Tracking Well-being in Australia
The Genuine Progress Indicator 2000

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Visit www.gpionline.net

The Australia Institute has launched a GPI web site designed to complement the research presented in this discussion paper. The address is www.gpionline.net

The gpionline.net site is an interactive web site that allows users to determine the impact of changes to a number of key variables on the overall measure of welfare.

In calculating the GPI index published in this discussion paper we have relied upon the best available evidence in determining the values assigned to each component. However, in a number of instances, such as the hourly value of household work and the value of human life in determining the impact of climate change, a case can be made for applying different values.

The gpionline.net website allows visitors to select from a range of different values for components such as income inequality, the costs of unemployment and the information content of advertising. Having made selections the site will then redraw the GPI based on the new values.

We hope that the web site will serve as a valuable educational device for those studying welfare and its measurement. It includes discussion of the problems with GDP, the rationale for an alternative measure and some results from GPIs built for other countries.

Preface

This paper reports an updated version of the Genuine Progress Indicator published by The Australia Institute in 1997. The earlier indicator covered the period 1950-1996, while the present one covers the period 1950-2000. In addition to extending it by four years, the new indicator incorporates a number of methodological improvements, notably in estimating the impact of income inequality and the costs of climate change, as well as two new components, the costs of problem gambling and the value of advertising.

The discussion paper is in two parts. The first part provides the rationale for the GPI and raises some key methodological issues. It also presents the results and analyses them. The second part provides a comprehensive discussion of each component making up the GPI. We have attempted to leave detailed information on data sources to the end of the discussion of each component so that readers can obtain a good understanding of how we measure each component without reading each section to the end.

The full data series for each component of the GPI is reported in Appendix 1, and the interested reader is urged to examine the table to obtain an understanding of the contribution of each component to the final indicator. Each data series has been produced by a separate spreadsheet containing the raw data and numerical workings required to obtain the final series for each column.

We would particularly like to thank Dr Hugh Saddler for his substantial contributions to the data and method for several components of the GPI. Peter Saunders kindly provided data on income distribution and the ABS provided advice on a number of data issues. Thanks also to Catherine Blakers and Aine Dowling for proof reading and editing assistance.

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Executive Summary

This study presents the results of the Genuine Progress Indicator (GPI), an alternative to Gross Domestic Product (GDP) as a measure of national progress in Australia. The GPI includes 23 factors that affect well-being in addition to those counted in the official national accounts. It updates the version of the GPI published by The Australia Institute in 1997. The earlier indicator covered the period 1950-1996, while the present one covers the period 1950-2000. In addition to extending it by four years, it incorporates a number of methodological improvements.

Many commentators have highlighted the apparent paradox that while GDP is ever increasing life does not seem to be improving. If the economy is doing so well, many ask, why aren't we enjoying the benefits? A simple explanation for this puzzle is that economic growth and welfare are not the same thing. On the contrary, economic growth can in many cases be associated with declining welfare. Increased pollution, traffic congestion and a sense of disconnectedness from the community can all be products of the unbridled pursuit of economic growth. The distribution of the fruits of growth also has a major influence on how society benefits from it.

Simon Kuznets, one of the 'fathers' of national accounting, was a critic of the use of GDP as a measure of welfare rather than simply as a measure of the extent of market activity in an economy. He wrote:

> The welfare of a nation can scarcely be inferred from a measurement of national income as defined (by GDP)… Goals for 'more' growth should specify of what and for what.

The Genuine Progress Indicator (GPI) attempts to measure the broader impacts of growth, those that fall outside of the national accounts or that are measured wrongly in the national accounts. Unlike GDP, the GPI does not treat expenditure on a home security system in the same way as it treats expenditure on food and clothing. The first is a 'defensive' expenditure, designed to maintain welfare in the face of a deteriorating environment (in this case, a declining sense of personal security). The second is assumed to add directly to the well-being of consumers.

The GPI also includes a range of other important factors that are excluded in the GDP. While unemployment reduces GDP, as unemployed people do not produce as much as employed people, this decline in GDP is not the full measure of the social costs of unemployment. The GPI, on the other hand, includes an estimate of the financial, social and psychological costs of unemployment. The GPI also includes estimates of the costs of underemployment and overwork. In a deregulated labour market hours of work are becoming more unevenly distributed, creating a situation in which overwork and unemployment now exist side by side.

While the natural environment provides the essential foundation on which market production can take place, GDP takes almost no account of the adverse impact of market activity on the environment. In an attempt to overcome this shortcoming, the GPI also includes changes in the value of the 'stocks' of our natural resources. While GDP records the transformation of a native forest into timber as being entirely

positive, the GPI deducts the lost environmental values so that the net effects of logging native forests are accounted for.

