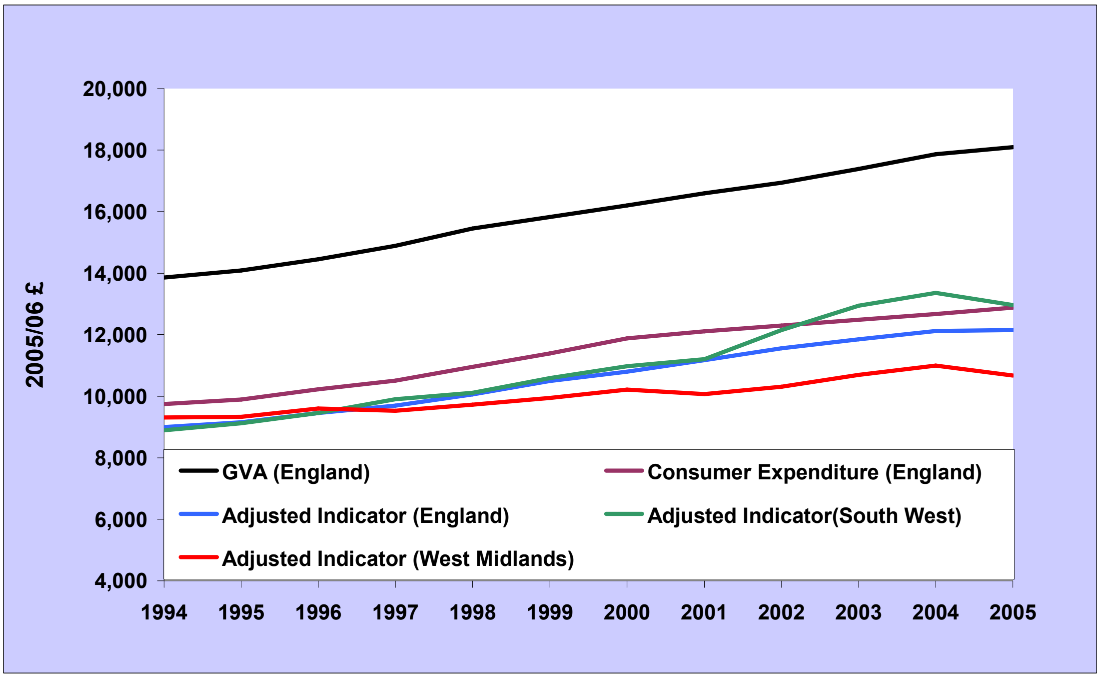



**Figure 6: Economic adjustments on consumer expenditure per capita.**

## 3.2 Social factors

In line with previous measures, the English Regions R-ISEW incorporates several adjustments to account for social aspects of the economy which are vital to sustainability, but which would normally be excluded from conventional economic accounts. Two of these adjustments are positive ones. The first positive adjustment accounts for the services to the economy provided by unpaid labour from households and volunteers. The second accounts for public expenditures on health and education. We then account for some social costs: crime, divorce, commuting and accidents on the road and in the workplace.

### *Services from domestic labour and volunteering*

*Value of total time spent on domestic labour and volunteering, based on Time Use Survey data, and valuing a unit of time equally across regions.*

The usual way of approaching this is to account for the time spent in different unpaid or voluntary activities and multiply this by a shadow wage rate, based either on the domestic wage rate or on some other appropriate proxy. The results of this exercise, using regional time use data and a national UK wage labour rate appropriate to domestic labour, lead to a net positive contribution to the index which ranges between £8.5 billion (North East, 2005) and £34.8 billion (South East, 1994).

Regional differences in these headline figures are due more to population sizes than behavioural differences: there is only around 15% variation between regions in the amount of time people spend on household chores and volunteering. For all regions there is a falling trend over the period of the study because people tend to spend less time in domestic labour (and as volunteers) today than they did even a decade ago.

### *Public expenditure on health and education*

*All public expenditure on health and education included (defensive health spending due to crime, car accidents and pollution subtracted elsewhere)*

The result of including public expenditures on health and education in the R-ISEW is to enhance both the absolute magnitude and the trend over time in the index. In this calculation we include *all* expenditures on education, rather than only tertiary education as in previous versions of the R-ISEW. The original Daly & Cobb ISEW deemed 50% of education expenditure as 'defensive'; and until now we followed a similar approach by considering primary and secondary education expenditures as defensive, and only tertiary as a positive addition to welfare. Both are somewhat arbitrary deductions which have faced criticism in the past.

Public expenditures on health and education increased by an average of 78% between 1994 and 2005 (rising much faster than both GVA and consumer expenditure), and by 2005 represented around 14% of GVA. The increase in spending in absolute terms ranges from £4.8 billion in the North East to £14.5 billion in London, but as a proportion of spending in 1994, the growth was fairly similar in each region. In the East of England it was 61% (£7.7 billion), while the North East and South West both saw growth of 87% (£4.8 billion and £8 billion respectively).

### *The impact of incorporating social benefits*

The overall impact of incorporating positive social benefits (the value of domestic labour and the value of public expenditures on health and education) on top of the economically adjusted expenditure measure is shown in Figure 7. As in the previous chart, this figure shows the adjusted index for England on a per capita basis, together with the regions at the top and bottom of the range of results in 2005.

Not surprisingly, the index is now considerably higher, and for most regions it rises above GVA for the entire period. Only in London, the South East and East of England do these first social adjustments fail to mitigate the large negative economic adjustments in these regions, so the index at this point still lags behind GVA. In 2005, the South West and West Midlands remain in position at the top and bottom ends of the range of results at this stage of construction.

### *Costs of income inequality*

*Determined using the Atkinson Index for each region (calculated from the Family Resources Survey).*

The measure of inequality used for the R-ISEW is the Atkinson Index rather than the more prevalent Gini co-efficient. The Atkinson measure has a strong foundation in welfare economics, and allows for some sensitivity analysis on the parameter $\varepsilon$, which represents society's aversion to inequality. At the most widely cited value of $\varepsilon$ (0.8), the costs associated with income inequality in England over the period vary between £61 billion in 1994 and £87 billion in 2000.

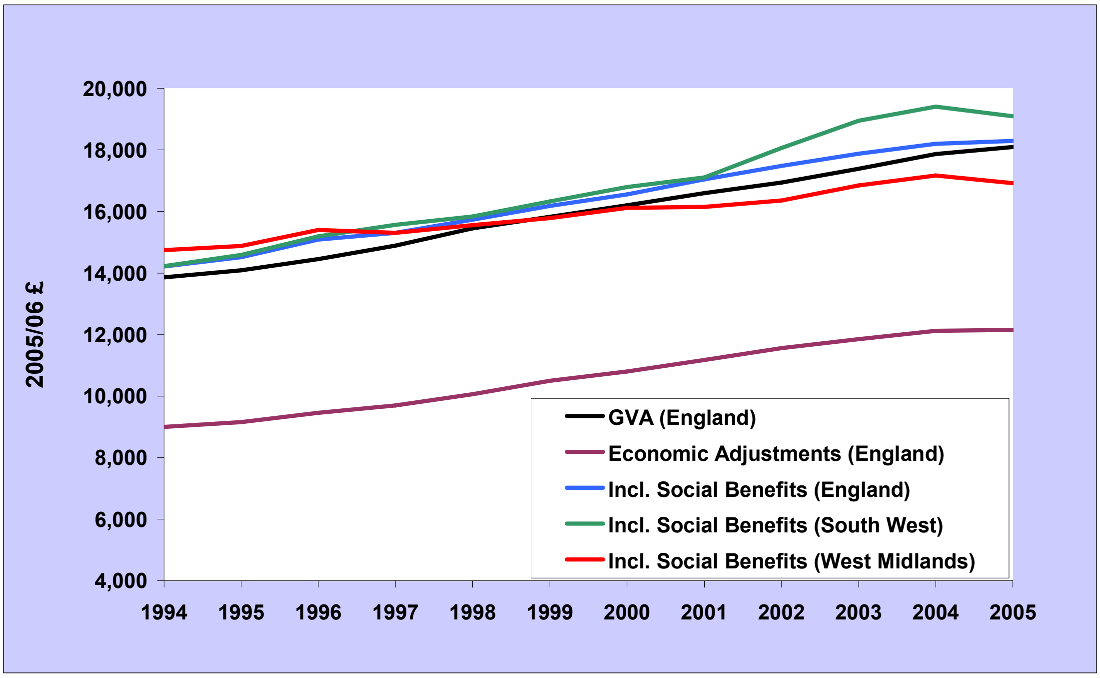



**Figure 7: Combined impact of social benefits and economic adjustments.**

Part of the rise in cost over the period is due to the rise in consumer expenditure, because the monetarised cost of the Atkinson Index results involves a factor adjustment to the baseline consumer expenditure data. But if we look at the value of the Atkinson Index itself we see that the underlying measure of inequality has also risen – in most regions. Exceptions to this rule are the North East and the East Midlands, where the Atkinson Index fell by 23% and 10% respectively. Consequently, while other regions saw an absolute increase in inequality costs of between 33% (North West) and 63% (East of England), rises in these two regions were much less pronounced: the North East saw an increase of just 0.3%, and the East Midlands a modest 15%.

### *Costs of crime*

*Based on Home Office estimates of the social costs (including health costs) of individual crimes in different categories, and incidence rates mostly from the British Crime Survey, with additional data on vehicle crime and homicides from other Government sources. Some defensive expenditure by business is also included.*

Crime is frequently high on the political agenda, but unfortunately this does not render the data on crime (or the interpretation of this data) any less complex or contentious. The data presented here is based on recorded crime, however it is well recognised in the literature that recorded crime may differ from *actual* crime levels for a variety of reasons and reflecting these differences lies outside the scope of the current work.[58]

As might be expected, the costs of crime are higher in regions with large metropolitan areas – London and the North West in particular, and lower in predominantly rural regions such as the North East, East of England and the South West. However, the evolution of costs in each region over time is not so predictable. London and the North West saw the cost of crime fall by 5.9% and 5% per capita respectively, only slightly less than the South West's 7.9%. Per capita costs in the North East fell by a dramatic 20%, as compared to the East of England, where costs *rose* by 16.3%, albeit from a relatively low starting point.

Over the period, regional disparities increased for the first few years. In 1997, the social cost of crime in the East was just £86 per capita, as compared to £199 in London in 2001. The range of costs as a proportion of the mean reached a peak of 82% in 1999, but has since converged to 54% by 2005; in absolute terms this equates to £108 per capita in the East, £179 in London and £135 for the English average. Regional totals range from £540 million in the East Midlands to £1,348 million in London. The divergences were driven largely by uneven changes in the incidence of robbery, common assault, criminal damage and fraud. And while all regions enjoyed substantial reductions in vehicle-related crime, some fared better than others: in the North East and West Midlands it fell by 68% and 67% (totalling £124 million and £263 million respectively), while in London the gain was less than 30% at £110 million.

### *Costs of divorce*

*Costs of divorce include defensive costs (identified in surveys commissioned by an insurance company) and the costs of increased risk of mortality for divorcees.*

Divorce imposes a variety of structural, legal and health-related costs on society, but accounting for these is a contentious issue where cost estimates may be subject to value-driven distortions. The R-ISEW has attempted to adopt a relatively conservative estimate of the social costs of divorce based on information from the insurance industry, and increased mortality costs.

The costs of divorce in make a modest contribution to the overall R-ISEW, ranging from £430 million in the North East (in 2000) to £1.5 billion in the South East (in 2002). Over the period of the study, most regions saw costs fall as fewer marriages dissolved, while the West Midlands saw an increase of 11.8%.[59] The largest reduction in the costs of divorce was in London, down 18.6% from £188 per capita in 1994 to £153 in 2005; Yorkshire and the Humber on the other hand started the period at a very similar £189, but fell only 8.8% to £173 per capita.

### *Costs of commuting and car accidents*

*The costs of commuting include the loss of leisure time through time spent commuting, and the direct spending costs of motoring and use of public transport. The costs of car accidents include the costs of damage to vehicles and property and the costs of ill-health and fatality. All data, including unit costs for commuting time, come from the Department for Transport.*

Our continued dependence on a ‘car culture’ is not without its price. As people drive longer distances, the associated social costs from commuting and car accidents have until recently tended to rise nationally.

Over the period from 1994 to 2005, the costs of commuting in England rose by 23.6% from £28 billion to £35 billion, as people travel longer distances to get to work. This was particularly true across the South and East of the country (including the East Midlands) where costs rose by 35–40%. In the North and West they rose more slowly: by less than 15% in the North East, 21% in the West Midlands, and up to 32% in the North West. Costs in London were much higher in absolute terms (almost £1000 per capita in 1994, compared to the range of £440–580 elsewhere), but actually dropped over the period while costs everywhere else rose. By 2005, per capita commuting costs in the North East were still only £509, but most regions were in the mid-£600s, and London had fallen to £862.

By contrast, however, the costs associated with car accidents have fallen across the board, from £14.8 billion in 1994 to £11.2 billion in 2005, as road safety measures have begun to have an impact on the number and severity of road casualties. London again performs well from a poor baseline on this factor, reducing its per capita costs by over 47% from £372 in 1994 to £196 in 2005. Other regions also tended to experience reductions reflecting their starting costs in 1994, as compared to the English average at that time. So the East of England and the East and West Midlands, which all had relatively high per capita costs in 1994, all enjoyed relatively large reductions to 2005; whereas the relatively accident-free North East and South West saw costs fall by a smaller proportion.

### *Costs of industrial accidents*

*Based on estimates of the UK-wide costs of industrial accidents, and regional incidence rates from the Health and Safety Executive.*

Following feedback from some regions that had an R-ISEW calculated previously, we now incorporate the costs of industrial accidents into the R-ISEW for the first time, following the logic that – like car accidents – these represent defensive expenditures, the social externalities of industrial growth. It appears to be a worthwhile addition, because this factor provides some very clear evidence of regional disparities. Total costs range from around £700 million in the East and North East, to just over £3 billion in the South East.

In per capita terms, Yorkshire and the Humber and the South East have significantly and consistently higher per capita costs than elsewhere (£397 and £364 respectively in 1994, rising to £405 and £384 in 2005). The East of England has the lowest per capita costs (£141 in 1994, falling yet further to £133 in 2005); while the South West and North West both saw a large increase in per capita costs (23.3% and 29.2% respectively).

The scope of this report only allows for a limited analysis of the Health and Safety Executive data used to calculate these costs, but this yields no clear explanation for the disparities. There are no apparent structural reasons such as the proportion of regional population employed in particular sectors. This may be an area which merits more detailed investigation into the underlying data.

### *The combined impact of social and economic factors*

Taking economic adjustments to consumer expenditure into account, incorporating social benefits and subtracting social costs, we can now see the impact of all these factors on the adjusted measure. This is shown in Figure 8, where the adjusted indicator is again shown on a per capita basis. Rising inequality and crime in the East of England have conspired to displace Yorkshire and the Humber as the worst-performing region at this stage of the index's construction.

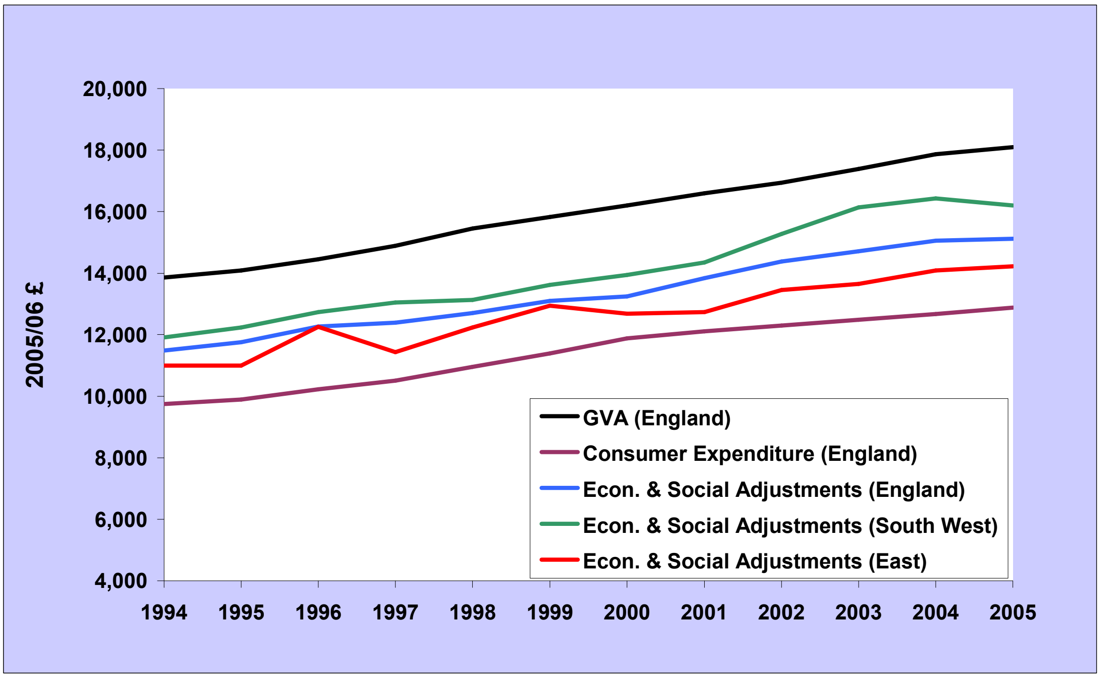



**Figure 8: Economic and social adjustments to consumer expenditure.**

Note that after making both economic and social adjustments the index remains higher than consumer expenditure. However, even the South West – the best-performing region at this stage of the index's construction – remains below GVA throughout, despite all the positive adjustments made thus far, and despite not yet taking any account of environmental adjustments. These will depress the index further still, as we will see in the next section.

## 3.3 Environmental factors

Several different kinds of environmental costs are worthy of consideration, even though some of these may be in the process of becoming less important to the economy. These costs include the costs associated with 'local' environmental pollutants (air pollution, water pollution etc.), the implicit costs in losses of agricultural land and natural habitats, the accumulated long-term costs associated with climate change, and the depletion of finite (non-renewable) resources, in particular of fossil energy resources. We discuss each of these adjustments in the following sections.

### *'Local' environmental pollution*

Conventional 'local' air and water pollutants such as sulphur dioxide, nitrogen oxides, chemical oxygen demand and so on have been the focus for environmental policy initiatives for several decades now. In the English Regions R-ISEW, we have accounted for four specific kinds of pollution costs under this category:

1. costs of local and regional air pollution (including sulphur dioxide, nitrogen oxides, carbon monoxide, particulates and volatile organic compounds).[60]
2. of water pollution (based on river quality measures and river quality targets);
3. costs of pollution abatement; and
4. costs of noise pollution (based on estimates of road traffic noise).

Some previous ISEWs also include an estimate of 'personal pollution control' costs – defensive costs by individuals against localised pollution, for instance water filters, cycle masks or soundproofing dwellings against external noise. Reliable data is hard to come by at the regional level, and as our best estimates for this were relatively small anyway, we have decided to omit it from this and subsequent calculations.

The first two categories measure the environmental impact of local water and air pollution – that is, the costs associated with levels of pollution actually recorded in the environment. The third category accounts for the abatement costs to industry – that is, expenditure at and before the point where emissions reach the smokestack or waste pipe. We include these costs because they are passed on to the consumer in higher prices, and are thus cashed out as a 'benefit' in the consumer expenditure data used as the R-ISEW baseline. They are, however, clearly *defensive* costs which cannot be said to positively contribute to welfare, and should therefore be deducted.

Taken together, the overall trend over time in the category of local pollution is a declining one. Although noise pollution costs are on the rise, the others are falling, and this category is dominated by the trends in air pollution, as we will see in more detail below. The estimated cost of local environmental pollution across all English regions has fallen from £49 billion in 1994 to less than £23 billion by 2005.

Again following trends in air pollution costs, we see that power-producing regions, such as the East Midlands and Yorkshire and the Humber, have the highest overall costs in this category – and the highest reductions over the period of the study, in both absolute and proportional terms. Regions with little energy generation or heavy manufacturing see lower costs and lower reductions: London and the South West, for example.

### Water pollution

*The cost associated with having rivers of low chemical and biological quality, as estimated by Defra. Levels of water quality for each region reported by the Environment Agency.*

Water pollution costs are relatively small by comparison with other costs, and in fact have generally fallen over the period as a result of initiatives to protect river quality – the total cost for all English regions was £436 million in 1994, falling 24% to £331 million by 2005. Note, though, that in recent years there has been a small upturn in some regions, notably the East of England and the West Midlands. Regional costs of water pollution range from around £8 million in the North East to £50 million in the South East.

Regions which have had an R-ISEW calculated previously should note that this component now *excludes* the costs associated with abating water pollution, as these have been moved into a separate component, together with air pollution abatement.

### Air pollution

*The costs of damage to health and property of local air pollution, estimated from various academic papers. Levels of air pollution for each region gathered from the National Air Emissions Inventory.*

The biggest single component contributing to local pollution is air pollution, although thankfully these costs have come down a great deal over the period of the study. In 1994, the cost of air pollution in England was £41 billion. Since then, costs have declined significantly as a result of EU and UK legislation on sulphur and nitrogen oxides, and increasingly stringent local air quality regulations. As a result, the costs of air pollution fell by over 60% during the period and by 2005 were just over £15 billion.

This reduction in air pollution costs has occurred across the country, but has a much greater impact in some regions, particularly power-producing regions, such as the East Midlands and Yorkshire and the Humber, because of the emissions associated with energy production. Such regions are hit very hard by this component of the R-ISEW in earlier years (the costs are £7.2 billion and £7.6 billion respectively for 1994), but also benefit most over the period of the study from reductions enforced at the smokestack.

In 2005, total costs are just £2.3 billion in the East Midlands and £2.6 billion in Yorkshire and the Humber (reductions of £4.8 billion and £5 billion respectively). It is no coincidence that these two regions experience some of the fastest growth in the overall R-ISEW. By contrast, London has little energy generation or heavy manufacturing, and also has the lowest absolute (and per capita) air pollution costs: just over £2 billion (£293 per capita) in 1994, falling to £900 million (£123 per capita) by 2005.

### *Pollution abatement*

*Current expenditure and annuitised capital expenditure per employee on pollution abatement by sector from Defra.  Labour Force Survey used to determine number of employees in each sector for each region.*

Pollution abatement costs are, of course, closely related to the prevalence of power generation and heavy industry. The distribution of costs is therefore not very surprising: low in London and the mainly rural South West, North East and East of England; higher across the Midlands, the North West, Yorkshire and the Humber and the South East. Costs in London are just £199 million in 2005 (£27 per capita); compared to £540 million in the North West in the same year. Interestingly, the North East has low absolute costs (£234 million in 2005), but the highest per capita costs (£92 in 2005).

The North West has particularly high costs (£708 million in 1994, falling to £540 million in 2005) compared to regions with similar sized manufacturing sectors: the West Midlands and South East have almost as many manufacturing jobs as the North West, but noticeably lower abatement costs (£599 million and £586 million respectively in 1994, and £402 million and £463 million in 2005). Without a more thorough investigation which is beyond the scope of this study, we can only presume the variation is due to the specific mix of industry active in each region and the resulting polluting load.

### *Noise pollution*

*Based on three estimates of the costs of road traffic noise pollution in the UK, and regional data from the Department for Transport.  Aviation noise is costed similarly, with the regional distribution of flights sourced from the Civil Aviation Authority.*

In addition to noise pollution from road traffic, which was accounted for in previous ISEWs, we now also incorporate an estimate of noise pollution from air travel. The addition is relatively small compared to road noise, as flight noise is highly localised; nevertheless, we believe it is worth including as this is a high-growth sector. In total, the costs associated with noise pollution for the whole of England are £3.2 billion in 1994, rising to £3.8 billion in 2005. Costs for individual regions range from £148 million in the North East (1994) to £737 million in the South East (2005).

### *Loss of farmlands and natural habitats*

*The value of natural habitats estimated based on a willingness-to-pay model using data from the RSPB. The value of farmland and costs of soil erosion sourced from earlier studies (see Appendix 4). Rates of farmland and natural habitat loss (or gain) from the Countryside Survey and the Defra June Agricultural Census.*

In the R-ISEW, these factors – particularly the loss of farmland – represent a modest adjustment to the overall index. Most regions, however, continue to lose farmland and natural habitats. As non-urbanised land becomes scarcer, so the unit value may well increase, which would push up these costs in future. Note that in this calculation, we look specifically at wetlands, so that the growth of managed forest for timber does not offset the loss of more biologically diverse habitats.

Total costs of habitat loss for England rose by about £100 million from £2.2 billion to £2.3 billion over the period of the study. The range within regions is from a mere £7 million in London (which of course has little in the way of wetlands to lose in the first place) to £605 million in the North West (both figures from 2005). Farmland loss in 1994 cost around £650 million across England; this figure fell slightly to £630 million by 2005 as some regions increased the area given over to agriculture. The South West in particular has seen an extension of agricultural land, causing costs to fall from £113 million in 1994 (the second highest costs in that year, exceeded only by the East Midlands) to £86 million in 2005.

Note that these costs account for the accumulated loss of land since 1950, which explains some of the results which may not be obvious at first glance. The East Midlands for instance has quite high costs for farmland loss (£121–127 million) but they neither rise nor fall much over the period: so though the historical loss has been significant, it had stabilised by the mid-1990s. The South East on the other hand started the period with a high level of accumulated loss (£112 million in 1994), continued to lose farmland to other uses until 2002 (£151 million) and has regained a little ground since then (£131 million in 2005).

Figure 9 below illustrates the combined effect of local pollution costs and loss of farmlands and habitats.