For the first time the GPI also includes measures of the costs of problem gambling and an assessment of the value of advertising. Expenditure on gambling has increased rapidly in Australia in recent years. Alarmingly, while problem gamblers account for only 2.1% of the Australian population they are responsible for more than 30% of total expenditure on gambling, losing an average of more than $12,000 each per annum. It makes no sense to count an increase in spending by gambling addicts as an addition to national welfare, so the GPI deducts expenditure on gambling by problem gamblers from total consumption expenditure.

The GPI also deducts a proportion of the total expenditure on advertising on the assumption that much advertising does nothing to enhance well-being. While advertisements can be informative, and in turn assist consumers in finding appropriate products and low prices, this is not always the case. Many advertisements are designed to be persuasive rather than informative, creating new ‘needs’ rather than fulfilling existing ones.

While GDP leaves out many things that reduce welfare it also ignores some positive contributors. One of the largest components of the GPI is the estimated value of household work. While restaurant meals and commercial cleaning services officially add to national welfare because they appear in the national accounts, home cooked meals and doing the housework do not count. The arbitrary distinction between market and non-market services in the calculation of GDP results in the appearance of ‘growth’ whenever in house services are ‘outsourced’. The GPI overcomes this problem by valuing household and community work. While people are free to choose between the two options, their choice should not have a major impact on the measure of national well-being.

The results of the GPI are shown in the figure below where both GDP and GPI are reported in real per capita terms for the period 1950-2000. It shows that the welfare of Australian citizens has grown much more slowly than growth in per capita GDP.

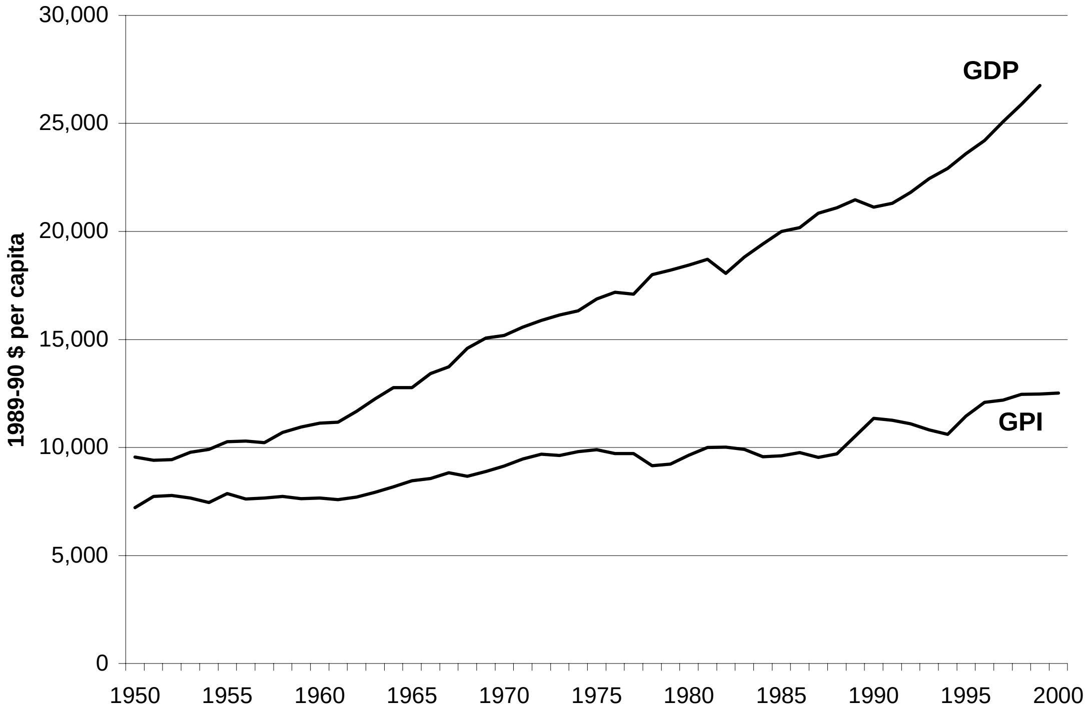
Since 1950, GDP per capita has trebled in real terms, rising from just over $9,000 to just under $27,000. Over the same period, however, the more comprehensive measure of welfare has increased by only 73%, from $7,218 to $12,527.

The rate of growth of welfare has slowed in more recent years. Since 1996 the economy has grown strongly, with GDP per capita rising by 13.4%. When welfare is measured by the GPI, welfare has risen by only 3.6%.