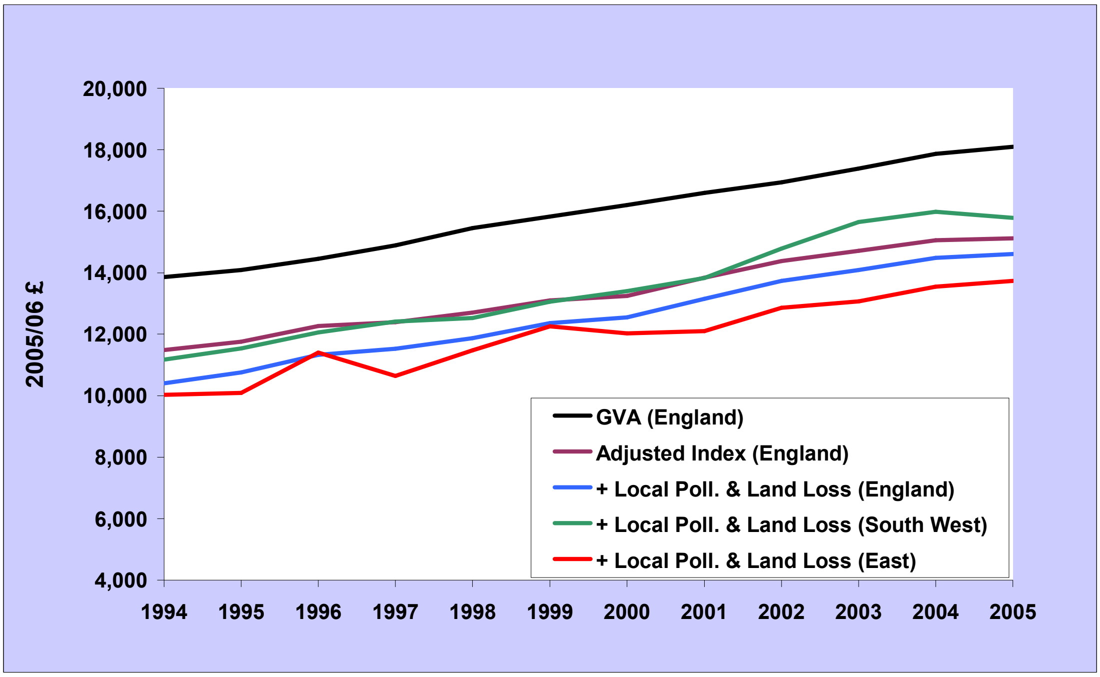



**Figure 9: Impact of local environmental and land loss adjustments.**

### *Long-term costs of climate change*

*In the R-ISEW, we use a methodology aimed at addressing the question of long-term ecological debt from a financial perspective (see Appendix4 for details). In summary, this method treats the current accumulated debt as though it could be paid off over time through an annuitised endowment fund which matures when required in the future. Regular payments into this fund over the next 50 years (say) will be sufficient to pay off the debt provided that we start making the payments today. Should we fail to pay the premiums this year, however, the time available to achieve the required sum at payout will shorten, and next year's required payments will therefore be higher. The costs of climate change in this R-ISEW have been distributed to the point of emission (using data from the National Air Emissions Inventory), rather than the point of consumption – that is to say that regions producing GHGs suffer higher costs, rather than those regions consuming more energy.*

The impact of this component on the index is significant, even in regions where per capita emissions of GHGs are relatively low (comparing rural to energy-producing regions, for example). The endowment premiums attributable to a climate change fund for the whole of England in 1994 are estimated at £74 billion or 11% of GVA. By the end of the period these premiums have increased by almost 40% – as a result on the one hand of continuing emissions and on the other of our failure to implement a payment plan – so that by 2005 they amount to almost £103 billion (11.3% of GVA). For as long as no plans are put in place to reduce emissions and to establish a dedicated climate fund against future costs, these premiums will continue to rise.

Looking at individual regions, we can clearly see how the major sources of greenhouse gas emissions – power generation, road transport and (to a lesser extent) industry – affect regional costs in this category. Power-producing regions such as Yorkshire and the Humber and the East Midlands see very high costs here (especially where coal is the fuel of choice): £14.4 billion for Yorkshire in 1994, rising to over £20 billion in 2005; £9.8bn and £13.7 billion in the East Midlands. Densely-populated regions with high road use also pay a price: results for the South East and North West, for example, range from £11.5 billion and £8.7 billion respectively in 1994, to £16 billion and £12.2 billion in 2005. Meanwhile, the mainly rural and less populous regions such as the North East and South West enjoy much lower costs: both are around £5 billion in 1994 and £7 billion in 2005.

Results are similar in London, where not only is there little heavy industry, there isn't much agriculture. And although commuting costs are high in London, this is due to the loss of leisure time rather than high road use, so in all, greenhouse gas emissions for the region are quite low. The resulting costs are very similar to the North East and South West in total, but much lower per capita: £980 in 2005 is less than half the English average of £2,040 per capita, and way below Yorkshire and the Humber or the East Midlands, at £3,976 and £3,186 respectively.

### *Resource depletion*

*Estimated as the cost of replacing fossil energy use with renewable energy, in line with the replacement cost methodology of Cobb and Cobb. National energy use data available from the former Department for Trade and Industry. Regional distribution estimated using data on sectoral GVAs, population and travel.*

Along with long-term environmental damage, our heavy use of non-renewable energy makes this factor one of the most significant in the index. The costs of resource depletion across England increased from £71 billion in 1994 to £95 billion in 2005, representing 10–11% of GVA in each year.

Some regions account for a larger proportion of this increase than others: London, the South and East of England all see costs grow by around 40%. In absolute terms this translates to amounts ranging from £6.6 billion in the South West to £12.1 billion in the South East in 1994, rising to £9.2 billion and £16.7 billion respectively in 2005. The North East sees the smallest rise of 24% from £3.6 billion to £4.4 billion; in the remaining regions the increase is around 30% – for instance, a 33% increase from £6.1 billion in 1994 to £8.2 billion for the East Midlands, and a 28% rise for the North West, from £9.8 billion to £12.6 billion.

The reasons for this vary from region to region, as energy use is entwined with almost every field of modern activity in varying degrees. In the East of England for example, the rapid growth of Stansted airport since the early 1990s brings a 316% increase in fuel use from air travel, so that by 2005 air travel accounts for almost 10% of all energy use in the region. In fact, the low-cost flight boom has increased energy use in this sector in all regions, according to the degree in which regional airports around the country succeeded in adding mass-market, budget air travel to their occasional domestic flights.

In 1994, industrial energy use accounted for an average of 27% of all energy use across the regions; by 2005 this had fallen slightly to less than 25%. The drop is driven largely by changes in the North West and the West Midlands, as heavy manufacturing relocates to low labour-cost sites in Eastern Europe and the Far East. Both regions see a drop of around 10% over the period of the study – from 7.3 million tonnes of oil equivalent (mtoe) in 1994 to 6.5 in the North West, and from 6.1 mtoe to 5.5 mtoe in the West Midlands. The overall effect is mitigated by rising industrial energy use in South East (up 7.4% to 7.6 mtoe) and, perhaps surprisingly, in the South West (up 13.2% to 4.87 mtoe).

Unfortunately, the reductions in industrial energy use are more than offset by a much steeper rise in energy use by private sector services. Even accounting for the shift in service provision from public sector to private sector over the last decade, total energy use in services has risen by 2.6 mtoe, almost four times the drop in industrial energy use. And in addition to the growing use of transport fuel, our increasingly profligate energy use in the domestic sector has thrown another 4.6 mtoe into the mix.

The combined effects on the overall index of incorporating these two adjustments (for greenhouse gas emissions and for resource depletion) are shown in Figure 10.

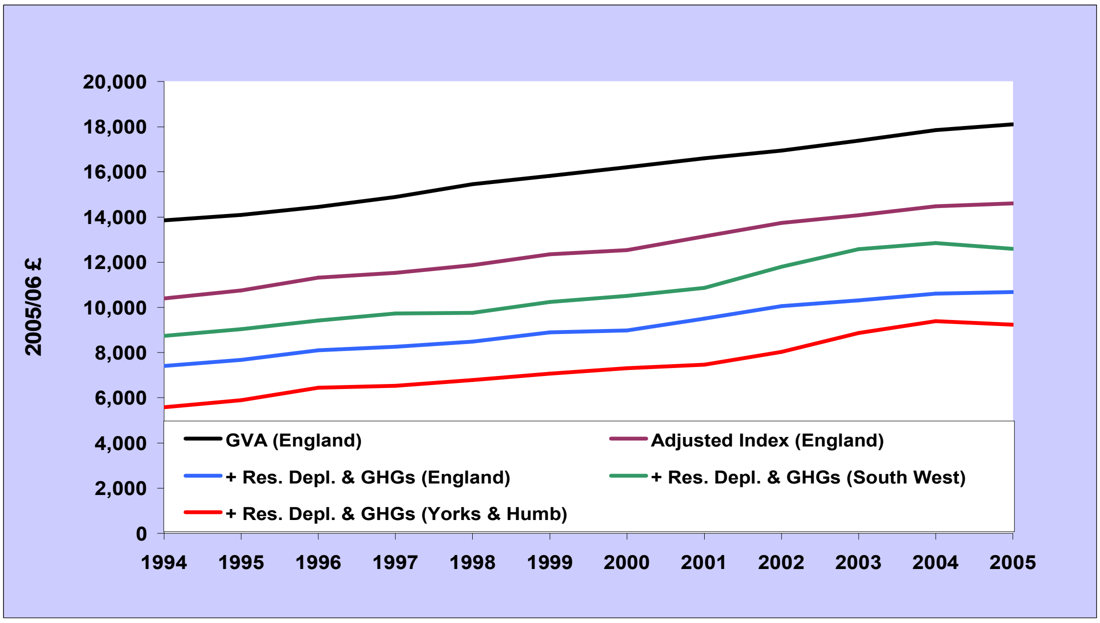



**Figure 10: Cumulative impact of GHGs and resource depletion.**

# 4. R-ISEW in the English Regions

## 4.1 Overall trends

After all economic, social and environmental adjustments have been made, the final R-ISEW for England is shown in Figure 11 below, plotted against GVA. The difference between the two measures is striking. The total GVA in the English regions rose by 37% from just under £670 billion in 1994 to just over £910 billion in 2005. By comparison (Figure 11), the English R-ISEW started at a considerably lower point (£357 billion) in 1994. It rose more or less steadily between 1994 and 2005, but was still significantly below GVA (at £539 billion) by the end of the period.

On the basis of discussion in the previous subsections we can conclude that the rising trend in R-ISEW was driven primarily by strong growth in consumption, increased public expenditure on health and education, and significant reductions in air pollution. The most significant countervailing forces were the costs associated with climate change and the depletion of non-renewable resources, and a failure to address the substantial and growing costs of income inequality.

On a per capita basis (Figure 12), the growth rates are slightly reduced (because population was also growing) but the overall picture is largely the same: GVA and R-ISEW grow steadily, but the R-ISEW does so at a significantly lower level than GVA.

Although the R-ISEW rises over the period, it does not do so as fast as GVA: the gap between what we conventionally assume to be 'progress' and what might be a more rounded vision of 'progress' is large – and still growing in absolute terms. To appreciate the gap between conventional and economically adjusted measures of progress, it is useful to look at the absolute difference between the two measures over time. Figure 13 below plots GVA minus R-ISEW (per capita) over the period of the study for England as a whole. The absolute difference between R-ISEW per capita and GVA per capita increases from just under £6,500 in 1994 to almost £7,500 in 2005.

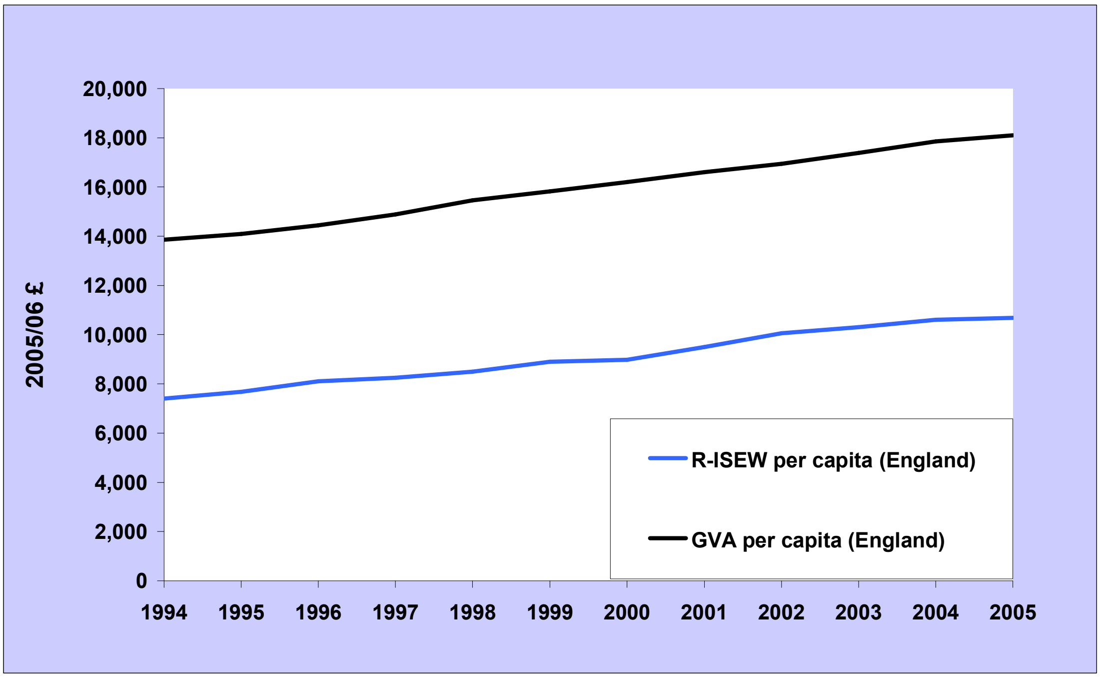



**Figure 11: English R-ISEW and GVA.**

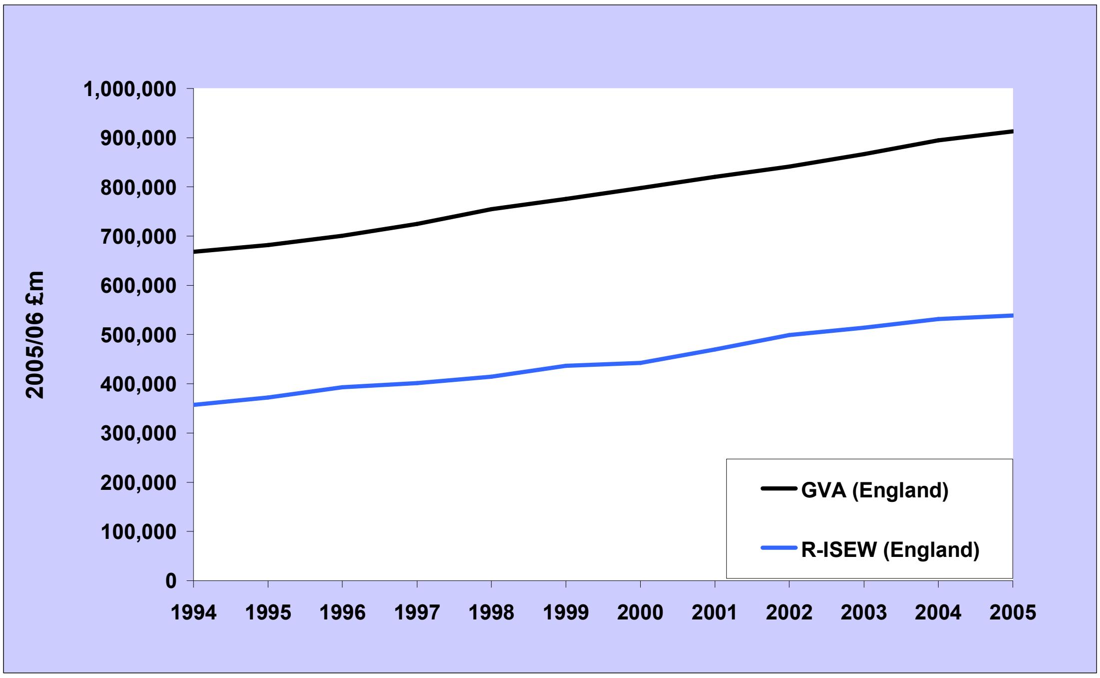



**Figure 12: English R-ISEW and GVA on per capita basis.**

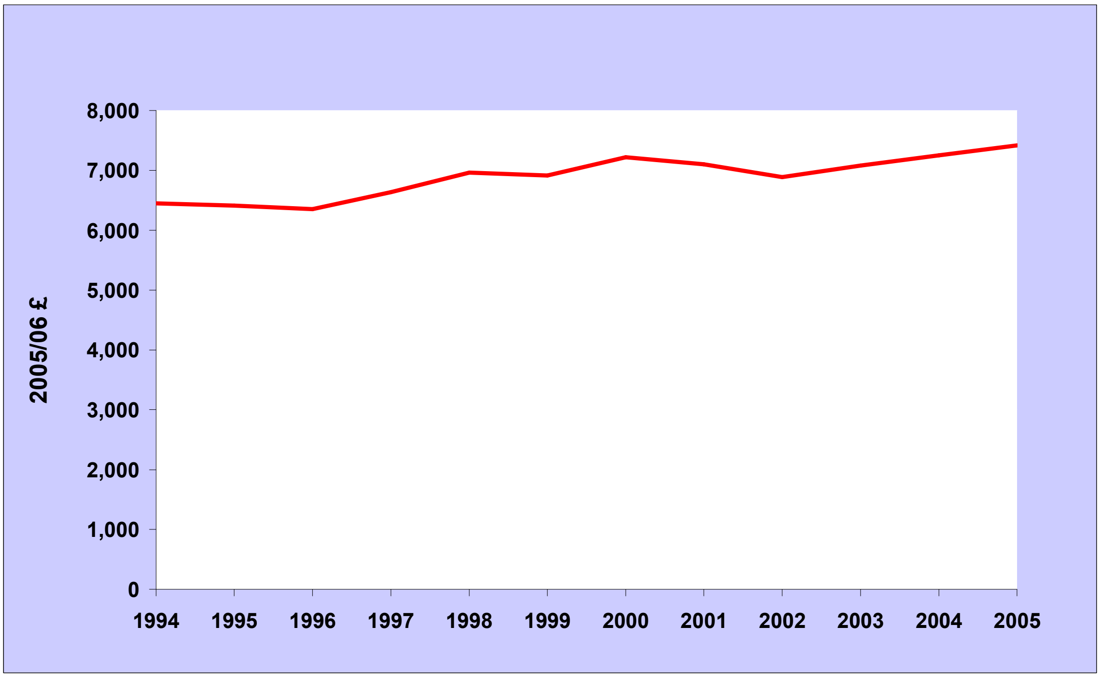



**Figure 13: Gap between English R-ISEW and GVA on per capita basis.**

## 4.2 Regional trends

Within this overall picture there are some significant regional differences, as Figures 14 to 22 illustrate. The following charts show the regional R-ISEW per capita against the GVA per capita for each of the nine English Government Office Regions.

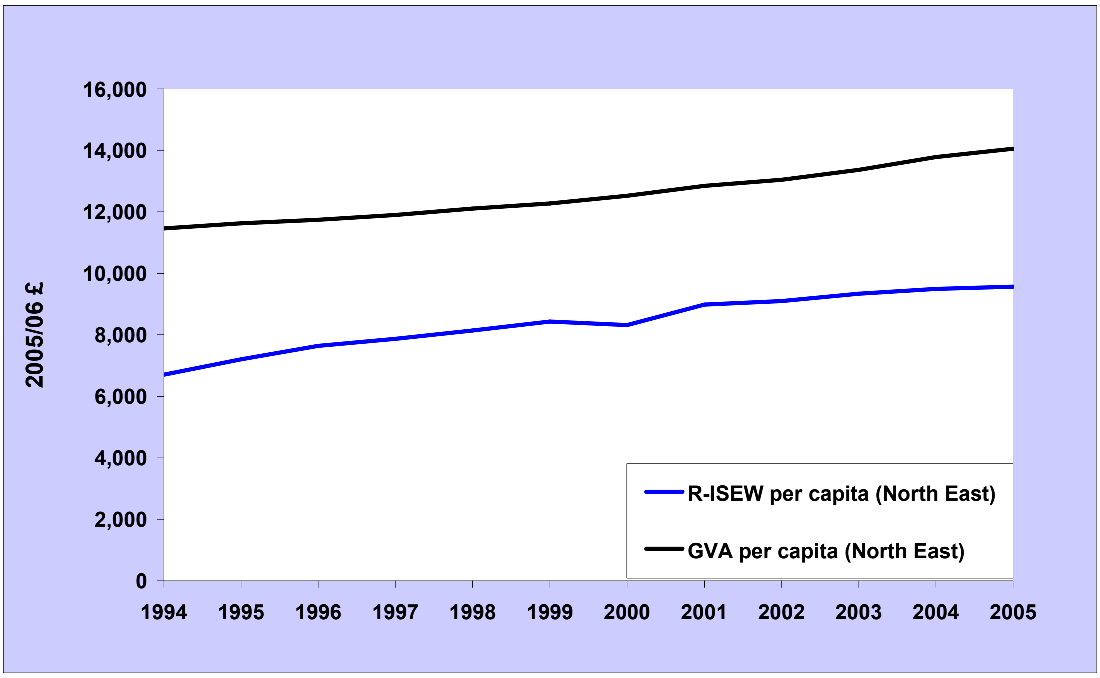



**Figure 14: North East R-ISEW and GVA on per capita basis.**

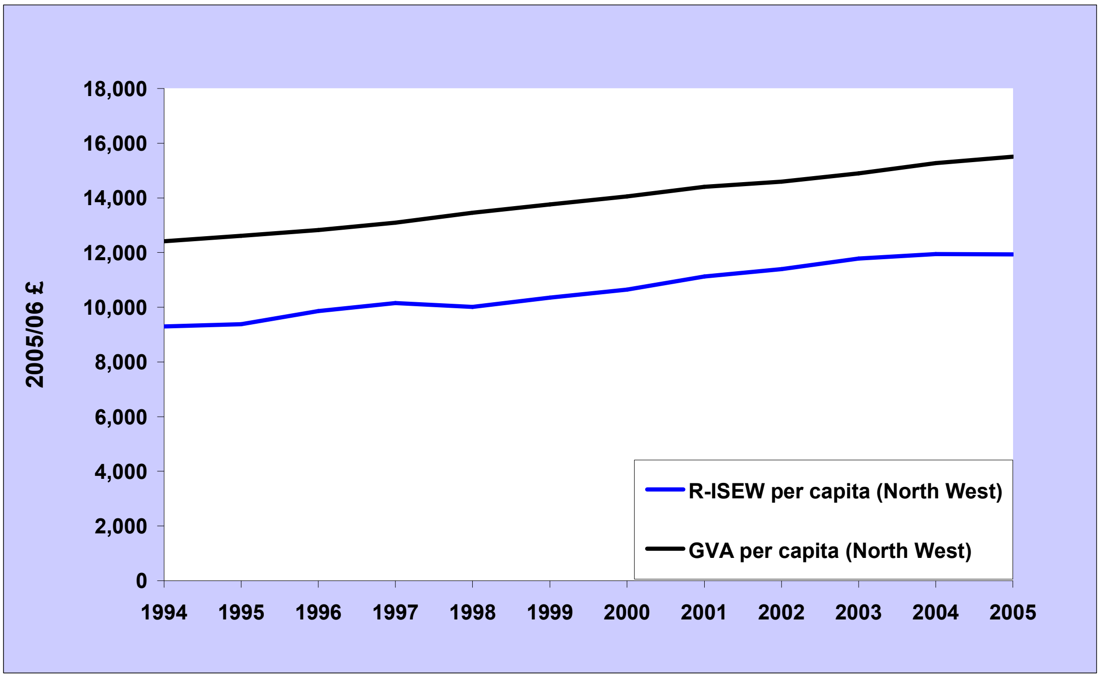



**Figure 15: North West R-ISEW and GVA on per capita basis.**

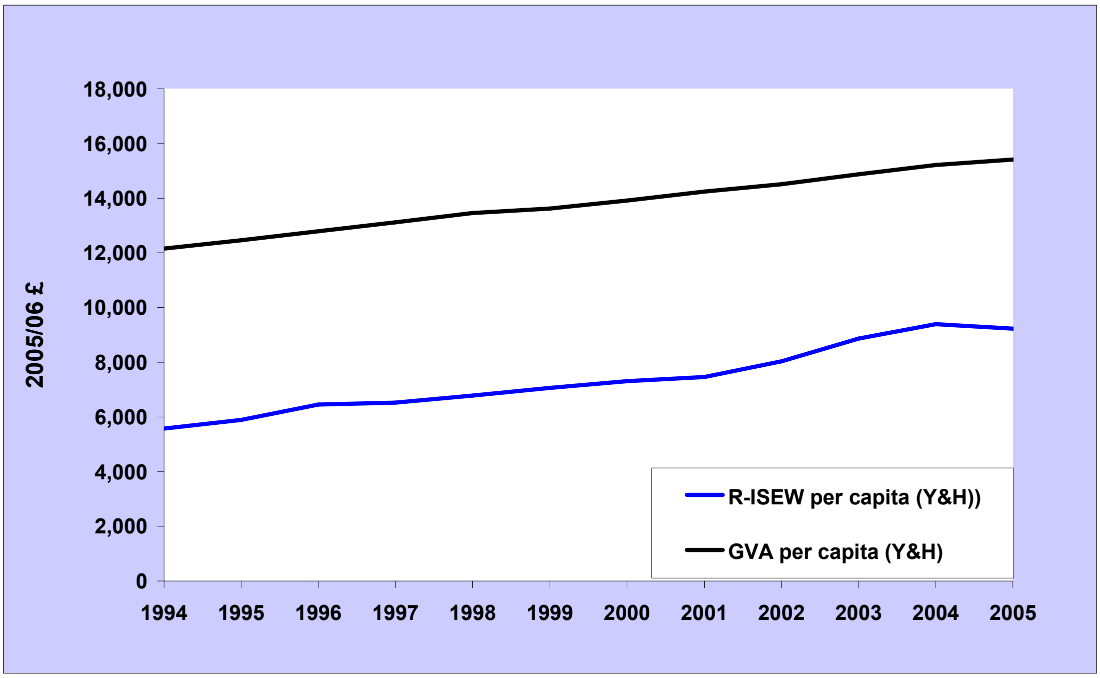



**Figure 16: Yorkshire and the Humber R-ISEW and GVA on per capita basis.**

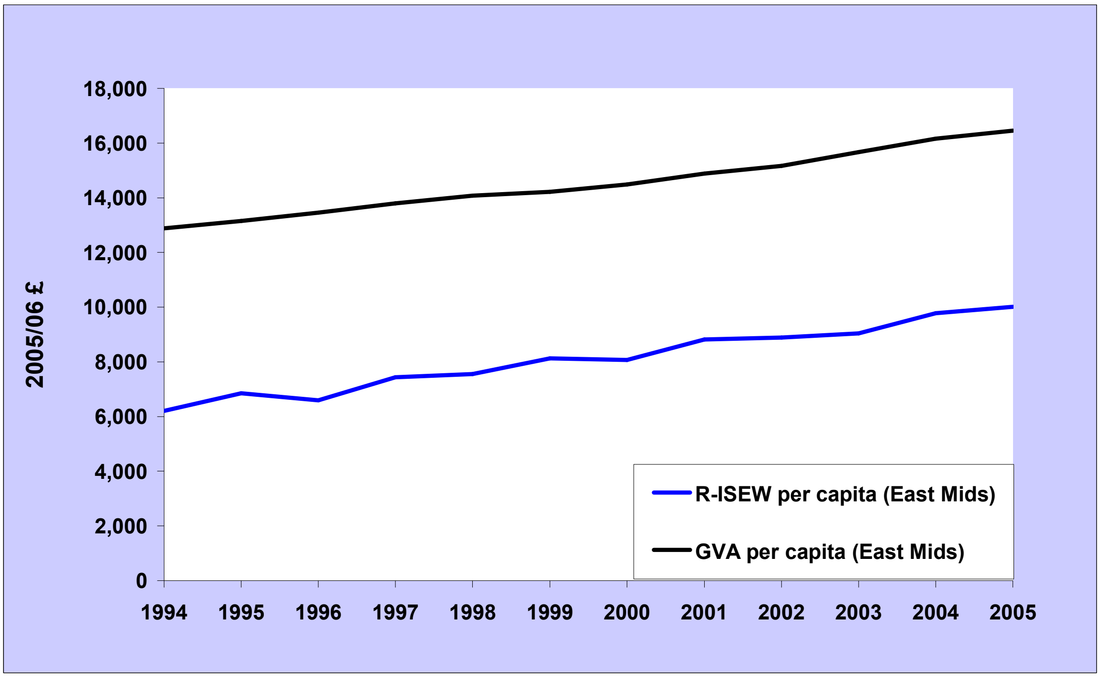



**Figure 17: East Midlands R-ISEW and GVA on per capita basis.**

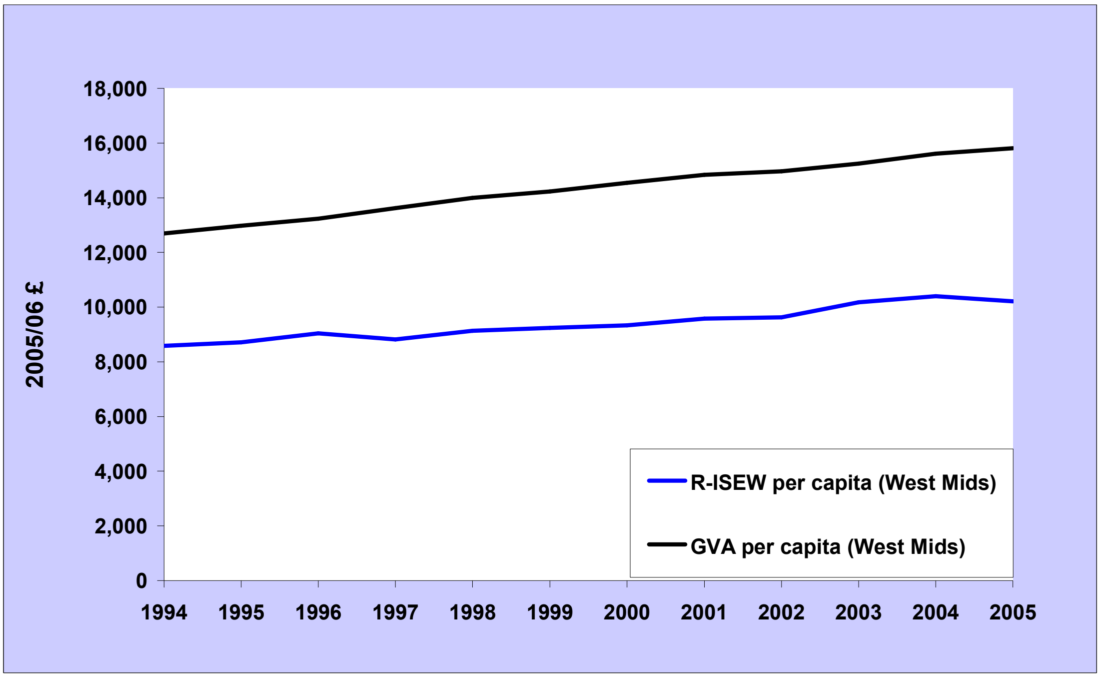



**Figure 18: West Midlands R-ISEW and GVA on per capita basis.**

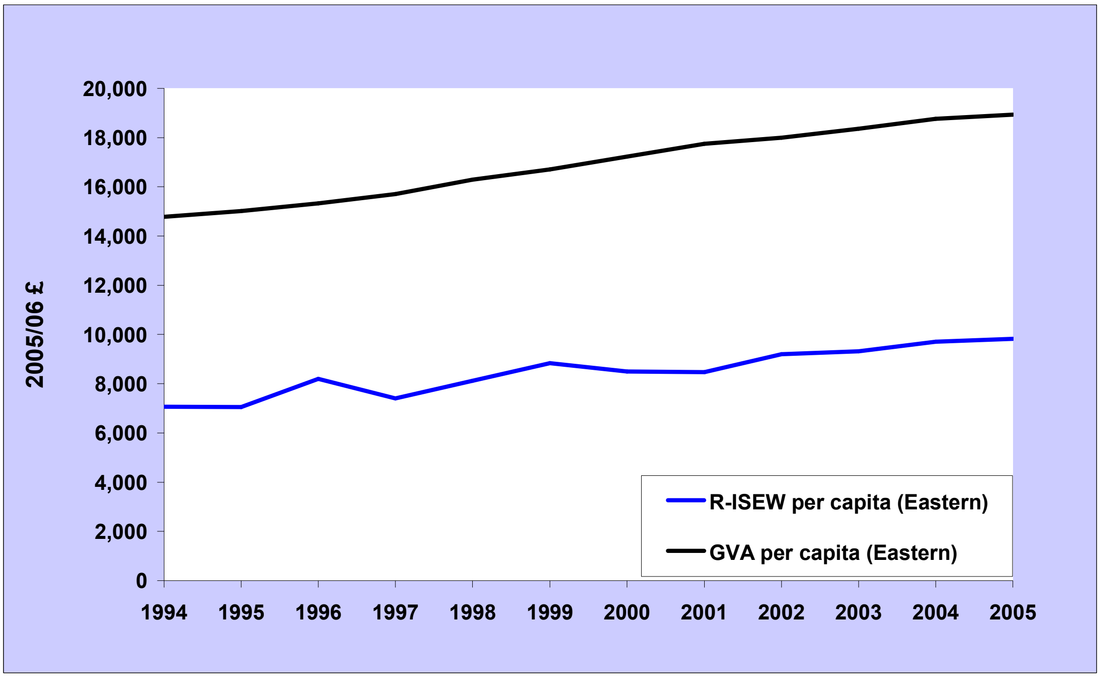



**Figure 19: Eastern R-ISEW and GVA on per capita basis.**

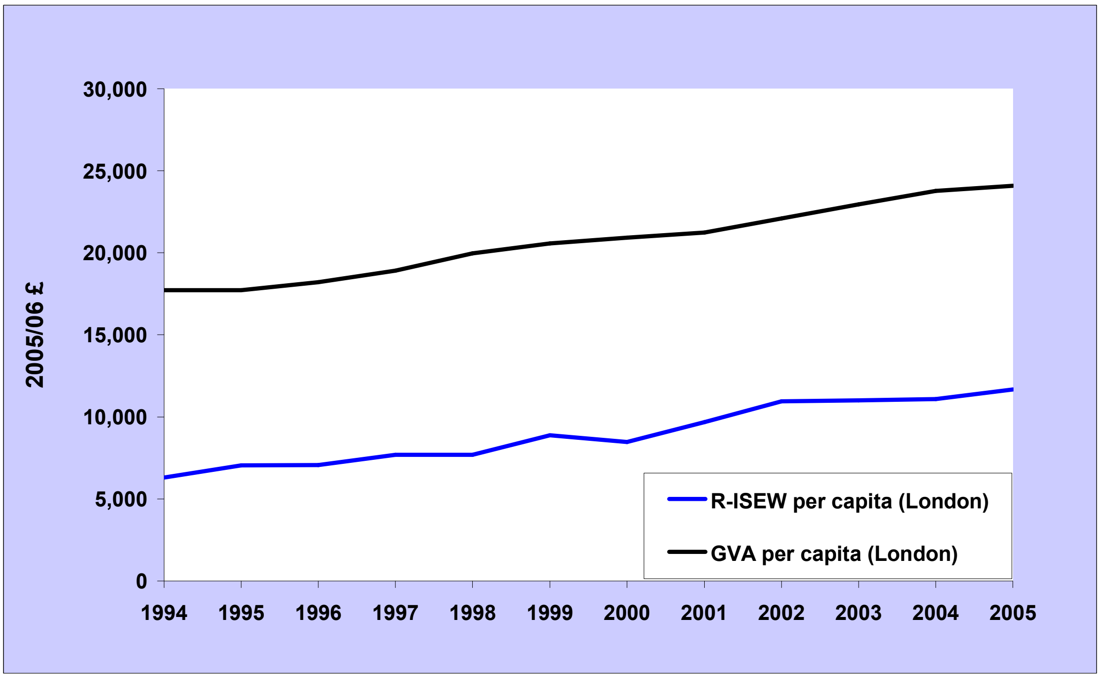



**Figure 20: London R-ISEW and GVA on per capita basis.**

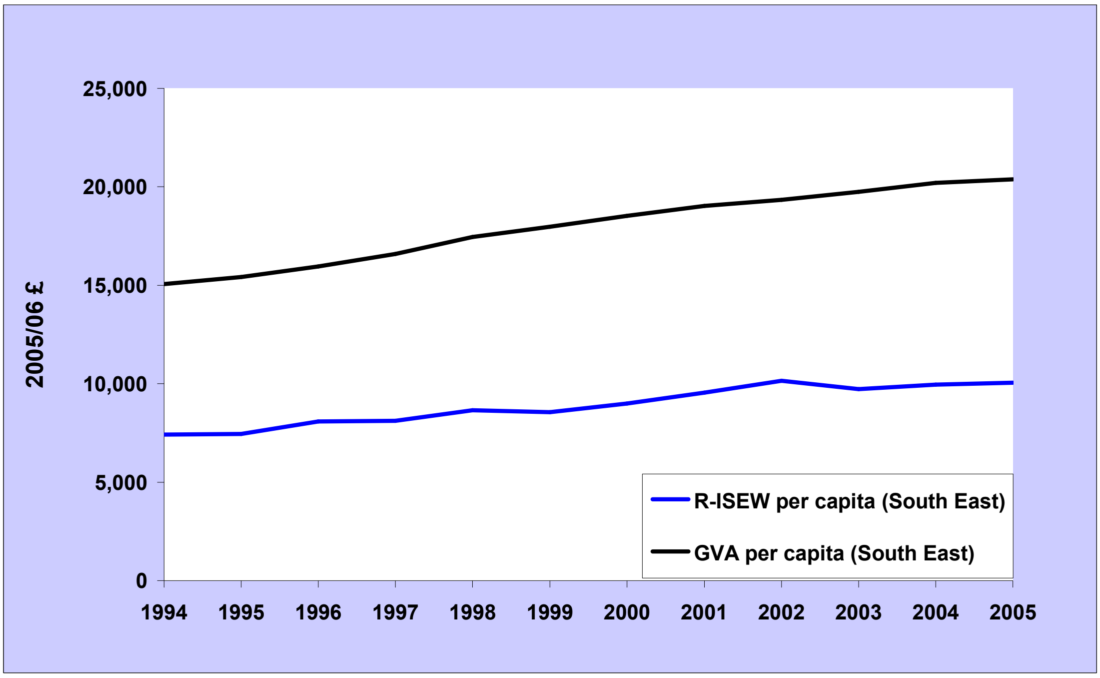



**Figure 21: South East R-ISEW and GVA on per capita basis.**

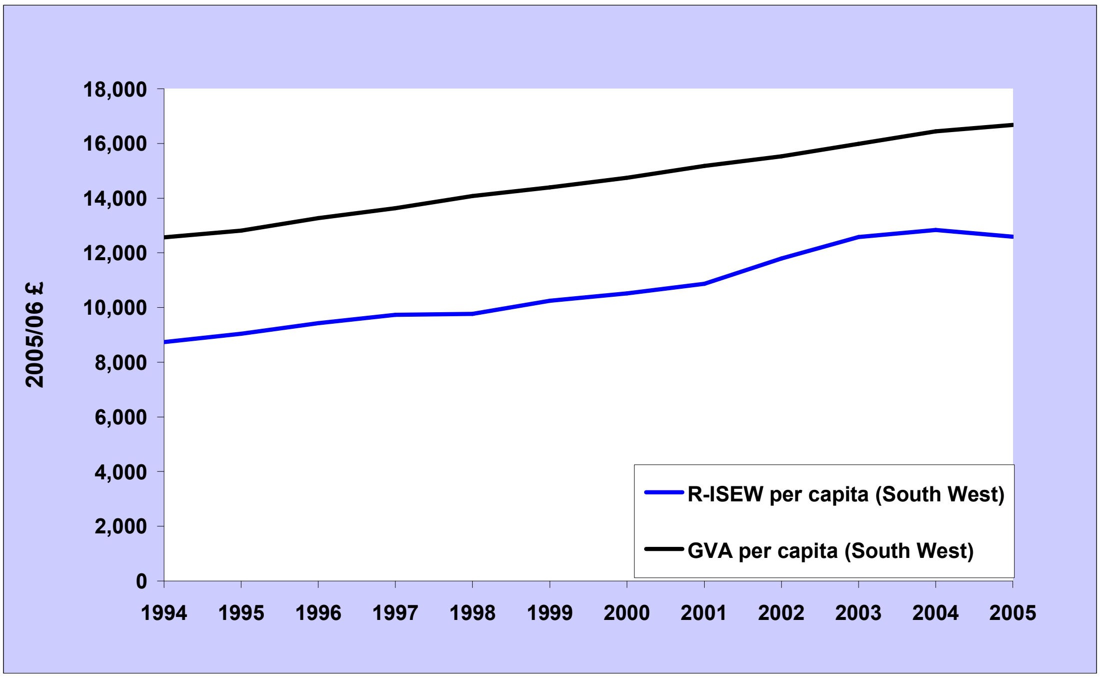



**Figure 22: South West R-ISEW and GVA on per capita basis.**

## 4.3 Differences across regions

In Figure 23 we illustrate some of the regional differences in per capita R-ISEW by plotting the highest (South West region) and the lowest (Yorkshire and Humber region) R-ISEWs against the English average per capita R-ISEW.

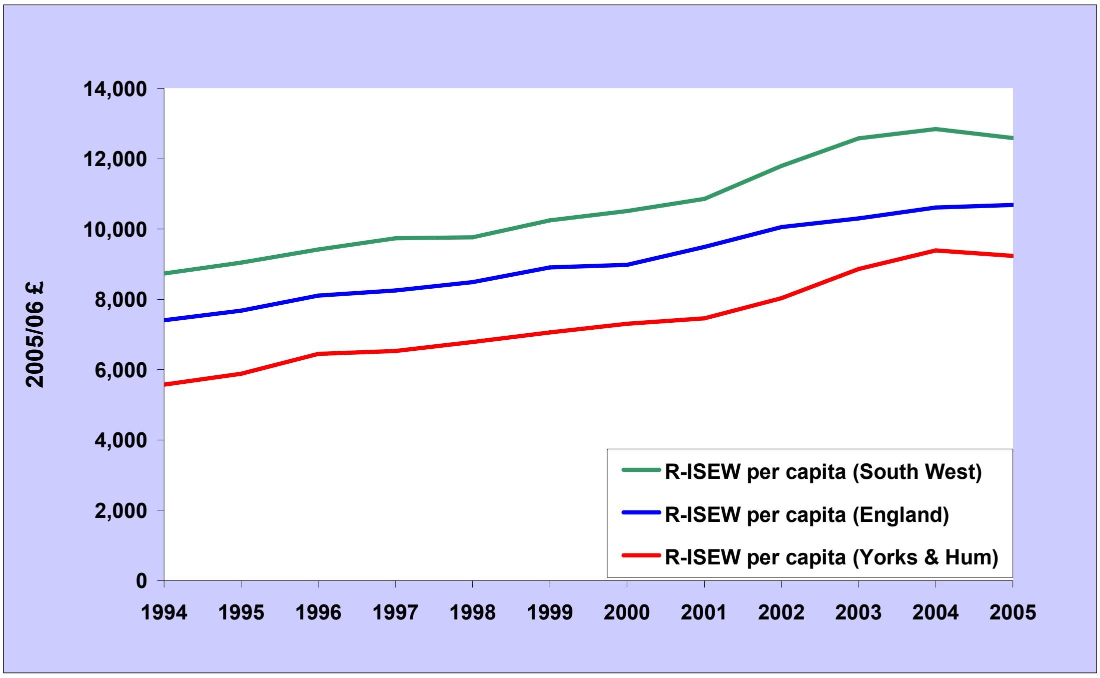



**Figure 23: Regional R-ISEW per capita (range and mean) .**

Given these regional differences it is perhaps not surprising to find that the gap between GVA per capita and R-ISEW per capita also varies between different regions. Figure 24 plots the difference between GVA and R-ISEW for four regions, the two with the highest and the two with the lowest gap.

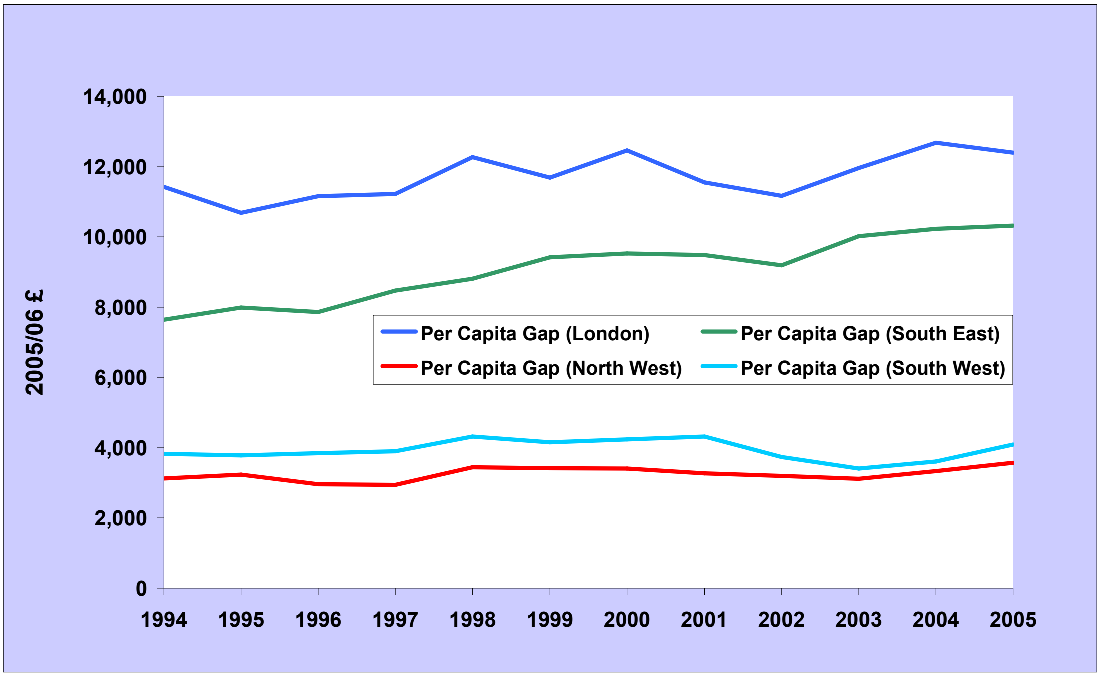



**Figure 24: Per capita gap between R-ISEWs and GVA.**

Both the North West and the South West regions have relatively small gaps, and have, at times, managed to close them somewhat (although the overall trend over the period is a growing gap even in these regions). London has the highest per capita gap throughout the period by a considerable margin, and it continues to widen; in the South East, the gap is not only large, it is also increasing rapidly. Only the West Midlands exceeds the South East's 35% growth: here the gaps roses 36% from £4,108 per capita in 1994 to £5,607 in 2005.

Another way of representing these differences is by contrasting the performance of each region on the R-ISEW with their performance in terms of GVA, as shown in Figures 25 and 26.

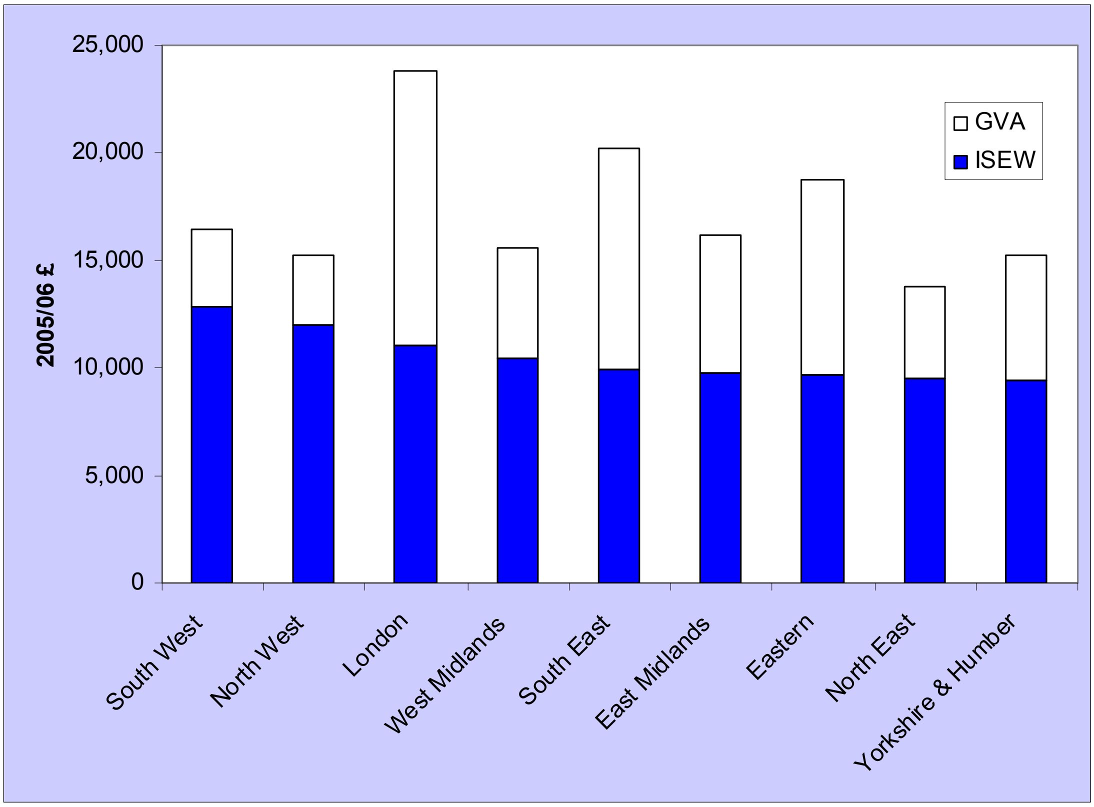



**Figure 25: Per capita R-ISEWs and GVAs by region in 2004.**

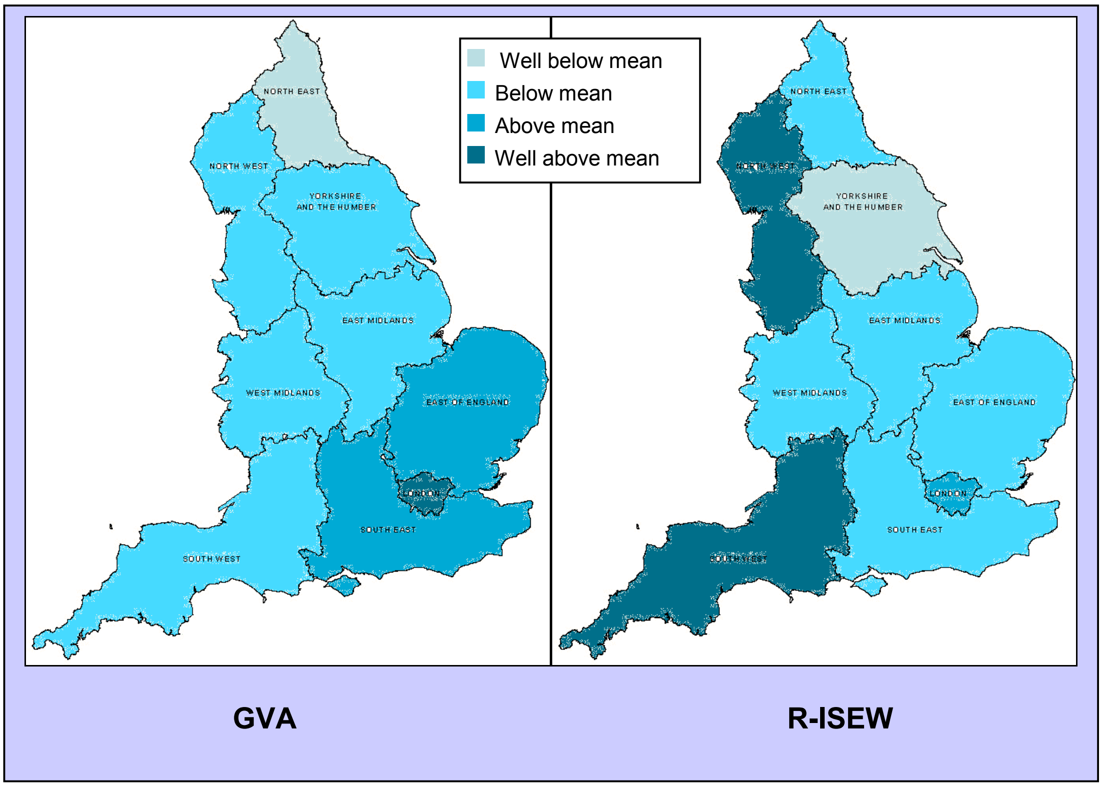



**Figure 26: Per capita R-ISEWs and GVAs by region in 2004.**

### *Overall patterns*

Whereas the top three regions in terms of GVA per capita are concentrated around London and the Home Counties (the South East and the East of England), the R-ISEW paints a rather different picture, with the North West and South West leading the way in 2004 (and indeed across our 12-year time-series). For the North West, in particular, this represents a large shift in relative performance (from seventh place in terms of GVA to second place in terms of the R-ISEW). Whilst London doesn't perform quite as well in terms of R-ISEW as it does in terms of GVA (coming third instead of first in 2004), it certainly performs better than the neighbouring regions (the South East dropping to fifth place, and the East of England dropping to seventh). Interestingly, it has made considerable gains in terms of R-ISEW over our time-series, moving up from the seventh place it held between 1994 and 1998 to a consistent third place by 2001.

The Midlands emerge in the middle of the rank order both in terms of GVA and R-ISEW. However, the West Midlands performs relatively better than the East Midlands, rising from sixth place in terms of GVA to fourth place in terms of R-ISEW. The East Midlands drops from fifth to fourth. Lastly, along the northeast coast of England, Yorkshire and the North East exchange places, with the North East moving up from bottom place to second from bottom (eighth).

### *Key components*

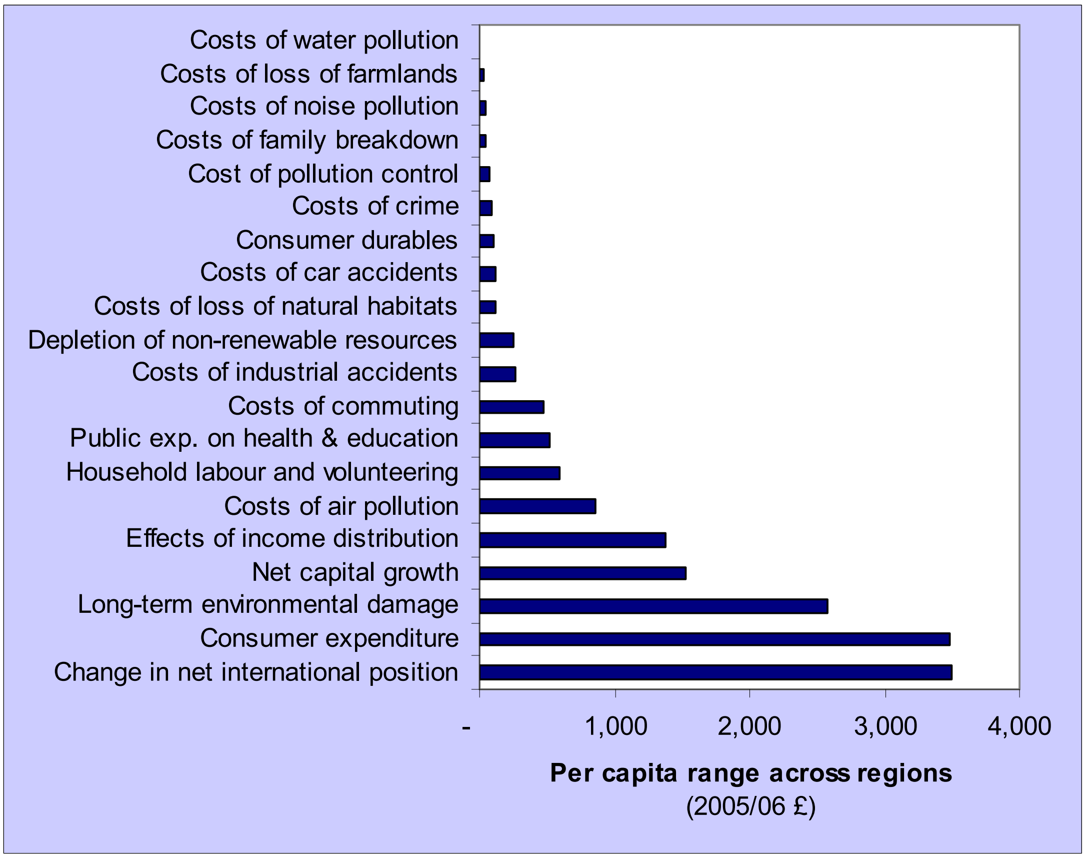



**Figure 27: Range across regions of values for each component.**

To understand these patterns, we need to go below the headline R-ISEW figure to explore the component patterns. Given the summative methodology of the ISEW, it is *absolute* differences in value across regions for each component that determine their importance in shifting overall R-ISEW, rather than *relative* differences. For example, the costs of loss of farmland and soil erosion in the East Midlands are some 220 times greater per capita than that in London. However, as neither figure is particularly big compared to other components (approximately £30 per person in East Midlands compared to some £3,000 per person for the costs of long-term environmental damage in the same region), these large relative effects have little impact on overall R-ISEWs. Figure 27 shows the range for each component, defined as the maximum regional per capita value minus the minimum regional per capita value for each year, averaged across the 12-year time-series. The following paragraphs will focus on those components of the R-ISEW which carry the greatest absolute values and differences. Unless otherwise stated, analyses have been carried out for the year 2004.

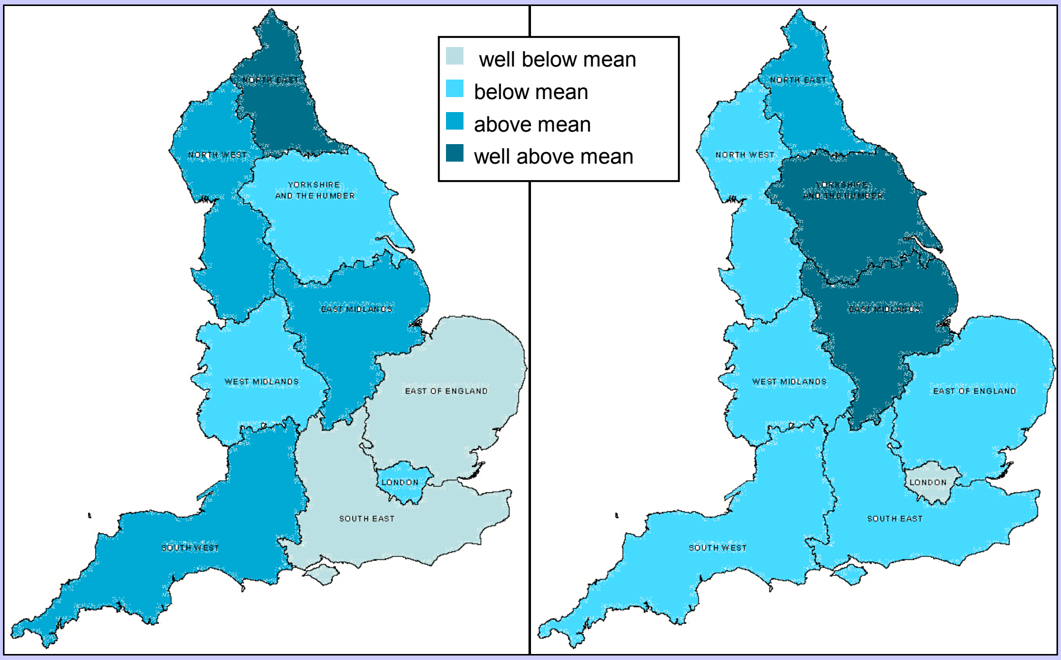
### *Consumer expenditure and income distribution*

Whilst consumer expenditure is obviously strongly correlated with GVA, the different patterns the two statistics produce across regions is important in determining the GVA–R-ISEW gap, particularly given the high absolute figures for this component (which is of course the starting point for R-ISEW calculations). Generally, use of consumer expenditure instead of GVA per capita serves to reduce the variance across regions, consumer expenditure having a standard deviation little over one-third that of GVA (£1,079 per capita vs £3,124 per capita), and a coefficient of variance half that of GVA.  Using consumer expenditure also changes the order of the regions, with London in third rather than first place (behind the South East and the East of England), Yorkshire & Humberside moving up to fifth place from eighth, and the West Midlands dropping from sixth to eighth.  However, all these shifts run in contrast to the overall changes in rank produced by using the R-ISEW instead of GVA.  In other words, the quite large differences in consumer expenditure between regions do not actually help us understand the patterns of R-ISEW, other than reducing the gaps between poorer and wealthier regions that would be registered using GVA.  Adjusting consumer expenditure by income distribution has a similar effect, the costs of income distribution by region correlating almost perfectly with GVA (R = 0.99).

### *Economic adjustments*

The biggest component of the R-ISEW in terms of range across regions is actually net international position.  Changes over time have already been discussed in section 3.1, particularly London's success in slashing its deficit over time. However, by 2004, it is still more northern regions that have the healthiest balance of payments.  Given the size of this component, we have highlighted this in the map in figure 28a.  Of the four regions with positive balances of payment (the North East, East Midlands, North West and South West), three perform better in the R-ISEW rankings than the GVA rankings (the exception being the East Midlands).  This, and the contribution to London's improving R-ISEW made by its reducing deficit, suggests that a surplus in the balance of payments is a key factor in ensuring a high R-ISEW.

Net capital growth is also a big contributor to variation in the R-ISEW, with Yorkshire & Humberside having the largest value in 2004 (£1,278 per capita), whilst London continued to witness negative growth (-£790 per capita).  These differences, however, do not help us to understand variation in R-ISEW very much. The only region where strong performance on net capital growth seems to coincide with a strong performance in the R-ISEW, is the North West, which had the third-highest figure for net capital growth in 2004.




**Net International Position** **Long Term Environmental Damage**

**Figure 28: Net international position and long-term environmental damage across the regions.**

### *Environmental costs*

Environmental costs are a key determinant of the relative performance of the regions. The second-biggest component, aside from consumer expenditure, is long-term environmental damage. Figure 28b visualises the patterns described in section 3.3. This component helps explain London's relatively better performance on the R-ISEW than its neighbouring regions. It also seems to contribute to the generally better performance of western regions on the R-ISEW, with the North West, West Midlands and South West recording lower $CO_2$ emissions than their eastern counterparts.[61]

Air pollution costs follow a similar pattern (which is unsurprising given they are calculated from similar data sources). Again, north and eastern regions (the East Midlands, Yorkshire and the Humber, and the North East) record the biggest costs, whilst London and the South West have the lowest. The pattern is congruent with overall R-ISEW scores. Further, it is worth noting that the North West, whilst being a relatively industrial region, maintains relatively low air-pollution costs (the third-lowest in fact).

Whilst the costs of resource depletion are very high across England, there is relatively little variation across regions. Nonetheless, the relatively high figures for the South East and the East of England contribute to the regions' relatively poor performance on the R-ISEW. Similarly, the relatively low figures for the South West and London (third- and fourth-lowest respectively), contribute to their relatively strong performances.

### *Other important components*

Public expenditure on health and education also appears to be an important determinant of the R-ISEW. London, the North East and the North West all spend relatively large amounts on health and education, per capita, whilst the East of England and the South East both spend relatively low amounts.

On the other hand, the costs of commuting have the strongest negative effect on London (thanks to the inclusion of the costs of the time spent commuting, rather than just the money spent). According to our analyses, the total costs were £983 per person in London, compared with £509 per person in the North East. Most other regions were around the £650 per person mark, with the only exception being the higher costs in the South East.

The last component to have a large and interesting effect on the R-ISEW is the cost of industrial accidents. The highest per capita costs per region are recorded by Yorkshire and the Humber, and the South East, which both perform relatively poorly on the R-ISEW. Meanwhile, aside from the very low costs in the East of England, the next three best-performing regions (the North West, London and the West Midlands), are all regions performing relatively well on the R-ISEW.

## 4.4 Trends in variation

It is interesting to explore in more detail the overall level of disparities between different regions, by representing the range of results for specific components of the per capita R-ISEW as a percentage of the average English per capita ISEW. If we take the highest cost minus the lowest cost in each component in each year and then express this as a percentage of the English mean in that year, we get a measure of how much variation there is between regions for each component. By plotting this over time, we get a sense not only of the comparative differences between regions for different components, but also of whether the regions are converging (becoming more equal) or diverging (becoming less equal) over time with respect to these components.

Figure 29 shows the overall level of regional variation for the per capita English R-ISEW as a whole. This is plotted against variations in two other conventional headline measures, the GVA per capita and consumer expenditure per capita, for comparative purposes. As we have already remarked, the variation in consumer expenditure between regions has remained at around 30%, with a slight divergence evident over the period. The variation in GVA is higher than the variation in consumer expenditure and shows a much clearer divergence over the period: i.e. regional differences in output and expenditure appear to be increasing over time.

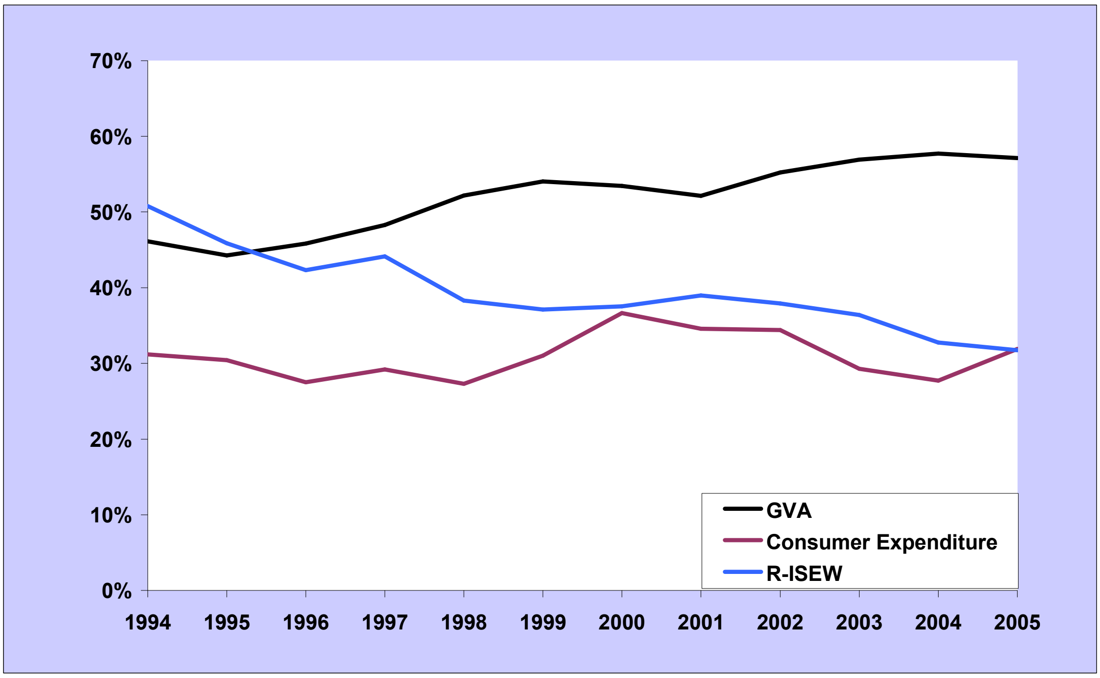



**Figure 29: Regional variation in R-ISEW, GVA and consumer expenditure.**

Interestingly, however, Figure 29 reveals that the variation in R-ISEW has decreased markedly over the time period, from around 51% in 1994 to 32% in 2005, suggesting that adjusted economic well-being is now more equally shared across the regions than it was a decade or so ago. Some of the underlying influences on this trend are illustrated in Figures 30 and 31.

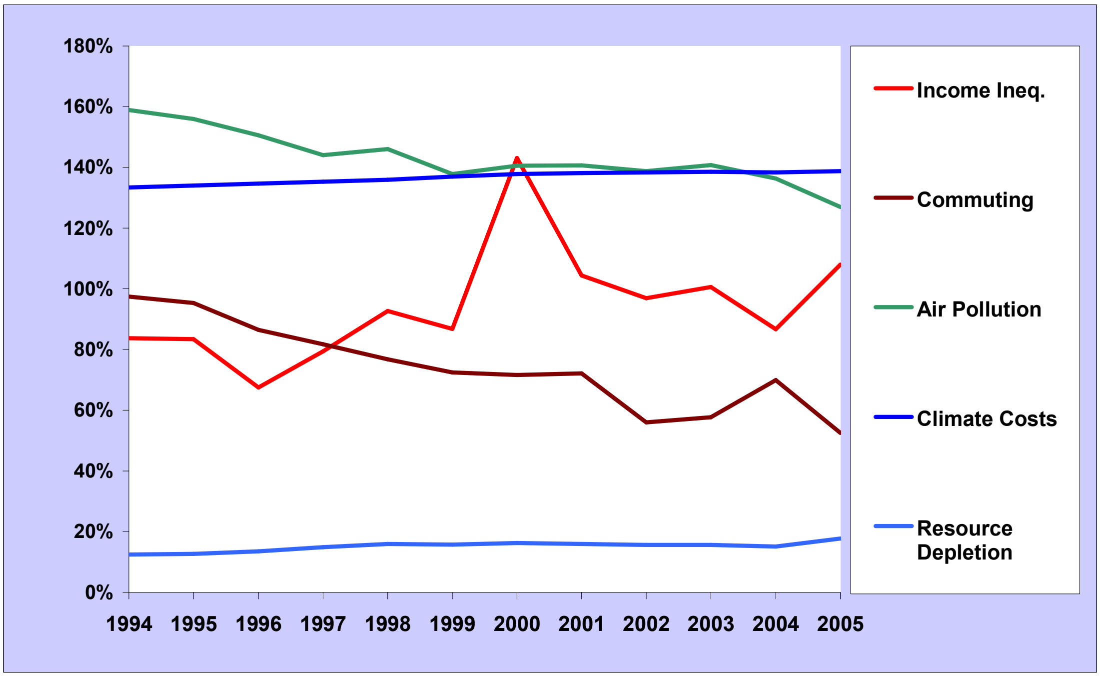



**Figure 30: Regional variations in selected component factors.**

Figure 30 includes those components which contribute most significantly to the index, such as climate change and resource depletion, and those which show a particularly striking trend, such as commuting and income inequality. Commuting is not a major contributor in absolute terms, but the convergence in costs between regions is notable. Income inequality (drawn in red in the graph) satisfies both criteria: it is a major determinant of the overall R-ISEW, *and* it is an area in which regional differences are significant and increasing.

The convergence in R-ISEW between regions is driven primarily by strong convergence in air pollution costs (green in Figure 30), and to a lesser extent, by trends in commuting, crime, divorce, car accidents and water pollution, all of which have become more equal across regions. Pushing against these convergent trends are some clear divergent pressures in other components, principally income distribution, resource depletion and noise pollution. Net international position and net capital growth also diverge noticeably (Figure 31) and are shown on a separate axis, because the underlying datasets for both of these components are quite volatile, which amplifies this measure of regional disparity.

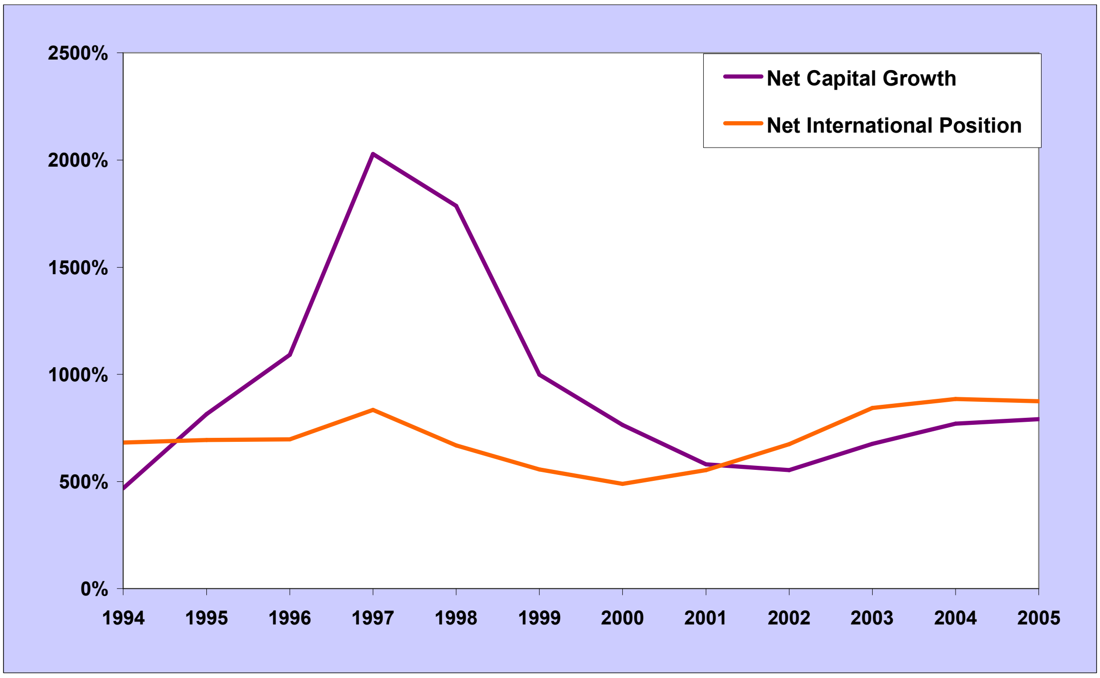



**Figure 31: Trends in selected regional disparities.**

# 5. Concluding remarks

This report reports on an exercise to construct pilot Regional Indexes of Sustainable Economic Well-being (R-ISEWs) for all nine Government Office Regions – and for England as a whole. It finds that, overall, the English ISEW rises consistently over the period between 1994 and 2005, although it remains throughout significantly lower than the conventional economic measure of GVA. More worryingly, the absolute difference between GVA and R-ISEW appears to be still widening.

The increase in R-ISEW is driven by a variety of factors. In particular, it is strongly shaped by the underlying (rising) trend in consumer expenditure. But it is also influenced by some positive environmental and social trends, such as the decline in local air and water pollution, increases in public spending on health and education, some decline in the costs of car accidents and a stabilisation in the costs of crime and divorce. Countervailing forces include the rising costs of income inequality, an increase in the costs of commuting, and the continuing failure to address the long-term costs of climate change.

When it comes to individual regions, the study makes clear that there are significant variations in R-ISEW across the regions. The South West region appears to have the highest level of per capita R-ISEW over the period, while the Yorkshire and the Humber region has the lowest. The gap between GVA and R-ISEW is largest for London and the South East, which also has the fastest growing gap. Interestingly, some regions show a degree of convergence between GVA and R-ISEW at least over some years within the study period. The smallest gaps between GVA and R-ISEW are found in the North West and the South West, which appears to be closing the gap in recent years.

There are also some interesting trends over time in regional variations. On the whole, the regional disparities in R-ISEW appear to be declining, in spite of a diverging trend in regional GVA. The convergent trend in R-ISEW is shown to be driven by a number of factors: some – such as the decline in air pollution across regions – are positive in terms of sustainability; others – such as the increase in the costs of commuting – are less favourable. There are also some clear countervailing (divergent) trends in factors, such as income inequality, resource depletion and net capital growth.

Compiling adjusted economic measures at the regional level is by no means straightforward. In this study, not all components could be compiled directly from existing regional datasets. Some had to be estimated using regional proxies to adjust national datasets. Others required specific regional changes to the 'national' methodology for constructing the ISEW.

As with all such exercises, the results are limited in their validity in part by the availability and robustness of the underlying data, and in part by the difficulty in making unequivocal choices about key parameters. As the R-ISEW has been applied and developed, some of these choices have been revisited, leading to differences between the results derived here and those derived in earlier R-ISEWs. These differences are summarised in Appendix 3. Appendix 4 provides a detailed methodological discussion of all the individual components of the Index. Appendix 5 carries out a sensitivity analysis on selected components of the Index, from which it is clear that the positive trend over time is sensitive to certain key choices and parameters.

In summary, this pilot study shows that it is possible to construct R-ISEWs for the English regions on a consistent and comparable basis. The results appear more favourable for some regions than for others, but there are some clear positive trends in all regions. R-ISEW is higher in every region in 2005 than it was in 1994. On the other hand, the R-ISEWs are all much lower than GVA in absolute terms and during the last few years the gap between GVA and R-ISEW has tended to widen. Sensitivity analyses (Appendix 5) reveal that on less optimistic assumptions, this gap could be wider still.

There is therefore little ground for complacency in any of the English regions. A robust effort to tackle income inequality, climate change and resource depletion will be necessary if the long-term vision of sustainable economic well-being is to be achieved.

# Appendix 1. Alternative indicators of progress

> *'[B]eyond a certain point, economic growth may cease to promote social welfare. In fact, it would appear that, when an industrial society reaches an advanced state of affluence, the rate of increase in social welfare drops below the rate of economic growth, and tends ultimately to become negative.'*
>
> *Xenophon Zolotas, 1981.*

This appendix supplements Section 2 of the report, by providing further information on different indicators of progress. See, for example Haggerty *et al*. (2004), McGillivray & Noorbakhsh (2004), Canoy & Lerais (2007), and Goossens (2007), for further reviews of well-being and sustainable development indicators.[62,63,64,65]

The final part of this appendix focuses on the development of adjusted economic measures, and particularly on the history of the ISEW.

## A1.1 Quality of life indicator sets

Periodic revisions of the SNA have taken place over the last 50 years. Recognising the limitations of conventional economic indicators, more recent revisions have attempted to widen the scope of the conventional national accounts to incorporate data and indicators relating to environmental and social factors. In 1993, the UN first proposed that countries should adopt integrated environmental and economic accounting.[66] The basis of this revision was to propose a set of 'satellite accounts' to complement the collection of conventional economic data.

The most recent revision of the SNA includes a detailed system of Integrated Economic and Environmental Accounting (SEEA 2003) which brings together economic and environmental information in a combined framework.[67] Its aim is to provide policy-makers with indicators and statistics to monitor the interactions between economy and environment, as well as 'a database for strategic planning and analysis to identify more sustainable paths of development'.

SEEA 2003 incorporates four categories of accounts: flow accounts for pollution, energy and materials; an account of expenditures on environmental protection and resource management; an account of changes in the stocks of natural resources; and valuations of the environmental damage and resource depletion arising from economic activities. These accounts are intended to be an adjunct to rather than a modification of the core SNA. For the most part, there has been no systematic implementation of the SEEA across the EU. Individual countries have developed various kinds and types of satellite accounting, some of them based on the UN SEEA recommendations. These satellite accounts tend to incorporate a variety of different kinds of social and environmental indicators.

An example of the development of satellite accounts is provided by the UK Sustainable Development Indicator set. The UK's 1999 Strategy established a detailed set of 147 indicators measuring different aspects of quality of life.[68] The intention of the strategy was that these indicators should make up a 'quality of life barometer' which will be used to measure 'overall progress' towards 'a better quality of life for everyone, now and for generations to come'. The sustainable development indicator set includes factors such as adult numeracy and literacy, social investment as a percentage of GDP, river quality, levels of reported crime, air pollution levels, greenhouse gas emissions, waste arisings, and populations of wild birds as well as the more conventional economic indicators, such as GDP per capita and employment rates.[69] The latest edition of the Sustainable Development Indicators, launched in 2007, includes subjective measures of well-being as well.[70]

At regional level, implementation of the concept of satellite accounts has been patchy. In the UK, most regional effort has been focused around the development of regional economic strategies, regional spatial strategies and regional sustainable development strategies. These initiatives, which have gained increasing ground over the last decade, have now begun to spawn some useful regional databases. For example, the set of targets and actions identified by East Midlands in support of its ten strategic priorities can be thought of as a form of satellite accounts.

At the local authority level, the Audit Commission will, in 2009, based on work by the Young Foundation and **nef**, recommend how best to bring together data from the new 198 national indicators to form a coherent well-being indicator set.

The advantage of developing extended indicator sets of this kind is obvious. It allows national and regional governments at any one point in time to assess progress towards key social or environmental policy targets, and to understand how trends in different factors are evolving. Such databases are an essential first step, not just in understanding regional environmental and social trends but also in providing the foundation for adjusted economic indicators of the kind developed in this report.

One of the disadvantages of this approach however is the unwieldiness of such a disparate set of indicators. Recognising this, the UK Government selected 15 representative 'headline' indicators to reflect different aspects of its strategic sustainable development objectives. But even 15 indicators can present potentially confusing policy messages to policy-makers. What does it mean if seven of the indicators go upwards, and eight go downwards? Is this better or worse than the case in which eight go upwards and only seven go downwards, but go down more dramatically? Does it depend on which go up and which go down? How, in fact, can we make a balanced assessment of 'overall progress' on the basis of this knowledge?

In addition, of course, the identification of a limited set of headline indicators also introduces an element of selectivity (if not arbitrariness) into the measurement of progress. This is not to suggest that having a comprehensive set of satellite accounts is a waste of time. Far from it. But it does not necessarily take us any further forward in determining the 'overall' direction of progress, or allow us to investigate potential tradeoffs with economic growth.

## A1.2 Composite quality of life indicators

One way of addressing the multiplicity of indicators is to aggregate separate components of satellite accounts into a single index. An early attempt to construct such a composite indicator was Morris's Physical Quality of Life Index (PQLI) which quite simply aggregated measures of infant mortality, literacy and life expectation into a single unweighted indicator.[71] Slottje's Multidimensional Quality of Life Index incorporates 20 attributes including civil liberty, life expectancy, infant mortality, percentage of women and children in the labour force, energy consumption per capita, national territory per square kilometre of road and per capita GDP.[72] Estes's Index of Social Progress aggregates 36 social indicators into a single measure.[73] Another index involving 15 (mainly economic) variables has been developed at the Center for Living Standards in Ottawa, Canada.[74]

By far the most well-known and widely used attempt to construct a composite quality of life index is the United Nations Development Programme's Human Development Index (HDI).[75] Influenced heavily by the work of Amartya Sen, the HDI is composed of three elements: GDP per capita, life expectancy at birth and education, assessed in terms of literacy and school enrolment rates.[76] Reported annually for 177 countries in the world, the HDI has been very successful in raising the level of debate about the relationship between income growth and well-being. It has also helped to promote intelligent debate about health, education and poverty as related policy objectives in the World Bank and elsewhere.[77]

The main advantage of the composite quality of life indicators is to have a single point of comparison between different nations on the basis of a given set of objectively measurable factors known to affect quality of life. Such indicators, however, suffer from a lack of transparency and tangibility. What does an HDI of 0.703 look like? More importantly, as many authors have noted, they require typically arbitrary decisions to be made regarding weightings.[78,79] One solution to this is discussed at the end of section A.1.3.

### A1.3 Indicators of subjective well-being

A very different approach to the measurement of well-being derives from the understanding that economic resources are not in themselves final goods, but only intermediary in the 'production' of human well-being. Final welfare, according to one economist, 'consists of states of consciousness only and not material things'.[80] Another early economist argued that the services enjoyed by final consumers could be thought of as 'psychic income'.[81] From this perspective, it is legitimate to ask: can we measure this psychic income directly by inquiring about people's own perceptions of their quality of life.

This avenue of exploration has been developed widely over the last 30–40 years, on the back of an interest in how well people think they (and society) are doing. The most well-known indicators in this category attempt to measure reported life satisfaction – or 'subjective well-being' – by using survey methods based around questions such as: '*All things considered, how satisfied are you with your life as a whole nowadays?*' In the UK, as of 2007, Defra has begun to collect data on this question as an indicator of subjective well-being.[82]

Though simple in concept, the results of this exercise can be useful in understanding trends in life satisfaction in different countries and also in interrogating the relationship between per capita income and people's happiness.

An interesting pattern begins to emerge from this data. It transpires that in poorer countries, increases in subjective well-being correlate well with rising income per capita. But as income per capita grows, the correlation is much less marked. For countries with per capita incomes over $20,000 there is almost no increase in life satisfaction as GDP per capita continues to increase.[83]

This result appears to suggest that income is an important factor in improving people's well-being in poorer countries. But if improving well-being is the goal of development, then the importance of income diminishes as people get richer. At the level of the individual nation, the data appear to suggest a powerful 'life-satisfaction paradox'. Incomes in such countries have almost doubled in the last thirty years, but life satisfaction has barely changed at all.

If rising consumption is supposed to deliver increasing levels of well-being, these data on stagnant 'life satisfaction' pose a series of uncomfortable questions for modern society. Why is life satisfaction not improving in line with higher incomes? Is economic growth delivering improved well-being or not? What exactly is the relationship between income growth and life satisfaction?

Explanations for the life-satisfaction paradox have been sought in a variety of different places.[84,85] Some authors highlight the fact that relative income has a bigger effect on individual well-being than absolute levels of income. If my income rises relative to those around me I am likely to become happier. If everyone else's income rises at the same rate as my own, I am less likely to report higher life satisfaction. Moreover, if my increase in income causes envy in those around me, my increased satisfaction is likely to be offset by dissatisfaction in others, such that aggregate life satisfaction across the nation may not change at all.

Others point to the impact of 'hedonic adaptation'. As I get richer, I simply become more accustomed to the pleasure of the goods and services my new income affords me. And if I want to maintain the same level of happiness, I must achieve ever higher levels of income in the future just to stay in the same place.

Others have suggested a different – but equally radical – explanation for the life-satisfaction paradox. In their examination of quality of life in 74 different countries, *The Economist's* Intelligence Unit suggested the explanation for the paradox was that 'there are factors associated with modernisation that, in part, offset its positive impact'. It argues that:

> *'[a] concomitant breakdown of traditional institutions is manifested in the decline of religiosity and of trade unions; a marked rise in various social pathologies (crime, and drug and alcohol addiction); a decline in political participation and of trust in public authority; and the erosion of the institutions of family and marriage.'*[86]

The point about these changes – which have occurred hand-in-hand with the rise in incomes and the expansion of individual choice – is not that income growth is irrelevant to individual quality of life; we have already noted that it *is* relevant. Rather it is that the pursuit of income growth appears to have undermined some of the conditions (family, friendship, community) on which we know that people's long-term well-being depends.[87,88]

Returning to issues of measurement, one should note that the single life-satisfaction question has little use for policy makers on its own. Obviously, no single figure can offer fine-grained information or recommend specific policies. There is no immediately apparent 'theory of change' at hand when low levels of life satisfaction are found. Secondly, whilst life satisfaction does appear to correlate with interesting measures at the individual level, there is evidence that it lacks sensitivity when taken at the aggregate national level.[89,90,91] In other words, we may find that overall life satisfaction does not respond to policy changes in a useful manner. Given these problems, **nef** has begun exploring more textured measures of subjective well-being. For example, the Caerphilly Sustainability Index survey has recently been developed, which includes questions on not just hedonic well-being, but also the Aristotelian concept of *eudaimonic*[92] well-being. Meanwhile the European Foundation for the Improvement of Living and Working Conditions runs a European Quality of Life Survey which brings together data to explore levels of 'deficit' across Europe.[93] Four types of deficit are considered – having deficits, loving deficits, being deficits and time deficits. Both these approaches have the potential to provide policy-makers with more textured information on well-being. as with objective indicators, however, the problem of aggregation remains – for example does reducing 'having deficits' justify an increase in 'loving deficits'?

Another approach to the problems of sensitivity and policy implications is to return to objective data sources, but to use subjective data to help develop non-arbitrary weights. *The Economist's* Intelligence Unit has recently explored this approach, combining aggregate-level objective data to produce a single Quality of Life Index, using weightings derived from regression analyses using the objective indicators as independent variables and life satisfaction as the dependent.[94] This produces a single, predicted life-satisfaction value which has the potential to change over the years (if weightings are held constant), but also offers clear levers for policy change by identifying which objective conditions determine well-being and to what extent.

At the moment, however, this approach has not been fully explored, and remains rather atheoretical and data-driven.

## A1.4 Adjusted economic indicators

One of the first people to highlight the deficiencies of conventional economic measures of progress was the US economist Robert Eisner. The basis of his argument was that the GDP fails to distinguish appropriately between intermediate and final goods and cannot therefore be regarded as even a consistent measure of economic welfare. It counts investment in roads, for example, as a final good rather than an intermediary. It fails to account for some things – such as unpaid household labour – that clearly contribute directly to economic welfare. It includes work-related spending by households (such as commuting costs) as a final *good*, even though they are clearly only intermediary in the production of other aspects of economic welfare.[95,96]

The result of Eisner's critique was the development of a new accounting framework – the Total Income System of Accounts (TISA) designed to correct for some of these deficiencies. Though wide-ranging and impressive in its attempt to impose coherence on economic accounting structures, TISA was also notable for the absence of certain important aspects of well-being. For example, it fails to deal with the question of income distribution and it takes no account of the depreciation of natural assets or the loss of environmental quality.

Nonetheless, Eisner's attempt to correct – in economic terms – for the deficiency of the SNA was clearly one of the inspirations for others to attempt the same task. In particular, if it were possible to incorporate some of the environmental and social costs associated with income growth into a single measure of economic welfare, it was argued, this would provide a powerful way of understanding whether or to what extent growth was really contributing to overall progress in society. As we shall see in this section, this provided the inspiration for the development of a variety of adjusted economic measures including the ISEW.

### *Understanding GDP*

GDP may be viewed (and is conventionally calculated) in three different, but formally equivalent ways. It may be seen first as the total of all *incomes* (wages and profits) earned from the production of domestically owned goods and services. Next, it may be regarded as the total of all *expenditures* made either in consuming the finished goods and services or investing for future consumption. Finally it can be viewed as the sum of the *value added* by all the activities which produce economic goods and services. It is this third calculation which allows for the GVA to be used as a regional proxy for GDP.

Of the three formulations, however, it is the second which provides (arguably) the strongest foundation for a welfare-based interpretation of GDP. Specifically, the expenditure formulation sums all private and public consumption expenditures and adjusts these to account for net exports and the formation of fixed capital (i.e. gross investment). Since the sum of consumption expenditures is equivalent (under certain conditions) to the value placed by consumers on consumption goods, the GDP can be taken – according to the conventional interpretation – as a proxy for the well-being derived from consumption activities.

In formal economic terms, however, the equivalence of consumption expenditures with consumer values is valid only in perfect, equilibrium markets, and it is well enough known that in practice, markets are not perfect. Consumer preferences are not always the result of free, informed choice. Perfect information is particularly problematic in a message-dense society such as the one we live in. Consumers often find themselves 'locked-in' to specific patterns of consumption by a combination of perverse incentives, inequalities of access, social norms and expectations, marketing pressures and sheer habit.[97] To make matters worse, it is clear that public expenditure does not take place in equilibrating markets at all; government spending is not allocated according to market forces but according to the political and social priorities of the day.

Throughout much of the latter part of the twentieth century, the response advocated by economic and social theorists – particularly those on the right – to these market 'failures' was to strive for fewer market distortions: reduced taxation, improved information, lower public expenditure, less government intervention; in short to pursue hands-off, laissez-faire government. Since this strategy also has the consequence of placing more disposable income in the pockets of the electorate and reducing the drain on the public purse, it has had a strong appeal across the political spectrum.[98]

But the welfare-theoretic interpretation of GDP falls heavily at a number of hurdles other than those associated with simple market failure.[99] Even conventional economic theory recognises that it is not sufficient to attend only to current levels of consumption. Well-being today, it is understood, consists at least in part in feeling secure about our own (and our children's) well-being in the future. Future consumption possibilities must also play some part in any account of sustainable well-being. This realisation has a long pedigree and has formed the basis for numerous attempts to revise or adjust the GDP as a well-being measure.

### Hicksian income and the Net Domestic Product

The point was raised long ago by the economist John Hicks that 'the purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume [in the present] without impoverishing themselves' [in the future]. Thus, 'true' income should be calculated as 'the amount that a community can consume over some time period and still be as well off at the end of the period as at the beginning'.[100] Being as well off at the end of the period depends *inter alia* on having the same consumption possibilities in the following period. Since these consumption possibilities flow from income streams which are generated by capital investment, this requirement has often been translated into a demand to maintain capital intact. On one interpretation therefore, 'true' income is the income in the period minus the net depreciation of capital during that period.

At the national level, this would lead us to compute first the *Net* Domestic Product (NDP) by subtracting the depreciation of all capital assets from the GDP. Hicks's argument suggests that the NDP provides a better representation of national well-being than does the GDP. In fact, in a seminal paper in welfare economics, Martin Weitzmann argued that the NDP can be regarded as a proxy for sustainable national welfare in the sense that (under certain conditions at least) it is proportional to the present discounted value of all future consumption.[101]

In particular, therefore, a non-declining NDP can be taken as an indication of non-declining consumption possibilities into the future. Conversely, of course, the pursuit of NDP growth assumes (under this interpretation) a welfare-theoretic justification.

Though GDP may be flawed as a measure of societal well-being, an appropriate correction for capital depreciation is (according to Weitzmann and others) a suitable proxy for sustainable welfare.

It is clear that a correction of the kind outlined in the previous section requires only a marginal adjustment to the conventional picture. In 2000, for instance, NDP in the UK, as conventionally calculated, would have differed from GDP by less than 3%. The orthodox view, in which increasing quality of life is correlated with economic growth, might be regarded as surviving this kind of adjustment more or less intact.

### *Adjusted Net Savings (genuine savings)*

One very obvious extension of the Hicksian approach would be to account for the depreciation not just of physical (human-made) capital, but also of natural capital (the natural resource base) and human capital (the skills and capabilities of the population). This is the basis for an indicator called the Adjusted Net Savings – developed originally as the Genuine Savings Index by World Bank economist Kirk Hamilton.[102,103] In principle, Adjusted Net Savings measures the 'true rate of savings in an economy' after taking into account investments in human capital, depletion of natural resources and damage caused by pollution.

In practice, Adjusted Net Savings is calculated as the gross savings in the economy net of four[104] important factors: the depreciation of physical capital (as in NDP); the net depletion of energy, mineral and forestry resources;[105] expenditure on education (as a proxy for investment in human capital), and the estimated cost of annual carbon emissions (as an indicator of environmental damage).[106] Adjusted Net Savings is now calculated by the World Bank for around 150 countries and reported annually in the World Bank Indicators report.[107]

It is in principle possible to calculate a 'Green Net National Product' (GNNP) by replacing the gross investment component of GDP with Adjusted Net Savings. The resulting index would clearly be an improvement over GDP as a measure of welfare in an economy. At the same time, the Adjusted Net Savings measure has been criticised for being over-restrictive in its methodology – for example in relation to calculating resource depletion. It is also clear that in practice, GNNP does not entirely escape the kinds of criticisms traditionally levelled against GDP. It is therefore worthwhile to explore some more systematic attempts to construct adjusted measures of economic welfare.

### *Early adjusted measures of economic welfare*

Amongst the earliest attempts to address the shortfalls of GDP as a measure of economic welfare was a landmark paper published in 1972 by Nordhaus and Tobin, entitled *Is Growth Obsolete?* In that paper, the authors constructed a 'measure of economic welfare' (MEW) by adjusting GDP to account for certain economic and social factors not normally included in the GDP. The original MEW was less concerned with the environmental factors affecting economic welfare. The results of the exercise indicated that between 1929 and 1965, economic welfare – as measured by the Nordhaus and Tobin index – increased consistently; but that the growth rate in MEW was somewhat slower than the growth rate in GDP. The authors concluded from this analysis that growth was not obsolete; that, on the contrary, it continued to deliver increasing levels of welfare; and that as an indicator of well-being, GDP could still be regarded as robust.

When Nordhaus examined the same question from an environmental perspective in 1992, in a paper entitled *Is Growth Sustainable?* he discovered that his (revised)

MEW began to diverge more substantially from GDP in the later years of the study. Nordhaus attributed this increased divergence to 'conventional sources' such as declining productivity growth and dwindling savings rather than to the unsustainable use of natural resources. But the importance of the study was already clear enough: by making certain economic, social and environmental adjustments to the conventional measure, it had been possible to show that GDP could not necessarily be regarded as a robust indicator even of economic welfare, let alone of social well-being or quality of life.

A more radical attempt to incorporate environmental and resource effects into an adjusted economic indicator for the US was pioneered by Zolotas.[108] Even in the mid-1970s Zolotas was able to demonstrate that his index of the Economic Aspects of Welfare (EAW) rose more slowly than GDP. Zolotas argued that there would come a time – as the quotation at the beginning of this appendix suggests – when an increment of economic output would produce no increase in welfare at all.

In the concluding section, we shall return briefly to this hypothesis which appears, at one level, to have been reinforced by the broadest set of studies to attempt to construct an adjusted economic measure – the Daly and Cobb Index of Sustainable Economic Welfare (ISEW).

### *The Daly and Cobb Index of Sustainable Economic Welfare*

The ISEW was first developed for the United States for the years 1950 and 1988 by Herman Daly and John Cobb and printed as an appendix to their landmark book *For the Common Good*.[109] A slightly revised version of the index, updated to 1990, was published by Clifford Cobb and John Cobb in a collected volume of papers on the *Green National Product* which also incorporated some early criticisms of the ISEW methodology.[110]

Daly and Cobb's aim was to develop an indicator capable of reflecting the range of criticisms which had been directed at GDP as a welfare measure. They wanted, for example, not only to incorporate a correction for the depreciation of natural and human-made capital, but also to account for reduction of welfare associated with the unequal distribution of incomes.[111] They aimed to include the contribution to welfare from the 'informal' economy,[112] correct for the social and environmental costs of production, and take account of so-called 'defensive' expenditures: 'expenditures necessary to defend ourselves from the unwanted side-effects of production'.[113] As Robert Kennedy's Kansas speech pointed out, the GDP includes a variety of these kinds of expenditures. An increasing proportion of the national income may be spent on cleaning up environmental damage resulting from the production of goods and services, or on treating illnesses arising from impaired environmental quality or social degradation. These 'defensive expenditures' may be vital to maintain our quality of life against the adverse welfare impacts of other expenditures. But it is surely then inappropriate to count both sets of expenditures as positive contributions to welfare.

The Daly and Cobb ISEW starts out from the standard economic measure of private consumer expenditure or 'personal consumption'. For various reasons, many of which are discussed elsewhere,[114] this measure may not in itself provide an unassailable basis from which to account for welfare in the nation. Nevertheless, it is clear that personal consumption provides some indicator of the amount of money which consumers are willing to pay for (and hence the value they assign to) the goods and services through which welfare may be provided.

### *Genuine progress and beyond*

Since the publication of the original US ISEW, several similar studies have been carried out in the US and elsewhere. Many of these studies incorporated additions or revisions to the original methodology. One of the less significant but potentially more confusing revisions of the ISEW has been a kind of 'rebranding' of the original idea.

In 1995, Clifford Cobb and his colleagues at an organisation called *Redefining Progress* decided that the terminology of ISEW was not particularly attractive to most people and published an index – based substantially on the ISEW methodology – called the Genuine Progress Indicator (GPI).[115] The idea of the 'rebranding' was to have a shorter, more accessible acronym, which specifically identified the index as a better indicator of national progress than the GDP.

The GPI also introduced certain factors that had been left out of the original ISEW, including adjustments for social costs such as crime, divorce and unemployment – all recognised as factors affecting the level of well-being in the nation. Some later versions of the ISEW or GPI have extended this set of factors to include the psychological and social costs associated with under- and over-employment.[116]

In 2004, **nef** published an updated ISEW variant for the UK which was again re-branded, this time as a Measure of Domestic Progress – MDP[117,118] (Figure 5). One of the aims of this work was to cast the green GDP more specifically as a useful way of measuring a country's progress towards sustainable development. The various components of the index were related explicitly to the different dimensions of sustainability: economic, social and environmental. It is this ISEW that the R-ISEW presented in the body of this report is based upon.

# Appendix 2. The numbers

## A.2.1 R-ISEW by region (£m 2005/06)

| | North East | North West | Yorkshire & Humber | East Midlands | West Midlands | Eastern | London | South East | South West | England |
|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 17,352 | 63,570 | 27,648 | 25,273 | 45,055 | 36,572 | 43,259 | 57,188 | 41,553 | 357,188 |
| 1995 | 18,600 | 64,097 | 29,208 | 28,037 | 45,790 | 36,717 | 48,714 | 57,789 | 43,233 | 371,726 |
| 1996 | 19,677 | 67,118 | 32,003 | 27,076 | 47,559 | 42,913 | 49,210 | 63,093 | 45,166 | 393,026 |
| 1997 | 20,204 | 68,968 | 32,379 | 30,630 | 46,389 | 38,964 | 53,953 | 63,741 | 47,007 | 401,637 |
| 1998 | 20,839 | 68,027 | 33,628 | 31,215 | 48,146 | 43,068 | 54,312 | 68,275 | 47,356 | 414,441 |
| 1999 | 21,495 | 70,108 | 34,997 | 33,775 | 48,747 | 47,151 | 63,542 | 68,078 | 50,010 | 436,638 |
| 2000 | 21,151 | 72,129 | 36,219 | 33,640 | 49,163 | 45,642 | 61,238 | 71,833 | 51,688 | 442,242 |
| 2001 | 22,822 | 75,356 | 37,134 | 36,954 | 50,560 | 45,746 | 70,890 | 76,598 | 53,684 | 469,595 |
| 2002 | 23,098 | 77,296 | 40,107 | 37,542 | 51,061 | 49,896 | 80,663 | 81,613 | 58,593 | 499,231 |
| 2003 | 23,710 | 80,125 | 44,404 | 38,435 | 54,160 | 50,907 | 81,263 | 78,516 | 62,894 | 513,836 |
| 2004 | 24,149 | 81,547 | 47,317 | 41,860 | 55,502 | 53,301 | 82,348 | 80,798 | 64,685 | 531,471 |
| 2005 | 24,466 | 81,706 | 46,763 | 43,127 | 54,759 | 54,457 | 87,756 | 82,072 | 63,833 | 538,697 |

## A.2.1 R-ISEW per capita by region (£ 2005/06)

| | North East | North West | Yorkshire & Humber | East Midlands | West Midlands | Eastern | London | South East | South West | England |
|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 6,702 | 9,295 | 5,574 | 6,207 | 8,584 | 7,063 | 6,293 | 7,415 | 8,735 | 7,406 |
| 1995 | 7,201 | 9,387 | 5,888 | 6,852 | 8,710 | 7,053 | 7,047 | 7,444 | 9,041 | 7,683 |
| 1996 | 7,639 | 9,856 | 6,451 | 6,591 | 9,036 | 8,200 | 7,056 | 8,089 | 9,423 | 8,101 |
| 1997 | 7,868 | 10,151 | 6,531 | 7,434 | 8,816 | 7,398 | 7,691 | 8,117 | 9,738 | 8,253 |
| 1998 | 8,137 | 10,016 | 6,783 | 7,553 | 9,134 | 8,123 | 7,687 | 8,654 | 9,766 | 8,489 |
| 1999 | 8,429 | 10,351 | 7,062 | 8,135 | 9,246 | 8,831 | 8,882 | 8,558 | 10,246 | 8,905 |
| 2000 | 8,317 | 10,648 | 7,304 | 8,071 | 9,329 | 8,492 | 8,462 | 8,989 | 10,512 | 8,982 |
| 2001 | 8,985 | 11,126 | 7,461 | 8,820 | 9,574 | 8,472 | 9,682 | 9,547 | 10,861 | 9,497 |
| 2002 | 9,101 | 11,396 | 8,033 | 8,890 | 9,627 | 9,203 | 10,943 | 10,146 | 11,794 | 10,056 |
| 2003 | 9,338 | 11,774 | 8,865 | 9,039 | 10,181 | 9,319 | 10,999 | 9,717 | 12,581 | 10,307 |
| 2004 | 9,489 | 11,945 | 9,390 | 9,780 | 10,405 | 9,707 | 11,085 | 9,963 | 12,839 | 10,610 |
| 2005 | 9,564 | 11,935 | 9,234 | 10,016 | 10,207 | 9,826 | 11,673 | 10,053 | 12,595 | 10,682 |

# Appendix 3. Impact analysis of recent changes to methodology

The headline results of the regional R-ISEWs in this report differ to varying degrees from those calculated over the last two years for some regions. In the South East for instance, the difference is quite small, ranging from minus 3% in 2004 to plus 10% in 2002. In the East Midlands, it is a little more significant: ranging from 7% in 2001 to 20% in 1997.

The reasons for this are twofold: first, there have been a number of revisions to the methodology, including the addition of new costs and benefits; and secondly, because some of the underlying datasets are subject to annual revision.

Three new components have been added in this version of the R-ISEW: the loss of leisure time due to commuting; industrial accidents; and pollution abatement. Between them, these new components add around 10–15% to the costs deducted from the R-ISEW.

Against this, we now include *all* public expenditure on education as a social benefit, including primary and secondary (these were excluded from previous R-ISEWs as defensive costs); and we exclude the personal pollution control costs. The latter reduces costs by only 1–2%, but the additional public expenditure adds up to 50% to this component, and raises the headline R-ISEW by up to 10%. We also update the unit valuation of domestic labour and volunteering to a constant 2005 rate for UK domestic services; this adds up to another 10% in the earlier years of the study.

In the resource depletion component, we have improved estimations of transport fuel use and energy use in services. Revisions to the GVA datasets used in the calculations also affect the results here, particularly in industrial energy use. For long-term environmental damage, we have better estimates of methane emissions which also increase costs (methane is one of the most powerful greenhouse gases, so any increase in emissions translates into a much larger difference in overall costs). Between them, these two components increase the headline R-ISEW by up to 8%, though this varies between regions depending on the absolute level of costs in these categories.

In measuring income inequality, we now have access to better data which removes a lot of estimation from the calculations; the effect of this is not huge – around plus or minus 3–4%, but the magnitude and direction varies between regions, making the rise in inequality less pronounced in some regions, and more so in others.

Finally, two of the components which experience the greatest differences are the ever-volatile net capital growth and net international position. Here we have introduced only minor revisions to methodology to replace some extrapolated figures with new data. The changes seen here are in large part due to changes in the underlying datasets: regional estimations of GVA and the Pink Book balance of payments data are periodically revised. Although the changes in those datasets may not appear to be large as a proportion of the original values, these components are all about changes at the margins, especially net capital growth. Apparently small changes can significantly affect the R-ISEW calculations, especially when datasets such as net capital expenditure and the various components of the balance of payments are in themselves quite volatile.

# Appendix 4. Methods and data

## A4.1 Overview

Most of the data used to construct the English Regions R-ISEW have been taken from UK government statistics, often provided through the Office for National Statistics (ONS). Since the mid-1990s, a growing range of statistical publications have been broken down at the level of the Government Office Regions (GOR). The GORs only exist in England, but datasets sometimes also include parallel data from Scotland, Wales and Northern Ireland. They also sometimes include a UK comparator.

Regional data prior to the mid-1990s is patchy at best and makes it difficult to construct a regional index with an acceptable degree of robustness. For the purposes of this exercise we have therefore adopted the time period from 1994 to 2005 as the object of study. This time-series still involves some regression or interpolation where datasets begin later than 1994. It has also sometimes involved some forecasting, as the most recent data are sometimes from 2004. But trend estimations are limited to the minimum possible, and remain within the bounds of confidence in this context.

The compilation and use of regional datasets is a comparatively new field and is still subject to difficulties (the ONS often postpones publication of its regional GVA estimates because of uncertainty over the data). It is assumed, however, that the quality and range of regional data will continue to improve as the compilation techniques and sources mature, so that the ability to construct the R-ISEW will only strengthen over the coming years.

A continuing source of uncertainty in constructing an R-ISEW is the difficulty of assigning monetary values to social and environmental factors. Monetary estimations can involve assumptions or value judgements which may be difficult to justify on any concrete first principles – for instance, climate change science is still in its infancy and there are simply no definitive answers to the question of how much climate change will 'cost'. Indeed, we continue to rely on the best estimates laid down in a joint Treasury/Defra report from 2002, although the recent Stern Report on the economics of climate change suggests that these may need to be revised. Unfortunately, due to some opacity in the report as to how their cost models work, we have not been able to incorporate any new values into the R-ISEW at this point.

In such instances we have chosen to use, as far as possible, the most widely accepted or defensible values.

The following sections describe in some detail the assumptions, data sources and methods employed to calculate the individual components of the R-ISEW. All prices have been converted to constant £2005/2006 using the GDP deflator series from HM Treasury.

The last section of this appendix is a brief note on the relation between the R-ISEWs for the regions, and the R-ISEW for the whole of England.

## A4.2 Economic factors

### *Consumer expenditure*

The initial basis for the index is personal consumption – final household expenditure – as this is an indicator of the value which individuals assign to the goods and services through which welfare is provided. At the UK level, these data are taken from the UK National Accounts *Blue Book*[119] datasets. To derive regional figures we used household expenditure data from the *Expenditure and Food Survey* (formerly the *Family Expenditure Survey*)[120] as a proxy.

Regional household expenditure data are provided as the weekly average spend per household. Data exist only from 1994–2004, so figures for 2005 are estimated from 1994–2004 trends. Combining these data with population data (from ONS population estimates)[121] and the average number of people per household (also given in the *FES/EFS*), gives an estimate of total consumer expenditure for each region. We perform the same calculations for the UK spending data and then divide the regional figure by the national to show the region's household expenditure as a proportion of the UK total. This ratio is then applied to the UK *Blue Book* data to give an estimation of total regional personal consumption.

### Net capital growth

Capital formation needs to be offset against growth in the labour market, if we assume an equal amount of capital per worker is necessary to maintain productivity. We use UK data on net capital stocks from the ONS *National Accounts* datasets,[122] and derive regional estimates using regional data on net capital expenditure by industry, which is reported in the *Annual Business Inquiry*.[123] The net stock per worker is calculated for each year, then multiplied by the change in the available labour force (population of working age)[124] in that year to derive a capital requirement to maintain the status quo. The remaining capital formation is the net capital growth.

Regional data on net capital expenditure is available for the years 1998–2004. We calculate the ratio of regional expenditure to UK expenditure for these years, and then extrapolate the trend in this ratio to cover the whole time period. These percentages are multiplied by the UK data on net capital stocks (excluding dwellings, are these are not part of the production process) to give regional estimates. To reduce sampling errors we take a rolling five-year average to derive the change in stocks for each year.

This is multiplied by the change in the available labour force each year (also taken as a rolling average) to give the benchmark capital requirements for that year, then this figure is subtracted from the capital growth to give net capital growth.

### Net international position

The purpose of this component in national ISEW-type indicators is to assess whether the country is maintaining a sustainable balance of payments or is running up international debt. At the subnational level, this does not hold in the same way, because it is impossible to obtain sufficiently detailed data to treat any region as a trading bloc in its own right, and establish ‘imports and exports’ to other *regions* as well as outside the UK. However, it is useful to show how each region contributes to the UK's net international position rather than simply omitting it.

To do this, we start with UK balance of payments data taken from the ONS's *Economic Trends* datasets,[125] and derive regional estimates using GVA and data on regional imports and exports as a share of the UK total. The import/export data was sourced from HM Revenue and Customs' regional trade statistics for 1996–2005,[126] and extrapolated from the trends to 1994–1995.

The balance of payments data are broken down into imports, exports, and income and current account transfers. We multiply the UK import and export figures for each year by the relevant regional percentages of UK imports/exports. We use these percentages calculated from the HM Revenue and Customs data rather than using the reported data, because these latter only count imports and exports of *goods*, not goods *and services*. We cannot assume that the percentage of UK trade in services is the same as that in goods, so we use regional consumer expenditure as a proxy for the *imports* of services; and regional GVA in private services as a proxy for service *exports*.

To estimate the regional share of income and current account transfers we use regional GVA as a proxy. The resulting three figures are summed to give a total for each year which represents the 'net international position' of each region. A rolling average is used, as this dataset is prone to sharp swings which can have a disproportionate effect on the overall R-ISEW.

### *Services from consumer durables*

Expenditure on durable goods is included in the personal consumption data, but this in itself does not accurately reflect the welfare contribution of durable goods, because this may be enjoyed over the period of several years rather than just this year's accounting period. To adjust for this, we calculate the difference between expenditure on consumer durables and the service flows from the net stock of durables in each year, and subtract this from top-line expenditure. These estimations are problematic given the scarcity of estimates of the net stock of durables, and service flows from that stock.

The most recent estimates of the stocks and flows of consumer durables in the UK are in a 1997 paper,[127] and give estimates from 1948 to 1995. In previous R-ISEW calculations we had simply extrapolated from there, but as those estimates age and the time period under study moves forward, this approach becomes increasingly indefensible. Instead, we adopt a simplified model to estimates stocks from durables expenditure: we assume an average eight-year lifespan for all durables with linear depreciation, so a given purchase will lose 1/8 of its value each year, and be retired from the stock after 8 years. In any given year then, we calculate the net value of stocks to be the full amount of expenditure in that year, plus 7/8 of the previous year's expenditure, 6/8 of the year before that … and so on.

We then estimate annual service flows as 1/8 of the net stocks in that year, plus an additional proportion of the stock to account for the interest foregone. In this we follow the established methodology for treating consumer durables as household capital – in choosing to invest in durable goods which provide an ongoing flow of services instead of putting the money in the bank, the consumer implicitly values that good at the purchase price *plus* the interest foregone in making the purchase.[128,129,130] The interest rate used in the calculation is the average Bank of England base rate over the period of the study.

## A4.3 Social factors

### *Household labour and volunteering*

The value of services from domestic labour and volunteering are added to the index, as this is a major source of productive value which goes uncounted in conventional economic measures. Valuing an hour of household labour and volunteering is problematic: we use an UK average wage for domestic staff (source: *ASHE*[131]). This hourly wage is then applied to time use data from the ONS's *UK Time Use Survey* of 2000 [132] and its pilot study in 1995.[133]

Time-use data are sporadic and subject to many uncertainties involving the coding of time slots, especially where the coding is done directly by the individuals surveyed rather than via interview with survey staff. Categories are not always directly comparable between different surveys, and the margin of error due to sample size in the earlier survey is quite large.

In this version of the R-ISEW we therefore discard much of the older, reported time-use data we had been relying on, and have gone back to the raw time-use data from the more recent and reliable ONS surveys. Where the data appear to conflict (particularly where we are looking at regional rather than national figures), we look to the more comprehensive 2000 data. We filter out any respondents not in the 16–60/64 age bracket, as domestic labour is conventionally calculated only on the basis of people who could be economically active.

The mean minutes per activity, per day, per person are converted to hours per year and scaled up using the regional population of working age, to give a total figure for domestic labour and volunteering person-hours for the region. This is then valued using a constant wage rate: we use the UK average wage in 2001 (the mid-point of the study) in the category 'domestic staff and related occupations'.

### *Public expenditure on health and education*

There is some debate in the literature over the way to treat public expenditure – whether some proportion should be considered defensive spending which does not actually contribute to welfare. Rather than deeming an arbitrary proportion of expenditure to be defensive, we consider *all* expenditure on health and education to be a non-defensive benefit. In this model, defensive expenditure on health is subtracted elsewhere in the index, for instance by counting the health costs of crime, car accidents and atmospheric pollution, and all education is deemed a social benefit.

This is a change from previous versions of the R-ISEW, where we still followed the spirit of the early ISEWs in deeming a proportion of education expenditure as 'defensive' on the grounds that it is necessary merely to maintain a country or region's competitiveness, but this seems too limited an interpretation of education.

The data for this component are taken from the Treasury's *Public Expenditure Statistical Analyses* (*PESA*) datasets.[134] Data are available at UK level for all years, but only from 1996 at GOR level. For the years 1994–1995, we back-cast from 1996 using the UK trends.

### *Effects of income distribution*

The measure used to determine the costs of unequal income distribution is the Atkinson Index. This has the advantage over other inequality measures of containing an explicit variable *epsilon (ε)* which represents the degree of aversion to inequality.

Income inequality is usually measured using net income after tax and benefits in order to capture redistributive effects. In previous versions of the R-ISEW, we began with gross weekly pay from the *Annual Survey of Hours and Earnings* (*ASHE*),[135] estimated the means in each income decile from there, and then corrected for the effects of tax and benefits following UK trends.

This involved more assumptions and stages of estimation than we would like to have, but given limited resources at the time, it was the best estimation possible. In this version we go back to the raw data on household income after tax and benefits from the *Family Resources Survey*. This is equivalised for household composition using the McClements factors (because a couple living on *X* pounds per week are relatively better off than a family of four living on the same *X* pounds per week).

The Atkinson Index requires mean incomes in each group, so we order the households into income bands for each region (and for England and the UK as a whole), and take the mean of each band for each year. The Atkinson Index is then calculated using the following equation:

$$I = 1–(\sum(Y_i/Y^{(1–\varepsilon)} \times P_i))^{1/(1–\varepsilon)}$$

where $Y_i$ is the average income in the $i$th group of the income population, $Y$ is the average income in the whole income population, $P_i$ is the proportion of the income population in the $i$th group, and $e$ is the aversion to inequality.

A value of ε of 0.8 is generally used as the norm in the literature, though acceptable values range from -0.5 (indicating a preference for some inequality) to 2.5 (strongly anti-inequality).

The resulting values are then multiplied by the consumer expenditure figures to give the social cost of inequality: this cost is subtracted from the original consumer expenditure to give income-adjusted personal consumption.

### *Costs of crime*

Data for this component come from various sources, principally the Home *Office* [136,137,] but also the Department of Transport for some vehicle-related theft data.[138] These all give the numbers of reported crimes in various categories; there are some disjunctures in the data where offence categories change, and also where certain offences (e.g. common assault) become notifiable. No attempt has been made to adjust for these disjunctures as there seems to be no defensible method for doing so; and because the effects are not large. Data on most costs come from a report from the Home Office research department which gives estimates of the economic and social costs of crime. This report was updated in 2003–2004,[139] and we use the costs from there. Other cost data related to commercial victims of crime come from the Home Office's *Commercial Victimisation Survey* from 2002.[140]

The costs of crime estimated by the Home Office are broken down into categories, some of which are not included in the R-ISEW. Health service costs *are* included, because we are including public health expenditure as a benefit elsewhere in the index; victim services and legal costs are not, because the public expenditure on these services is not included in the index to begin with. These are therefore removed from the cost for each category of crime to give an average allowable cost per incident before combining this with the numbers of incidents.

In addition to the preventative cost components estimated by the Home Office report, we also have data on the average defensive expenditure by businesses against crime. To simply include this in its entirety would be to double-count some costs, but it is appropriate to include *some* of it. Commercial properties require greater expenditure per incident to protect against crimes such as theft (they are larger, more likely to be empty of people but full of valuable goods, and in business districts there are no neighbours to watch over them). They also have to spend money to protect themselves against fraud and forgery, which is not covered in the Home Office costs.

To ensure we have made some accounting for these factors, we take 50% of the average crime prevention expenditure per business, and multiply it by the number of VAT-registered businesses in the region.

## *Costs of family breakdown*

Divorce statistics (numbers of divorces granted per year) were supplied by HM Courts Service.[141] Estimating the unit cost of divorce is problematic, as it is extremely multifaceted. Some aspects are covered by other components of the ISEW: for instance, lost output will be reflected in lower consumer expenditure. But the true costs also include the emotional impact on divorcees and their families, greater pressure on housing stock and thus rising prices, 'unnecessary' consumption (a married couple only needs one kettle but a divorced couple needs two), as well as the arguable and almost certainly unquantifiable effects on social cohesion in general.

We identify two kinds of cost in this category: direct defensive costs (legal fees, maintenance payments, setting up a new home, etc) and costs due to the increased risk of mortality (many studies have shown a correlation between family breakdown and shortened lifespan).

To estimate defensive costs, we take the results of two surveys carried out by the insurance industry, which put the total UK cost of divorce at approximately £2 billion in 2003 and £2.5 billion in 2006. We divide each of these by the number of UK divorces in those years and use the average of the two as our unit cost per divorce.

The second kind of costs are based on an American study of 180,000 men and women aged 45–64,[142] which assessed the change in risk of mortality following divorce, and applying these risks to the median value of a standard statistical life.

## *Costs of commuting*

In line with some other ISEWs, we now account for the loss of leisure time as well as the direct costs of commuting (motoring expenses and public transport fares). The unit value of an hour's commuting time is based on research from the Department of Transport,[143] which estimates the mean perceived value of commuting time in 2002 at £5.04 per hour in current prices, and that this varies with income with an elasticity of 0.8. This can be used to estimate valuation costs for other years by using the mean hourly wage for each year from *ASHE*. The time spent commuting is available at regional level in the Department for Transport's (DfT's)*Regional Transport Statistics*,[144] so the two are combined to give regional total costs.

To estimate direct costs we rely on travel data from the DfT's *National Travel Survey*[145] and its *Regional Transport Statistics*,[146] and expenditure data from the *FES/EFS*.[147] The travel data are used to calculate what proportion of travel via three main types of transport (private motor vehicle, bus/coach and rail/tube) is due to commuting, and then we take that proportion of the relevant household expenditure as the cost.

The ideal travel data would give distances travelled due to commuting and other purposes, so that we can calculate the number of passenger-kilometres due to commuting. Unfortunately this is not available at the regional level, or even consistently at the national level. At the regional level, we have the *number* of commuting and other trips, but this does not take into account the fact that most commuting trips are longer than most shopping trips. To assign a fair proportion of travel costs to commuting, we really need to work off distance rather than number.

To do this, we take the national data on distance travelled and modes of transport, and interpolate as necessary to give a full time-series. We then compare these to the national data on the number of trips, and establish a relationship between them. This is then applied to the regional data on number of trips by each mode of transport to estimate regional distances travelled due to commuting.

Finally, we take household expenditure on these three modes of travel (including motor insurance in the private vehicle category) from the *FES/EFS*.[148] The totals for each mode of travel are then multiplied by the proportion of travel due to commuting, and then again by the appropriate proportion of commuting by that mode of transport to give an estimate of the total costs of commuting for each; these are then summed to give an overall cost.

Note that the motoring costs are adjusted to account for the proportion of people who commute as *driver* and those who are a *passenger* (we only want to count motoring costs once per car, rather than per person). Finally, we use the survey sample metadata (number of people per household) and regional population data to translate this weekly household expenditure into a regional total per year.

### *Costs of car accidents*

The data for this component is sourced from the DfT's *Regional Transport Statistics,*[149] but also from the ONS's *Annual Abstract of Statistics*.[150] Costs are taken from a briefing paper the DfT published in 2003.[151] This paper gives an average cost per incident in the four categories of accident for which statistics are commonly reported: accidents involving damage to vehicles and property only; accidents producing slight injury; accidents producing serious injuries; and accidents producing fatalities.

Accidents which resulted in serious injury or death are bracketed into a single KSI (Killed or Seriously Injured) category at the regional level. Costs are substantially different for serious injury and for death, however, so we estimate a breakdown of this figure at the regional level using the average split at the UK level for 1994–2004. The costs given in the DfT's briefing paper are broken down into categories; following the reasoning outlined in the comments on the costs of crime outlined above, we include medical and ambulance costs but exclude police costs.

### *Costs of industrial accidents*

We have some regional data from the Health and Safety Executive on the costs to employers of injury, and we also have some UK estimates of *overall* costs – i.e. including the costs to individuals and society as well as to employers. These costs are from 2001. We also have some unit costs of injuries in different sectors, from which we derive two weighted mean costs per injury (‘serious or major’ and ‘over 3 days’). For fatal injuries we assume the same unit cost as for car accidents.

We then have incidence rates for 2001 to 2005; using these with the unit costs we estimate interim costs per region for those years. We do not use these costs directly, because they do not tally with the totals as reported from 2001; rather, we index these figures on 2001 (and extrapolate back to 1994), and use this index with the reported 2001 costs to give consistent cost estimates for each year.

The costs of illness due to work are not included in these analyses.

## A4.4 Environmental factors

### *Costs of air pollution*

The National Air Emissions Inventory (NAEI) maintains a time-series database of certain pollutants in the UK,[152] the most recent of which are for 2004 and are available at a granularity of 1km x 1km across the country; previous years are available at the national level only. We use the regional data from 2004 to estimate regional emissions for previous years, applying the 2004 proportions of the UK totals to the national data for each year. Emissions measured in this way are: carbon monoxide, carbon dioxide, methane, nitrous oxides, sulphur dioxides, particulate matter smaller than 10 micrometres (PM-10s), volatile organic compounds (VOCs), lead, benzene, and 1,3-butadeine.

Of these, we have sourced estimates of the social/environmental costs per tonne for all but lead, benzene and 1,3-butadeine, which are therefore omitted from the air pollution costs in the ISEW. Carbon dioxide and methane are not used in this component but are costed in the long-term environmental damage component instead. Nitrous oxide is also costed for its climate change effects in that component, but the immediate pollution effects of all oxides of nitrogen are costed and used in this component. Unit costs are taken from a number of sources[153,154] and averaged to derive plausible working values.

The NAEI database can be interrogated by local authority area to produce results for each 1km$^2$ in each authority: these were then summed to give regional totals for each pollutant. Total emissions are multiplied by the cost per tonne for the selected pollutants, and these are summed to give an overall total cost.

### *Costs of water pollution*

The Environment Agency gives data[155] on chemical and biological quality of a given stretch of river; the results are given separately, as the percentage of total river length which falls into each category. We take the average of the chemical and biological quality as a measure of overall quality.

A Defra paper published in 1999 looked at possible policy measures to control pollution.[156] This estimated the benefits associated with bringing a stretch of river up from one quality grade to another, which we use in conjunction with the Environment Agency data. The target quality of all lengths of river is set at ‘good’.

The costs estimated by Defra for a change in river quality are based on a model which has four scenarios and thus four sets of costs: (i) low density population, agricultural; (ii) high density population, agricultural; (iii) clean industry and (iv) traditional industry. We take an average of the costs given by the scenarios which best characterise each region. The costs are only calculated for improving a stretch of river by a single quality grade, so we derive the necessary additional figures from these to be able to cost the improvement from the worst grade to the best.

The costs give are per kilometre of river: for each category *below* the target quality of ‘good’, we derive the cumulative cost of bringing 1km up to the target standard, and then multiply those costs by the lengths of river in each subtarget category.

Given the lack of overlap between the regions defined by the Environment Agency and the GORs, one should not be surprised to see that the sum of the costs of water pollution for all regions does not come to the same figure as the total cost of water pollution for England for any given year. Section A4.5 in this appendix investigates this discrepancy in more detail.

### *Costs of pollution abatement*

Defra provides current and capital expenditure per employee in different industry sectors for 2001–2004. We annuitise the capital costs over ten years with an interest rate of 5%, and extrapolate for the remaining years in the period. We then use employment data from the *Labour Force Survey* to get total number of employees in each sector for each region. These figures are combined with the unit costs and summed across all sectors to give total costs for each region.

### *Costs of noise pollution*

Whereas in the past we have restricted the noise pollution costs to road traffic, we now also include aviation noise. Estimates of the total cost of road traffic noise in the UK were sourced from three studies,[157,158,159] which all yielded similar results. We take the average of these, which is approximately £2.9 billion in 1993. We then use data on vehicle-kilometres per region from the DfT's *Regional Transport Statistics* to apportion an appropriate amount to each region.

Aviation noise is costed using two sources. First is an estimate of the total noise pollution costs of activity in and out of Heathrow airport,[160] which is combined with the number of Heathrow flights from the Civil Aviation Authority[161] to give a cost per flight of about £90. We also refer to a document from HM Treasury which estimates the noise pollution cost per flight at rural airports is about 1/8 of the cost at Heathrow (because less people are affected by it).

Then we estimate what proportion of flights in each region going to and from rural and urban or semi-urban airports, by looking at the 20 busiest airports in the country, and their surroundings. For instance, in the North East, around 80% of flights are to or from the semi-urban airport of Newcastle, while 20% go to the rural Teesside airport. Using these breakdowns with data on the total number of flights per region, we can estimate the costs from aviation noise in each region.

### *Costs of loss of natural habitats*

To value the loss of natural habitats, we use a willingness-to-pay model to estimate a cost per hectare: data from the Royal Society for the Protection of Birds (RSPB) in three separate purchases of wetlands for conservation values a hectare of wetland at between £3,093 and £6,373 (at 2005/06 prices). These figures agree with a study from 1994 giving a range of WTP values from £1,529 to£5,703 per ha.

As natural habitats should be considered a capital stock which we have been depleting for some time without accounting for it, a cumulative model is appropriate here. The actual data on habitat loss are not available for all years: UK data were estimated from several sources for the *MDP 2002*,[162] but regional data are only available for 1990 and 1998 in the *Countryside Survey* (*CS 2000*).[163] We use this together with various estimates of wetlands loss in the UK and northern Europe[164] to extrapolate back to a starting point of 1930, assuming a constant proportional loss of 1.3% per year. The cumulative total loss since 1930 is calculated for each year and multiplied by the cost per hectare.

### *Costs of loss of farmlands*

The loss of farmlands is costed using two components: first, soil erosion and loss of productivity due to intensive agriculture and secondly, loss of land actually given over to agriculture. We take the UK MDP[165,166] estimates of both costs and scale to the regional level using the area of land under agriculture as a proxy. Data for land use are taken from the *CS 2000*,[167] the Eurostat regional statistics database[168] and Defra's *June Agricultural Census*.[169] These sources have some gaps over the period which require interpolation of data points.

To estimate soil erosion costs, we use the UK MDP estimates of UK annual productivity loss and the cumulative loss at 1950, and scale them down to the regional level using the ratio of area of land under agriculture in each region to that in the UK. We then multiply this by the total area of land under agriculture in each region to get a cost of soil erosion for each year, and accumulate it.

In an improvement on previous R-ISEWs, we have sourced concrete figures for the amount of land under agriculture in each region in 1950; these starting points were previously estimated using an assumed annual rate of loss. Again using the UK MDP unit costs, we calculate the cumulative cost of the loss of farmlands for each region. Finally, the soil erosion and loss of farmland costs are combined to give a single total cost for each year.

### *Long-term environmental damage*

The data sources and methodology for this component are almost identical to those for the air pollution component described above.[170,171] Regional data for methane and nitrous oxide are not available. We derive estimates for methane based on three proxies, each representing one of the major sources of methane. For energy production, we use sulphur dioxide emissions as a proxy, because over 90% of $SO_2$ emissions are from energy production. For enteric fermentation we use livestock numbers from the *June Agricultural Census*, and for waste, we use population (direct waste data is only available for the last 2–3 years). The relative proportions of each of these sources in each year are sourced from the UK's 2005 submission to the IPCC.[172]

For nitrous oxide we use all oxides of nitrogen as a proxy. Estimates for the social and environmental cost of atmospheric carbon are taken from the same RCEP study. Costs for methane and nitrous oxides are based on this cost plus information from the NAEI *Greenhouse Gas Inventories* reports[173] which estimates the Global Warming Potential (GWP) of these gases as a multiple of the effect of carbon dioxide.

Total emissions of carbon dioxide, methane and nitrous oxides are calculated as for air pollution described above. We multiply the methane emissions by 21 and the nitrous oxide emissions by 310 to give their GWP in terms of tonnes of carbon dioxide, and then by 12/44 to derive the carbon equivalent. These figures are then summed to give total GHG emissions in GWP tCe.

For unit costs, we use the estimates from a Defra/HM Treasury report in 2002, which studied the available literature at the time and provided a range of defensible values for the social cost of carbon. These ranged from £35/tCe to £140/tCe, with a recommended working value of £70/tCe.

The recent Stern Review of climate change economics may well lead to a re-evaluation of these costs, but unfortunately we have not been able to do this in this report. Climate change cost models are varied and complex, and the Stern Review gives rather limited information on the models it uses. Extracting the necessary information will take more time and resources than we have been able to commit to this project. It is unlikely, however, that our central estimate will be rendered completely redundant, and as it is towards the lower end of the range of possible values, we are at least erring towards a conservative cost estimate, and away from hyperbole.

The estimated cost per tonne of carbon is a marginal social cost, so we can calculate the marginal cost each year very simply. However, this does not reflect the true cumulative cost of emissions past, present and future, nor does it make good sense in accounting terms, since the damage done by each tonne emitted takes place over its lifetime in the atmosphere (around 100 years), and the cost is not truly borne until sometime in the future. The most accurate way to account for this would be to use the damage function which yielded the original cost estimate to plan payments into a kind of climate change insurance fund. This fund would ensure that sufficient money was available to cover the costs as and when they become due.

This is problematic however: the damage functions are not given explicitly in the literature, and although it is likely that they can be sourced given time, there will still be an issue over what kind of insurance instrument is most appropriate to each. Under the circumstances we have assumed a simplistic model, under which the full cost of each tonne of carbon becomes due in 2050. This allows us to calculate the amount required to offset damage at that point, and therefore what annual payments into an 'endowment fund' would be required to ensure that sufficient funds are available then.

The value in 2050 of the marginal cost each year is calculated using the same discount rate used in the study which derived the cost estimate. This cost is accumulated each year, and the resulting amount is used to calculate the annual payments required into an endowment fund which matures in 2050, given a constant interest rate. This interest rate is an assumption which reflects risk aversion, and can be varied between 0% and 3% for sensitivity analysis. We use 0%: as discussed above, our unit cost is relatively low, so it seems prudent to be as risk-averse as possible when projecting the growth of our hypothetical fund.

### *Depletion of non-renewable resources*

This column calculates the costs associated with replacing fossil energy used in the region with renewable energy, in line with the replacement cost methodology proposed first proposed by Cobb and Cobb in the revised US ISEW. Regional data on energy usage are extremely scarce.

However, national data are strong and available from the UK Department of Trade and Industry (DTI) in a variety of forms including a breakdown by sector, including details of energy use by different modes of transport.[174] This allows us to choose suitable proxies for regional estimates, specifically GVA (industrial component) for industry usage; GVA in private and public services for these two components; population for domestic energy use; and travel data for the energy use in each mode of transport. GVA figures are taken from the ONS's regional datasets,[175] population from its *Population Trends* datasets,[176] and transport data from the DfT's *Regional Transport Statistics*.

The resulting energy usage is converted to barrel of oil equivalents oil (at 7.315 barrels per tonne) and then cashed out using a replacement value per barrel. This unit cost is an average of the recent (2005) crude oil peak price of US$60/bbl[177] and a cost derived from the US Green National Product (Cobb & Cobb) estimate of $75/bbl[178] (in 1988: this is increased using an escalation factor of 2% per year). The crude oil price underestimates the true costs of replacing fossil fuels with renewable resources; the Cobb and Cobb figure is probably an overestimate now, as the cost of renewables has come down in recent years due to improvements in technology. An average of the two gives a defensible estimate.

## A4.5 The whole versus the sum of the parts

Readers should note that for some components the sum of the figures for the nine regions does not exactly match the total figure for England. In the case of resource depletion, this is due to rounding in the regional domestic energy use data; in others it is due to the limitations of the data available.

For consumer durables and for commuting, the discrepancy is an artefact of how the household expenditure data was used. Mean figures for household expenditure are available both at the regional level and for the whole of England. To calculate, for example, total consumer durables expenditure for a given region, we took the mean for a household in that region, divided it by the mean number of people per household for that region (according to the same data set) and multiplied it by the population for that region (from Population Trends).

The sum of all these regional totals does not equal the figure calculated in the same way for the whole of England. This is due to slight discrepancies between the distribution of the sample across regions in the household expenditure survey and the population distribution across regions in Population Trends. For example, in 2000, Population Trends estimates 83.6% of the population of the UK to be living in England. However, only 77.8% of the household expenditure survey's sample is from England. Such differences inevitably lead to slight differences in the totals calculated across the nine regions.

For water pollution, the problem is more convoluted. First, lengths of river in each region are only estimates – and it appears that the estimates available in regional trends do not add up to the total length of river in England. Even if this is adjusted for, however, the regional figures still don't add up to the total for England, primarily due to our use of different usage scenarios to estimate costs for each region, but also because the figures for the percentages of rivers in each region that are of different qualities do not quite align. For our purposes, the biggest problem is the lack of fit between the GORs and the Environment Agency regions, meaning that attributing the costs of pollution in one Environment Agency region to the appropriate GORs is in some cases only a rough approximation.

Fortunately, none of these differences makes much difference to the ISEW. Across the years 1994–2005, the mean absolute difference between the figures calculated by summing the regions and those calculated directly for the whole of England is 0.8% for the consumer durables column and 1.0% for the costs of commuting. The only column where there is a marked discrepancy is for water pollution where the sum of the regions undershoots the England total by an average of 14.4% across the 12 years in question. However, the water pollution column represents a tiny fraction of the ISEW, and the mean absolute difference (£53 million per year) represents a mere 0.01% of the total ISEW for England for any given year. Indeed, taking the ISEW as a whole, all three discrepancies make a marginal difference – on average the sum of the regions overshooting the England total figure by only 0.1%. The graphs below show the difference (or rather 'lack of') between the sums and the England totals for all three columns and for the total ISEW.

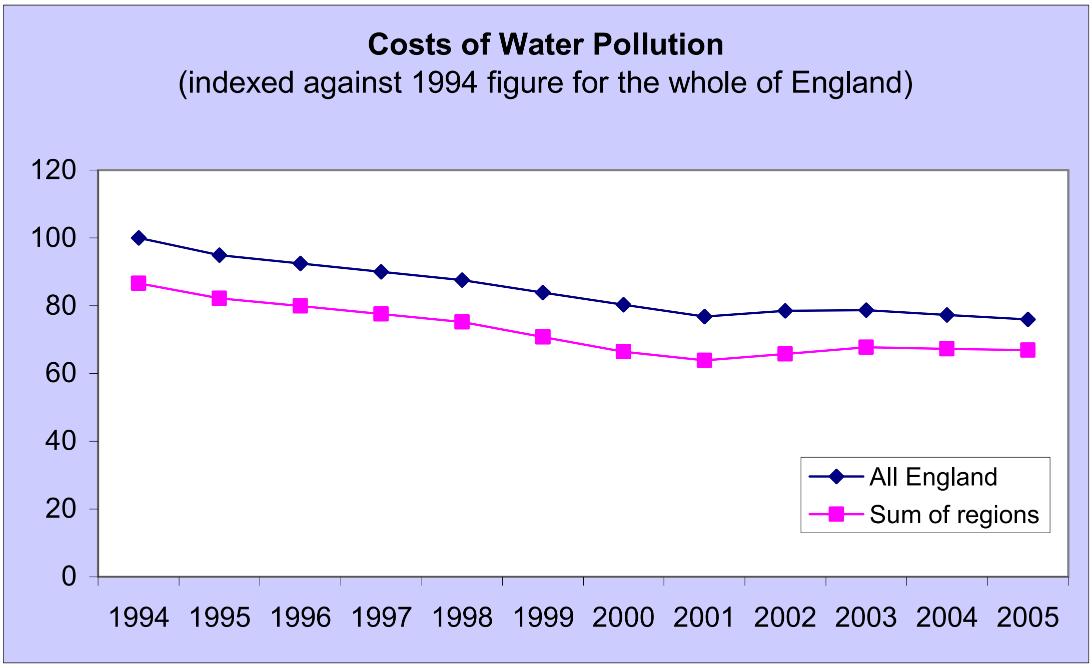



**Figure 32: Discrepancy between sum of regions and England total: water pollution.**

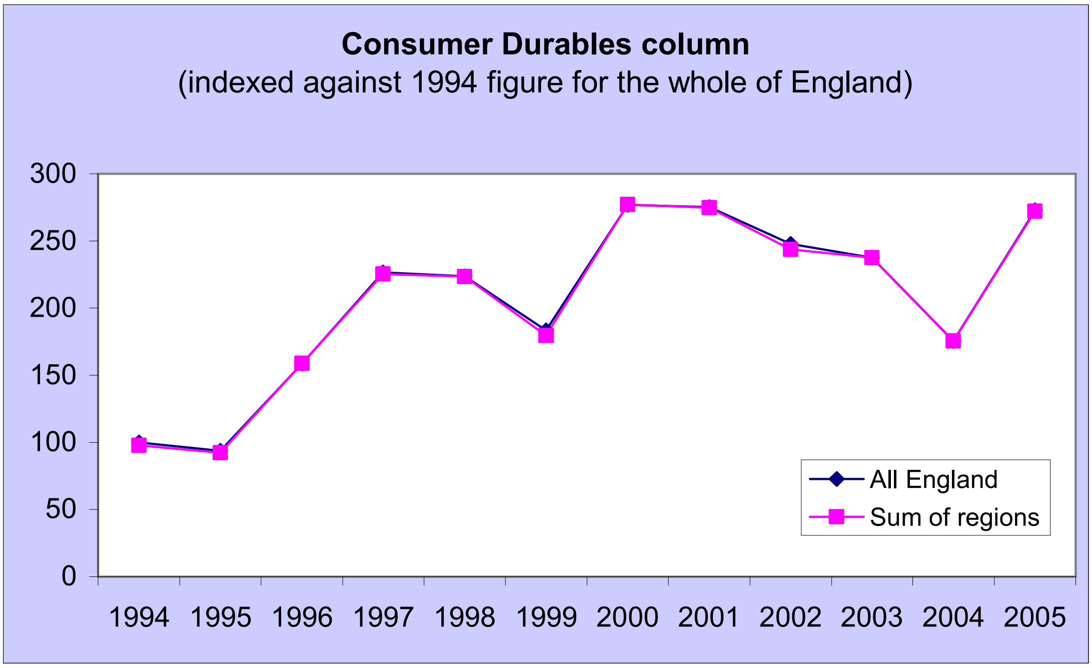



**Figure 33: Discrepancy between sum of regions and England total: consumer durables.**

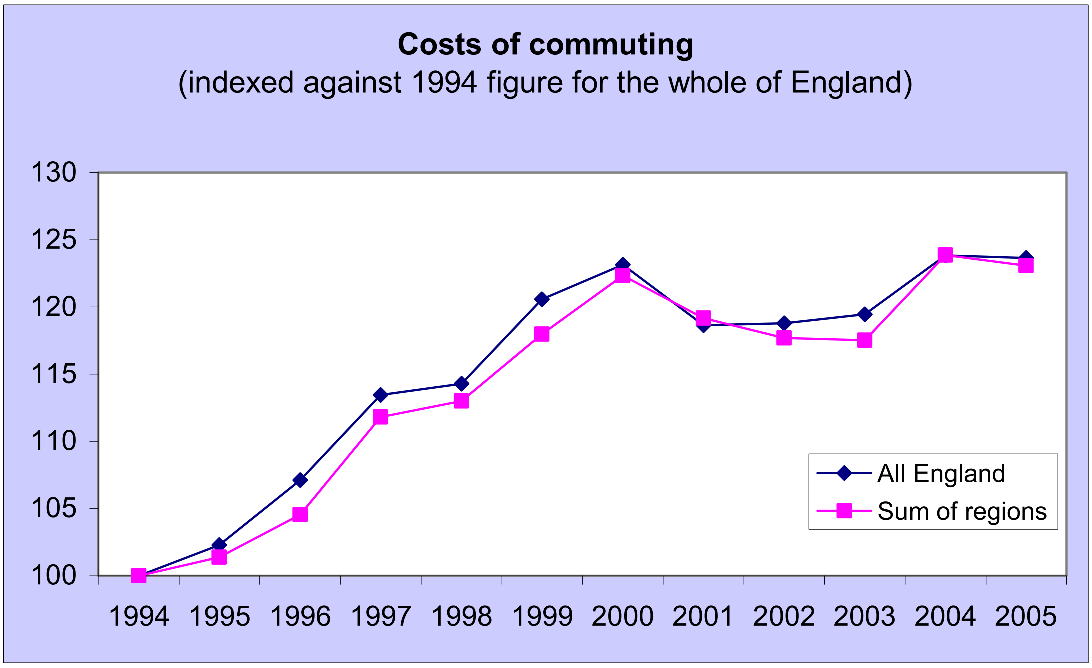



**Figure 34: Discrepancy between sum of regions and England total: costs of commuting.**

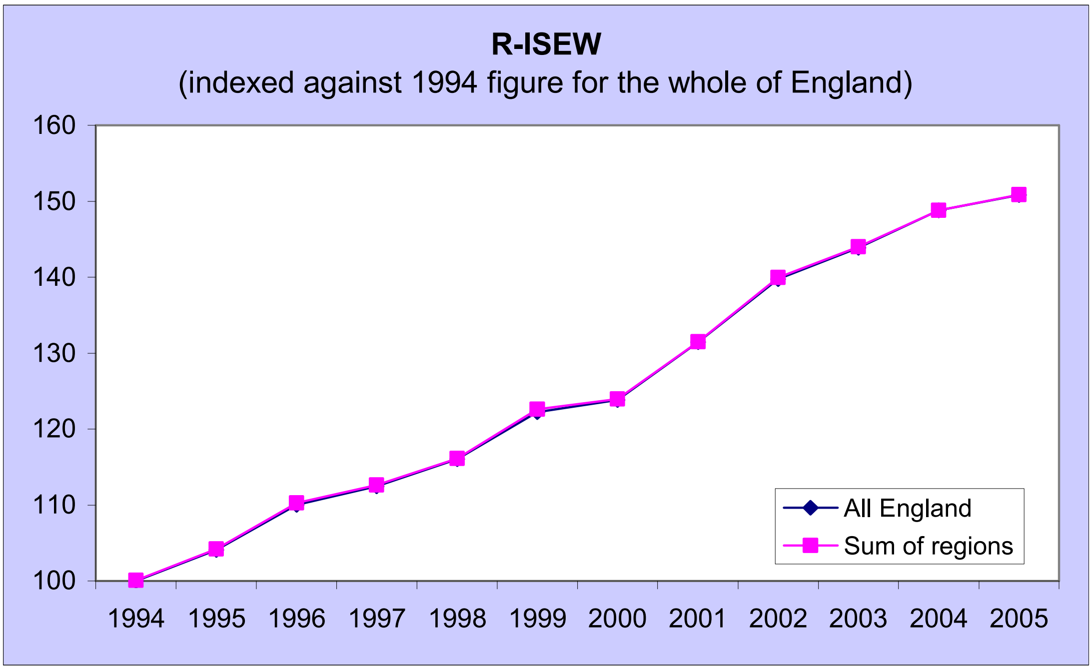



**Figure 35: Discrepancy between sum of regions and England total: R-ISEW.**

# Appendix 5. Sensitivity analyses

As indicated throughout this report, the R-ISEW is sensitive to assumptions made concerning a number of different parameters in the various environmental, social or economic factors incorporated in the index. In this final appendix, we present briefly sensitivity analyses based on changing parameters associated with the three components which have the largest impact on the headline results, and which are also affected by assumed costs. These are: i) the aversion to income inequality (ε); ii) the replacement cost assumed for fossil resources; and iii) the assumed social cost of carbon.

In each case we illustrate the impact of changing an assumption on the R-ISEW for England. The impact on individual regions will vary according to the degree to which their R-ISEW is dominated by each of these three factors. For instance, changes in the social cost of carbon will affect Yorkshire and the Humber more than London; while the reverse is true of changes in aversion to income inequality.

## A5.1 Variations in the value of epsilon

Figure 36 illustrates the results first of all of varying ε between 0 (no aversion to income inequality) and 1.6 (which lies well within the range of accepted values for high aversion to income inequality). By completely removing aversion to income inequality, the R-ISEW is increased by between 15% (in 2004) and 20% (in 2000). Increasing the aversion to 1.6 depresses the index by between 13% and 15% (again, in 2004 and 2000).

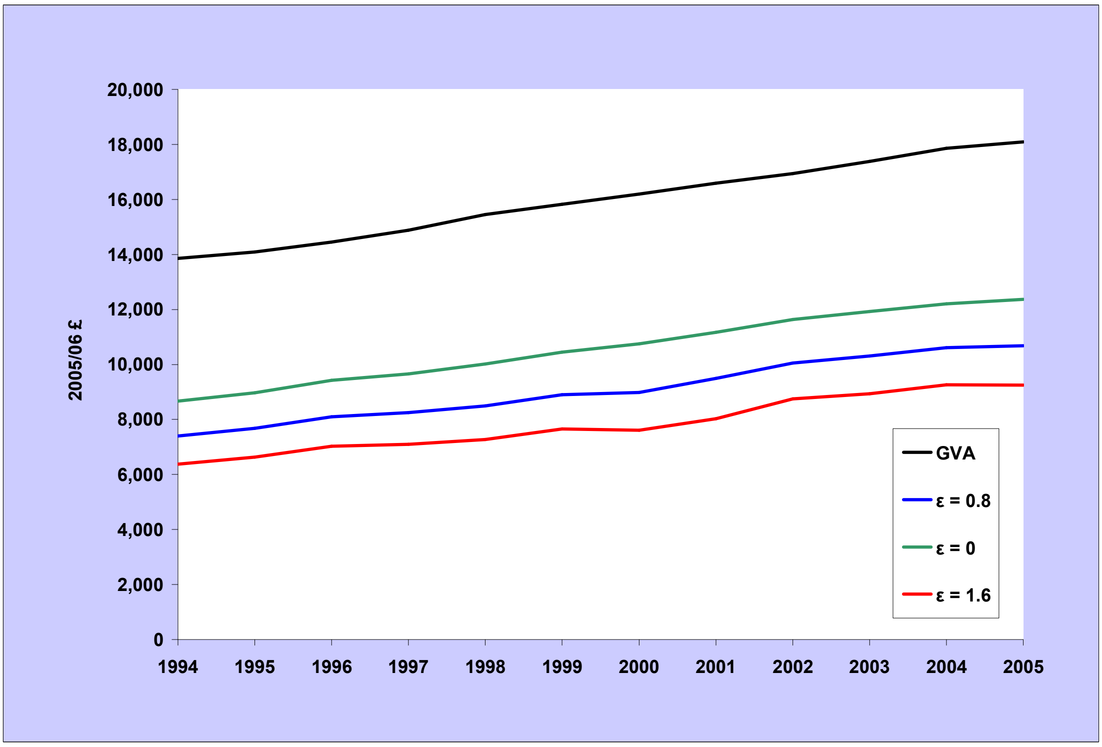



**Figure 36: English R-ISEW with variations in the value of epsilon (ε).**

## A5.2 Variations in the escalation factor in resource depletion

The escalation factor used in the original Cobb and Cobb revised US ISEW was 3% per annum. They justified this escalation factor on the grounds that a steadily increasing cost would be expected as higher and higher levels of energy consumption were met using renewable energy. At the margin, renewable energy source might replace fossil quite cheaply, but for greater levels of penetration this would no longer be the case. This escalation factor has its critics, and we concur that the choice of factor is somewhat arbitrary.

However, we do believe that some escalation is justifiable: the UK is going to struggle to meet its target of 10% of energy from renewable sources by 2010, so the idea that we can simply choose to replace *all* fossil fuels with renewables at a constant replacement cost seems far-fetched. As a concession to the critics, we have adopted a lower escalation factor of 2%, but believe that even this is conservative.

We have also adopted a lower replacement cost per barrel than assumed by Daly and Cobb (around £102/bbl in 2005/06 prices). In this sensitivity analysis, we investigate the effect of range of replacement costs based on the higher Cobb and Cobb estimate on the one hand and the September oil price peak (around £33 per barrel) on the other.

Figure 37 illustrates the impact of this range on the R-ISEW. There is clearly some variation in the R-ISEW as a result of this exercise with the higher per barrel replacement cost leading to a very slight divergence between R-ISEW and GVA over the period, by contrast with the central case.

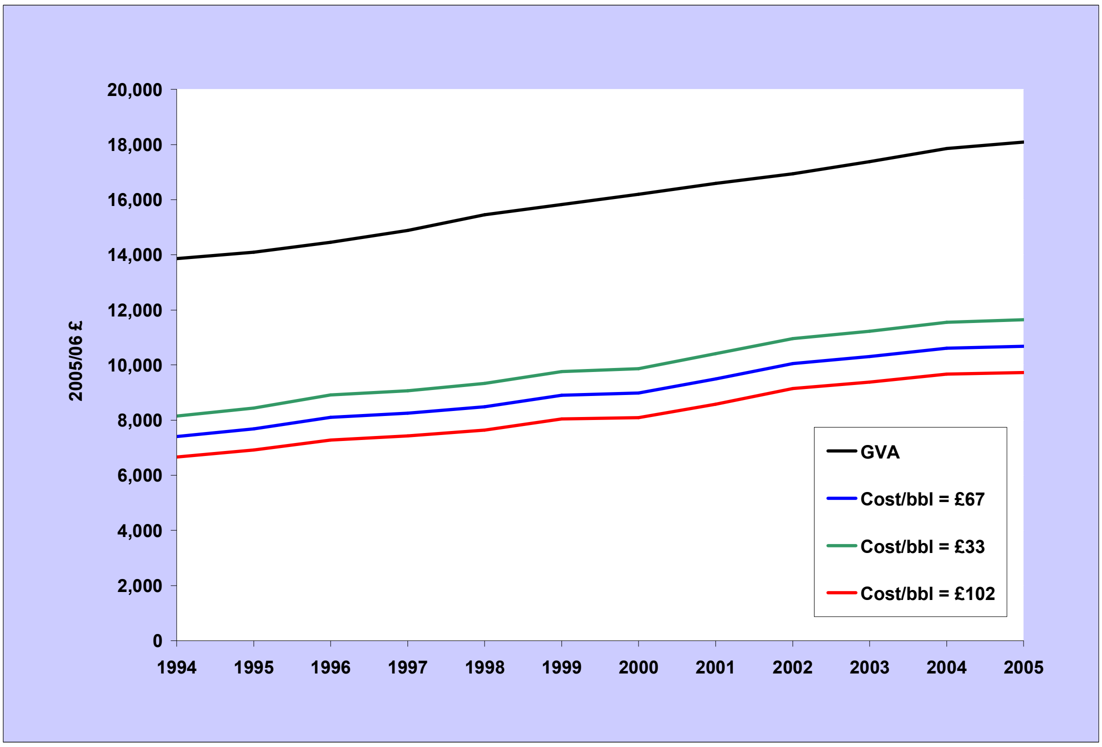



**Figure 37: R-ISEW with variations in the energy replacement cost.**

## A5.3 Variations in the social cost of carbon

The R-ISEW uses the Treasury estimate from 2002 of £70/tC as the social cost of carbon for the year 2000. The Treasury document reports a range of estimates however between £35/tC and £140/tC, with £70/tC as the central estimate. As discussed earlier in this report, this working value may need to be updated after a thorough analysis of the Stern Review.

However, it seems probable that the range of possible values will be similar to the range we use now. So although we may want to revise the central estimate in line with Stern at some point, a sensitivity analysis based on the 2002 Treasury estimates should still hold true. Figure 38 illustrates the impact of choosing a social cost of carbon at the two ends of this range. Clearly, the higher social cost of carbon has an enormous depressive effect on the index, and the gap between R-ISEW and GVA widens progressively over the study period by comparison with the central estimate.

The spread of results in this sensitivity analysis may raise concern over the robustness of the whole R-ISEW, but given the huge uncertainties that surround the issue of climate change (in particular how to cost it), such a divergence in possible results is simply unavoidable. Under the circumstances, all anyone can do is to work with the best estimates possible. In fact, the central estimate is very much towards the conservative end of the scale. This is intended to counter any allegations of hyperbole, but it should be noted that to follow the precautionary principle in practice – when in doubt, assume the worst and err on the side of caution – we should adopt a higher cost, which would result in a much lower R-ISEW.

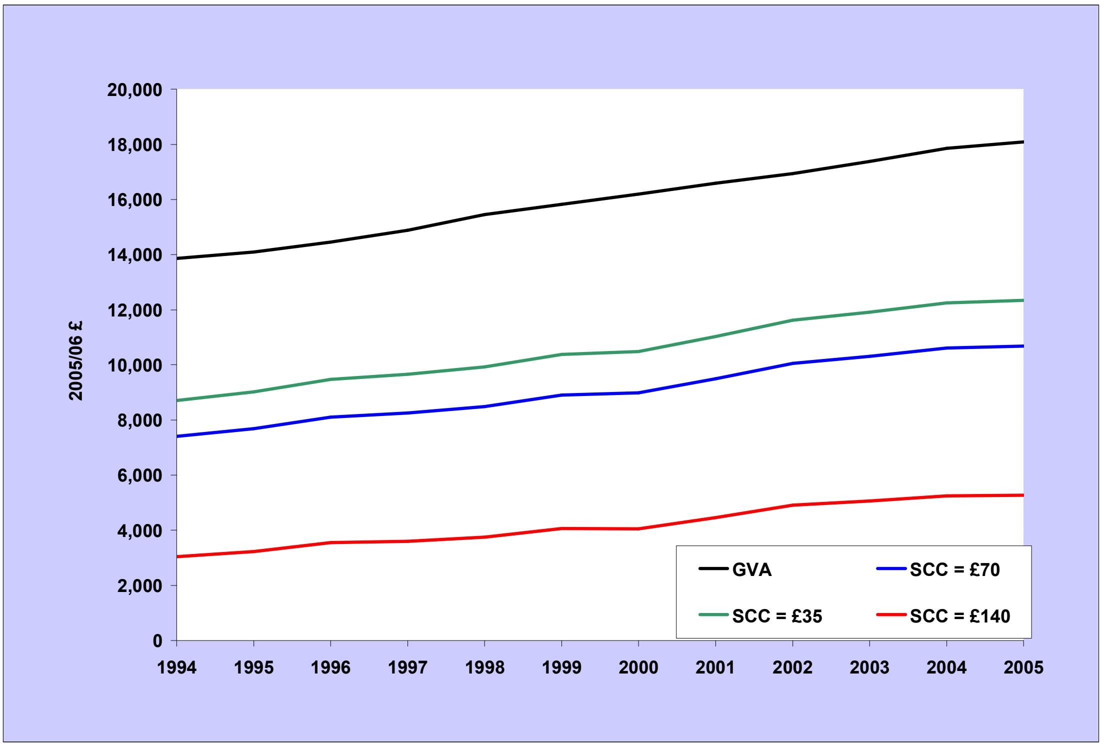



**Figure 38: R-ISEW with variations in the social cost of carbon.**

# Endnotes

[1] As measured by taking the absolute difference between the highest and lowest regional value in each year as a percentage of the English average.

[2] www.gos.gov.uk/aboutusnat/aimsobjectives/ Government Offices for the English Regions, 2007

[3] Marks N (2004) *Quality of life, well-being and regional economic development* (London: **nef)**.

[4] **nef** conducted a feasibility study for the Istituto Regionale di Ricerca della Lombardia (IReR); unfortunately the study concluded that there was insufficient robust data at the regional level to proceed with an R-ISEW, but IReR plan to work with a limited version of the model if possible.

[5] The literature on this dates back to the early Club of Rome report: Meadows DH, Meadows DL, Randers J, Behrens III, W (1972) *The limits to growth. A report to the Club of Rome* (London: Pan Books). It is beyond the scope of this paper to review this literature in detail.

[6] For a summary of some of this evidence see Kasser T (2002) *The high price of materialism* (Cambridge, MA: MIT Press).

[7] Diener E, Seligman M (2004) 'Beyond money: towards an economy of well-being' *Psychological Science in the Public Interest* **5**: 1–31.

[8] SNA (1993) *System of National Accounts 1993.* Prepared under the auspices of the Inter-Secretariat Working Group on National Accounts; Studies in methods – United Nations. Series F, No. 2, Rev 4. (New York: United Nations).

[9] www.beyond-gdp.eu

[10] Barroso J (2007) *Beyond GDP – Opening speech.* www.beyond-gdp.eu/download/barroso_speech.pdf

[11] Address to the German sustainability council. In: EFA Forum 3/7, p 4.

[12] Daly, for example, cites Mill as arguing for a 'stationary condition of capital and population' in which there would be more likelihood of 'improving the art of living... when minds ceased to be engrossed by the art of getting on.' Daly H (1996) *Beyond growth* (Washington, DC: Island Press), p 3.

[13] UN (2003) Integrated Environmental and Economic Accounting. Studies in Method: Handbook of National Accounting. Series F, No. 61, Rev 1. (New York: United Nations).

[14] Defra (2007) *Sustainable development indicators in your pocket (*London: Defra).

[15] Desai M (1991) 'Human development: concepts and measurement' *European Economic Review* **35**: 350–357.

[16] UNDP, various years, *Human Development Report* (Oxford: Oxford University Press).

[17] The income component of HDI is GDP per capita adjusted to reflect purchasing power parity (PPP). The original HDI used adult literacy to measure access to education. From 1991to 1994, the index used a weighted average of adult literacy and mean years of schooling. Since 1995 mean years of schooling has been replaced by the combined enrolment ratio for primary, secondary and tertiary education.

[18] www.sbilanciamoci.org/docs/misc/eng/quars.pdf

[19] Defra (2007) *op. cit.*

[20] Johns H, Ormerod P (2007) Happiness*, economics and public policy* (London: Institute of Economic Affairs).

[21] For some evidence of sensitivity to economic variables see Di Tella R, MacCulloch RJ, Oswald AJ (2003) 'The macroeconomics of happiness' *Review of Economics and Statistics* **85**: 809–827.

[22] Wolfers J (2003) 'Is business cycle volatility costly? Evidence from surveys of subjective well-being' *International Finance* **6**: 1–26.

[23] Ryan RM, Huta V, Deci EL (2008) 'Living well: A self-determination theory perspective on eudaimonia' Journal *of Happiness Studies* **9**: 139–170.

[24] Böhnke P (2005) First *European Quality of Life Survey: Life satisfaction, happiness and sense of belonging* (Dublin: European Foundation for the Improvement of Living and Working Conditions).

[25] Daly H, Cobb J (1989) *For the common good: redirecting the economy toward community, the environment, and a sustainable future* (Boston: Beacon Press).

[26] Stymne S, Jackson T (2000) 'Intra-generational equity and sustainable welfare' *Ecological Economics* **33:** 219–236.

[27] The integration of unpaid housework into GDP was recommended for example by the closing Nairobi Conference of the United Nations Decade for Women. Agenda 21, the Rio Earth Summit's 'blueprint for sustainability', declares that 'unpaid productive work such as domestic work and child care should be included, where appropriate, in satellite national accounts and economic statistics'.

[28] Daly and Cobb (1989) *op. cit.* As Robert Kennedy recognised, these expenditures are included in GDP just like any other expenditure.

[29] The term 'human-made capital' refers to the stock of conventional economic capital assets, and should not be confused with the term 'human capital' which refers to the stock of human resources. It might be noted that the GDP already includes a measure of gross fixed capital formation. The capital adjustment in the ISEW differs from the GNP adjustment in two specific ways: firstly it takes account of capital depreciation as well as formation; secondly it includes only that capital growth which is net of a basic capital requirement to maintain changes in the workforce.

[30] In the conventional expenditure-related calculation of GDP, there is also an assessment of net international trade (export minus imports). The difference entailed by the ISEW methodology is the inclusion of the capital aspects of overseas trade.

[31] Appendix 1 presents a more detailed account of the composition of the Daly and Cobb ISEW and subsequent variations on it.

[32] Re-drawn from data in Cobb and Cobb (1994) *The Green National Product: a proposed index of sustainable economic welfare* (Lanham: University Press of America).

[33] Jackson T (2004) *Chasing Progress? Beyond measuring economic growth* (London: **nef**).

[34] Jackson T, Marks N, Ralls J, Stymne S (1997) *Sustainable economic welfare in the UK: a pilot index for the UK 1950–1996* (London: **nef**).

[35] Hamilton C (1999) 'The genuine progress indicator: methodological developments and results from Australia' *Ecological Economics* **30:** 13–28.

[36] Stockhammer E, Hochreiter H, Hobermayr B, Steiner K (1997) 'The index of sustainable economic welfare (ISEW) as an alternative to GDP in measuring economic welfare. The result of the Austrian (revised) ISEW calculation, 1955–1992' *Ecological Economics* **21:** 19–34.

[37] Bleys B (2006) *The Index of Sustainable Economic Welfare for Belgium: First Attempt and Preliminary Results.* MOSI Working Paper, number 27 (Brussels: Vrije Universiteit).

[38] Diefenbacher H (1994) 'The Index of Sustainable Economic Welfare in Germany' In Cobb C and Cobb J (eds) *The Green National Product* (New York: University of the Americas Press).

[39] Guenno G, Tiezzi S (1998) *The Index of Sustainable Economic Welfare (ISEW) for Italy*. Worknote 5.98 (Milan: Fondazione Enrico Mattei).

[40] Bleys B (2007) 'Simplifying the Index of Sustainable Economic Welfare: methodology, data sources and a case study for the Netherlands' *International Journal of Environment, Workplace and Employment* **3**: 103–118.

[41] Jackson T, Stymne S (1996) *Sustainable economic welfare in Sweden: a pilot index 1950–1992* (London: **nef)**; (Stockholm: Stockholm Environment Institute).

[42] Castañeda B E (1999) 'An index of sustainable economic welfare (ISEW) for Chile' *Ecological Economics* **28**: 231–244.

[43] Clarke M (2004). 'Widening development prescriptions: policy implications of an Index of Sustainable Economic Welfare (ISEW) for Thailand' *International Journal of Environment and Sustainable Development* **3:** 262–275.

[44] Nicolucci V, Pulselli FM, Tiezzi E (2006) 'Strengthening the threshold hypothesis: Economic and biophysical limits to growth' *Ecological Economics* **60:** 667–672.

[45] Pulselli FM, Tiezzi E, Marchettini N, Bastianoni S (2008) *The road to sustainability: GDP and future generations* (Southamption: WIT Press).

[46] Lawn PA (2003) 'A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes' *Ecological Economics* **44:** 105–118.

[47] Anielski M (2001) *The Alberta GPI Blueprint* (Canada: Pembina Institute).

[48] Costanza R, Erickson J, Fligger K, Adams A, Adams C, Altschuler B, Balter S, Fisher B, Hike J, Kelly J (2004) 'Estimates of the GPI for Vermont, Chittenden County and Burlington, from 1950 to 2000' *Ecological Economics* **51**: 139–155.

[49] Pulselli F M, Ciampalini F, Tiezzi E, Zappia C (2005) 'The Index of Sustainable Economic Welfare (ISEW) for a local authority: A case study in Italy' *Ecological Economics* **60**: 271–281.

[50] Wen Z, Zhang K, Du B, Li Y, Li W (2007) 'Case study on the use of genuine progress indicator to measure urban economic welfare in China' *Ecological Economics* **63**: 463–475.

[51] Gill M, Moffat I (1995) *Index of Sustainable Economic Welfare for Scotland: a pilot study 1984–1990* (Stirling: University of Stirling).

[52] Matthews J, Munday M, Roberts A, Williams A, Christie AM, Midmore P (2003) *An Index of Sustainable Economic Welfare for Wales: 1990–2000* (Cardiff: Cardiff Business School).

[53] Jackson T, McBride N, Marks N (2006) *Measuring regional progress: developing a Regional Index of Sustainable Economic Well-being (R-ISEW) for the East Midlands* (London: **nef**).

[54] Jackson T, McBride N, Marks N (2008) An *Index of Sustainable Economic Well-being: A report for NHS Health Scotland* (Glasgow: NHS Health Scotland).

[55] Munday M, Roche N (unpublished) An *Index of Sustainable Economic Welfare (ISEW) for Wales (1990–2005).* Produced by the Welsh Economy Research Unit and the ESRC Centre for Business Relationships Accountability Sustainability and Society (BRASS).

[56] Since we began our work on R-ISEWs in 2006, an alternative measure has also been developed, called the Sustainable Prosperity Index (Regeneris, 2007). This has been calculated at an even smaller geographical level (local authorities). Of course, to do so, it uses a much reduced algorithm to the ISEW and must resort to estimated values for some data.

[57] Calculated as the difference between the highest region and the lowest region, divided by the average value across all regions. See Section 5 for more detail on regional disparities.

[58] Note also that the costs calculated here are the *social* costs over and above the costs of the police and legal system; these costs are excluded from the R-ISEW as they cannot legitimately be deducted from the baseline of consumer expenditure which serves as a proxy for welfare

[59] Note however that in 1994 this region had the lowest per capita costs of divorce of all regions, and even after this increase it still has the second lowest.

[60] We have excluded here consideration of global pollutants, such as carbon dioxide and methane, as these are included in the category of climate change costs. Also excluded are pollutants such as lead and benzene which may be important but for which we found no reliable estimate of cost.

[61] Whilst this pattern may be due to genuine differences in levels of industry, power generation and car use between regions, the map presented above does suggest there may be some value in considering the trivial effects of prevailing winds on the source data used for this component.

[62] Haggerty MR, Cummins RA, Ferriss AL, Land K, Michalos AC, Peterson M, Sharpe A, Sirgy J, Vogel J (2001) 'Quality of life indexes for national policy: review and agenda for research' *Social Indicators Research* **55**: 1–96.

[63] McGillivray M, Noorbakhsh F (2004) 'Composite indices of human well-being: Past, present and future' *World Institute for Development Economics Research* – Research Paper No. 2004/63.

[64] Canoy M, Lerais F (2007) *Overview paper for the Beyond GDP conference* (Brussels: Bureau of European Policy Advisers).

[65] Goossens Y (2007) *Alternative progress indicators to Gross Domestic Product (GDP) as a means towards sustainable development* (Brussels: European Parliament; Economic and Scientific Policy)

[66] UN (1993) Integrated Environmental and Economic Accounting, Interim version. Handbook of National Accounting, Series F, No. 61. (New York: United Nations).

[67] UN (2003) Integrated Environmental and Economic Accounting. Studies in Method: Handbook of National Accounting. Series F, No. 61, Rev 1. (New York: United Nations).

[68] DETR (1999). *Quality of life counts – Indicators for a strategy for sustainable development for the United Kingdom: a baseline assessment*.

[69] A new indicator set incorporating many of the same features has recently been published as part of the revised (2005) UK Strategy. See Defra (2005) *Securing the Future – Delivering UK Sustainable Development Strategy* (London: HMSO).

[70] Defra (2007) *op. cit.*

[71] Morris D (1979) *Measuring the changing quality of the world's poor: the physical Quality of Life Index* (Oxford: Pergamon).

[72] Slottje D (1991) *Measuring the quality of life across countries: a multidimensional analysis* (Boulder, Co: Westview). Some of the components specifically reward unsustainable conditions. For example, the indicator increases with energy consumption per capita and with $km^2$ of road per capita.

[73] Estes R (1988) *Trends in world social development: the social progress of nations 1970–1987* (New York: Praeger).

[74] Osberg L, Sharpe A (2002) 'An index of economic well-being for selected OECD countries' *Review of Income and Wealth* **48(3):** 291–316.

[75] Desai (1991) *op. cit.*

[76] The income component of HDI is GDP per capita adjusted to reflect purchasing power parity (PPP). The original HDI used adult literacy to measure access to education. From 1991to 1994, the index used a weighted average of adult literacy and mean years of

schooling. Since 1995 mean years of schooling has been replaced by the combined enrolment ratio for primary, secondary and tertiary education.

[77] World Bank, various years. *Poverty Reduction* (Washington, DC: World Bank).

[78] McGillivray and Noorbakhsh (2004) *op. cit.*

[79] Rahman T, Mittelhammer RC, Wandschneider P (2005) 'Measuring the quality of life across countries: A sensitivity analysis of well-being indices' *World Institute for Development Economics Research* – Research Paper No. 2005/06.

[80] As recognised, for example, by Pigou A (1920) *The economics of welfare* (London: Macmillan).

[81] Fisher I (1906) *Nature of capital and income* (New York: A M Kelly).

[82] Defra (2007) *op. cit.*

[83] See for example the discussion in reference 4 of **nef** (2004) *op. cit.*

[84] Shah H, Marks N (2004) *A well-being manifesto for a flourishing society* (London: **nef**).

[85] Layard R (2005) *Happiness – lessons from a new science* (London: Allen Lane).

[86] Economist Intelligence Unit (2005) The *Economist Intelligence Unit's quality-of-life index,* p 3.

[87] For a summary of the psychological literature around these issues see Kasser (2002) *op. cit.*

[88] James O (2007) *Affluenza: How to be successful and stay sane* (London: Vermilion).

[89] Johns and Ormerod (2007) *op. cit.*

[90] But for some evidence of sensitivity to economic variables see Di Tella *et al.* (2003) *op. cit.*

[91] Wolfers (2003) *op. cit.*

[92] Ryan *et al.* (2008) *op. cit.*

[93] Böhnke (2005) *op. cit.*

[94] Economist Intelligence Unit (2005) *op. cit.*

[95] Eisner R (1978) 'Total incomes in the United States 1959 and 1969' *Review of Income and Wealth* **21(2):** 153–181.

[96] Eisner R (1989) *The Total Incomes System of Accounts* (Chicago, IL: Chicago University Press).

[97] For a fuller discussion of these issues see Jackson T (2005) *Motivating sustainable consumption: a review of evidence on consumer behaviour and behavioural change. A report to the Sustainable Development Research Network* (London: Policy Studies Institute).

[98] For an insightful discussion of this point see, for example, Christie I and Warpole K (2001) 'Quality of Life' in *Transforming Britain,* A Harvey (ed) (London: Fabian Society).

[99] The limitations of this strategy are also discussed in Jackson (2005) *op. cit*.

[100] Hicks J (1939) *Value and capital* (Oxford: Oxford University Press).

[101] Weitzmann M (1976) 'On the welfare significance of the National Product in a dynamic economy'. *Quarterly Journal of Economics* **90:** 156–162.

[102] Bolt K, Matete M, Clemens M (2002) *Manual for calculating Adjusted Net Savings* (Washington DC: World Bank).

[103] Hamilton K (1994) 'Green Adjustments to GDP' *Resources Policy* **20(3):** 155–168.

[104] The earliest version of the Genuine Savings Index incorporated depreciation of human-made capital, depletion of natural resource and expenditure on education. Later versions also incorporated some of the costs associated with environmental damage.

[105] The calculation of net depletion of natural capital is complex. It involves calculating 'resource rents' for resources extracted during the period and subtracting the net resource discoveries during the period.

[106] Currently, this calculation is made using a marginal social cost of $20 (taken from Fankhauser 1995) per tonne of carbon emitted. Fankhauser S (1995) *Valuing climate change: the economics of the greenhouse* (London: Earthscan)

[107] World Bank (2001) *World Development Indicators* (Washington, DC: World Bank) pp 180–183.

[108] Zolotas X (1981) *Economic growth and declining social welfare* (Athens: Bank of Greece).

[109] Daly and Cobb (1989) *op. cit.*

[110] Cobb and Cobb (1994) *op. cit.*

[111] Stymne and Jackson (2000) *op. cit.*

[112] The integration of unpaid housework into GDP was recommended for example by the closing Nairobi Conference of the United Nations Decade for Women. Agenda 21, the Rio Earth Summit's 'blueprint for sustainability', declares that 'unpaid productive work such as domestic work and child care should be included, where appropriate, in satellite national accounts and economic statistics'.

[113] Daly and Cobb (1989) *op. cit*.

[114] See for example discussions in Daly and Cobb (1989) *op. cit.,* various contributions to Cobb and Cobb (1994) *op. cit*. and Jackson and Marks (1999) *op. cit*.

[115] Cobb C, Halstead E, Rowe J (1995). *The Genuine Progress Indicator – summary of data and methodology* (Washington, DC: Redefining Progress).

[116] These adjustments were first made in the Australian GPI. See Hamilton C, Saddler H (1997) *The Genuine Progress Indicator: a new index of changes in well-being in Australia. Discussion paper 14* (Canberra, Australia: The Australia Institute).

[117] Jackson (2004) *op. cit.*

[118] Jackson *et al.* (1997) *op. cit.*

[119] *Household final consumption expenditure, Blue Book time series data, ONS*. Data available online at www.statistics.gov.uk/statbase/tsdtables1.asp?vlnk=bb

[120] *Family Expenditure Survey / Expenditure & Food Survey, CSO, Family Spending 1994-02*, Data for 1999-2002 available online at www.statistics.gov.uk/statbase/explorer.asp?CTG=3&SL=&E=%204366#4366 Earlier years supplied by email.

[121] *Population Trends 122 (Table 1.3), ONS 2005*. Data available online at www.statistics.gov.uk/statbase/Product.asp?vlnk=6303

[122] *Net Capital Stock by sector and asset at current prices, ONS National Accounts Time Series Data, ONS*. Data available online at www.statistics.gov.uk/statbase/tsdtables1.asp?vlnk=capstk

[123] *Annual Business Inquiry Regional Data, ONS*. Data available online at www.statistics.gov.uk/abi/downloads/east_midlands.xls

[124] Population Trends (2005) *op. cit.*

[125] *Economic Trends Time Series datasets, ONS.* Data available online at www.statistics.gov.uk/StatBase/TSDTimezone.asp?vlnk=et&Pos=1&ColRank=1&Rank=272

[126] *UK Regional Trade in Goods Statistics Q3 2005, HM Revenue and Customs*. Downloaded from www.uktradeinfo.com/downloads/rtsdataq305.pdf (currently unavailable)

[127] Williams G (1998) 'The Stock of Consumer Durables in the United Kingdom: New Estimates 1948-95' *Review of Income and Wealth* **44***:* 417–436.

[128] As in the Cobb & Cobb ISEW for example.

[129] Patterson 1991/92. *The service flows from consumption goods with an application to Friedman's Permanent Income Hypothesis* (Reading: University of Reading).

[130] Berg L (1988) *Hushållens sparande och konsumtion*, Allmänna Fölaget.

[131] *ASHE, op cit.* Note that we use the *national* rather than *regional* wage so as to avoid regional distortions: as with other columns we want a constant means of valuing each unit.

[132] *United Kingdom Time Use Survey, 2000* available to subscribers from the Data Archive at Essex University www.data-archive.ac.uk/findingData/snDescription.asp?sn=4504

[133] *OPCS Omnibus Survey, Time Use Module, May 1995* – available to subscribers from the Data Archive www.data-archive.ac.uk/findingData/snDescription.asp?sn=3951

[134] *PESA 2001-2005*, HM Treasury. Data available online at www.hm-treasury.gov.uk/economic_data_and_tools/finance_spending_statistics/pes_publications/pespub_index.cfm

[135] *Annual Survey of Hours and Earnings / New Earnings Survey,* ONS 1994–2004. Data for 1998-2003 available online at www.statistics.gov.uk/StatBase/Product.asp?vlnk=13101, earlier years *NES* data supplied by email. In fact, *ASHE* replaced *NES* in 2003, but *NES* data from 1998–2002 has been re–estimated using *ASHE* methodology so there is a continuous data series from 1998–2004.

[136] Data available online at www.homeoffice.gov.uk/rds/recordedcrime1.html

[137] Additional data from *Crime in England and Wales: East Midlands Region 2005/05, Home Office* www.homeoffice.gov.uk/rds/pdfs05/eastmidlands05.pdf and *Notifiable Offences in England and Wales 1996–2000, Home Office*.

[138] *Theft of and from Vehicles (Table 7.8), Transport Trends 2001-2004*, DfT. Some data available online at www.dft.gov.uk/pgr/statistics/datatablespublications/regionaldata/rts/regionaltransportstatistics21833

[139] *Estimates of the economic and social costs of crime in England and Wales: Costs of crime against individuals and households, 2003/04, Economics and Resource Analysis, Research, Development and Statistics, Home Office*. Available online at www.homeoffice.gov.uk/rds/pdfs05/rdsolr3005.pdf

[140] *Crime against retail and manufacturing premises: findings from the 2002 Commercial Victimisation Survey Supplementary web report 1: costs of crime, Economics and Resource Analysis, RDS, Home Office*. Available online at www.homeoffice.gov.uk/rds/pdfs05/rdsolr3705.pdf

[141] Supplied by email.

[142] Johnson N, Backlund E, Sorlie P and Loveless C (2000) 'Marital status and mortality: The national longitudinal mortality study' *Annals of Epidemiology* **10**: 224-238.

[143] *Values of Time and Operating Costs*, TAG Unit 2.3.6, DfT, Feb 2007

[144] Regional Transport Statistics, *op cit.*

[145] *National Travel Survey 1999-2004, DfT*. Data available online at www.dft.gov.uk/pgr/statistics/datatablespublications/personal/mainresults/nts20051/

[146] *Regional Transport Statistics 2001-2005, DfT*. Data available online at www.dft.gov.uk/pgr/statistics/datatablespublications/regionaldata/rts/

[147] FES/EFS *op cit.*

[148] *Ibid.*

[149] Regional Transport Statistics *op cit.*

[150] Annual Abstract of Statistics, *op cit.*

[151] DfT (2004) *Highways Economics Note No. 1: 2003 Valuation of the Benefits of Prevention of Road Accidents and Casualties.*

[152] *National Air Emissions Inventory Data Warehouse* at www.naei.org.uk/data_warehouse.php

[153] Eyre (1998) *Environmental Impacts of Energy,* Royal Commission on Environmental Pollution.

[154] Jackson (2004) *op. cit*. Data from the EC's CAFÉ programme http://ec.europa.eu/environment/archives/cafe/index.htm

[155] England and Wales data from the Environment Agency: *www.environment-agency.gov.uk/yourenv/eff/1190084/water/213902/river_qual/gqa2000/?version=1&lang=_e;*

[156] Defra (1999) *Economic instruments for water pollution discharges.* Downloaded from www.defra.gov.uk/Environment/economics/index.htm but currently unavailable

[157] Maddison D, Pearce D, Johansson O, Calthrop E, Litman T and Verhoef E (1996) *The true costs of road transport* (London: Earthscan).

[158] Bowers C (1996) *The real costs of motoring* (Weybridge, UK: Environmental Transport Association).

[159] Bradbury N and Nalty G (1995) *The great road transport subsidy: a market place comparison with rail.* (London: Railway Development Society).

[160] Pearce B and Pearce D (2000) *Setting environmental taxes for aircraft: A case study of the UK.* CSERGE Working Paper GEC 2000-26.

[161] CAA 2000, *Airport Activity*.

[162] Jackson (2004) *op. cit.*

[163] *Countryside Survey 2000, Defra and National Environment Research Council, 2000.* CS2000 datasets & mapping tool (Countryside Information System, CIS) available at www.cs2000.org.uk

[164] EC communication to EU Council And Parliament on Wetlands protection, 1995, http://www.faunaeur.org/documents/ComBioDivStrat.pdf

[165] Jackson (2004) *op. cit.*

[166] Jackson *et al.* (1997) *op. cit.*

[167] *CS2000 op cit.*

[168] *General and Regional Statistics/Regions/Agriculture/Land Use, Eurostat database*. Data available at http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136162,0_45572076&_dad=portal&_schema=PORTAL

[169] *June Agricultural Census 1990–2004, DEFRA*. Data available at www.defra.gov.uk/esg/work_htm/publications/cs/farmstats_web/2_SURVEY_DATA_SEARCH/COMPLETE_DATASETS/regional_level_datasets.htm

[170] NAEI Data Warehouse *op. cit.*

[171] Environmental Impacts of Energy *op cit.*

[172] IPCC common reporting format tables, 2005 report.

[173] Baggott S, Brown L, Milne R, Murrells TP, Passant N, Thistlethwaite DG (2005) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-*

*2003*. Available online at www.airquality.co.uk/archive/reports/cat07/0509211321_Reghg_report_2003_Main_Text_Issue_1.doc

[174] *Digest of UK Energy Statistics 2005, Energy Consumption by Final User (Table 1.1.5), DTI*. Data available at www.dti.gov.uk/energy/inform/energy_stats/total_energy/dukes05_1_1_5.xls.

[175] *Regional GVA, ONS, op cit.;* Also *Regional Trends 38, ONS*. Data available at www.statistics.gov.uk/statbase/explorer.asp?CTG=3&SL=4788&D=4800&DCT=32&DT=32#4800

[176] Population Trends *op cit.*

[177] www.energybulletin.net

[178] Cobb and Cobb (1994) *op. cit.*