In recent years governments have focussed more and more attention on hastening the rate of growth. It is clear from the GPI, however, that higher growth does not guarantee that welfare will be increased. Trading off more pollution for cheaper electricity, accepting longer hours and reduced job security for faster employment growth, and diminishing the stock of environmental assets to provide a short-term flow of goods will all increase GDP, but such practices may have a deleterious effect on welfare.

The GPI represents a much broader indicator of social welfare than GDP. The results suggest that current policies are failing to improve substantially the welfare of Australians. Unless policy makers begin to rely on broader indicators of welfare than GDP they will continue to pursue policies that, while increasing the size of the market, do little to improve the well-being of Australian citizens.

GDP and GPI per capita, 1950-2000



1. Rethinking economic growth

1.1 Growth *versus* progress

Over the last two decades some far-reaching changes have been made to the Australian economy in the pursuit of more economic growth. Trade barriers have been dismantled, financial markets have been opened up to global investors, many publicly owned assets have been sold, foreign policy has been reoriented to emphasise trade and investment as never before, the labour market has been deregulated, the public sector has been cut, and taxes on the rich have fallen. While it is sometimes acknowledged that there are untoward effects from growth, no social or environmental cost, it seems, is too high to pay for the sake of more growth.

More than ever before, economic growth is the touchstone of policy success. Every newspaper, every day, quotes a political leader or a commentator arguing that we need more economic growth to improve our level of national well-being, to build a better society. The release of the quarterly national accounts unfailingly receives extensive coverage. Picking out growth in Gross Domestic Product (GDP), journalists write as if they have a technical barometer of our nation's progress. Produced by some of our best statisticians using the internationally agreed system of national accounting, GDP appears to provide a measure of prosperity that is immune to argument.

In the presence of sustained economic growth throughout the 1970s, 1980s and 1990s, Australians have been strangely restive. They are disgruntled, fractious and suspicious of the claims by politicians that the economy is doing well. There is a widespread perception, confirmed by social researchers such as Hugh Mackay and Richard Eckersley, that life in Australia is not improving, but is in fact deteriorating (Eckersley 1999). If growth is so good for us, people are asking, how come it seems that things are getting worse?

People do not experience economic growth as such, rather, they experience a complex set of economic and social changes that affect their daily lives. The two may diverge. A wealth of survey and other evidence reveals that, while the economy grows inexorably, people have found that they must work harder and longer just to keep up, they feel more insecure about their jobs and their futures, they no longer believe in the post-war dream that everyone can make a better future for their children, and they feel less connected to their communities than ever before. Australians worry about new social epidemics: family breakdown, youth suicide, drug addiction and drug-related crime, the gambling culture, and a pervasive fear about the destruction of the natural world.

Undoubtedly, one reason for this divergence between the performance of the economy and the perceptions of ordinary people has been the fact that the growth of income has been skewed towards the wealthy. But the problem runs much deeper than the age-old one of maldistribution of income. The problem lies in how we define and measure prosperity in Australia. Our official statistics provide a misleading picture of changes in national well-being. The national accounts that generate GDP fail to recognise that the growth process produces 'ill-being' in addition to well-being, 'bads' as well as goods.

Why are our measures of national progress so misleading?

During the years between the world wars, governments needed better means of managing their economies in the face of dramatic swings in the business cycle. Economists including John Maynard Keynes, John Hicks and Simon Kuznets developed the original systems of national accounting. They were acutely aware of their shortcomings and indeed repeatedly warned against using measures such as gross domestic product as indicators of prosperity. Kuznets, the originator of the system of uniform national accounts in the USA, warned Congress in 1934: "The welfare of a nation can scarcely be inferred from a measurement of national income as defined above".[1]

Kuznets watched with some dismay as his warnings were ignored and economists and policy makers grew accustomed to equating prosperity with growth in national income or GDP. By 1962 he was writing that the construction and use of the system of national accounting must be rethought: "Distinctions must be kept in mind between quantity and quality of growth, between its costs and returns, and between the short and the long run. ... Goals for 'more' growth should specify more growth of what and for what".[2]

The basic problem is that our measure of national progress has been bound inseparably to the price system. An activity is taken to contribute to our national well-being by virtue of the fact that, and solely to the extent that, it is produced for sale. This way of measuring national well-being omits two large realms: the contributions of family and community on the one hand, and of the natural environment on the other. Both of these are vital to our well-being, but because their contributions lie outside of the marketplace they simply do not count. Years ago ignoring these realms may have been justified.

But in the twentieth century these presuppositions have become insupportable. Our society has been penetrated at every level by market relationships. Increasingly, couples prepare for marriage by signing a financial contract. We buy our social identities through brand names and personal styles created by advertising agencies. Our leisure time is increasingly the preserve of commercial entertainment rather than family and community activity. Sporting competitions are now big business, with teams for sale to the highest bidder and 'loyalty' packaged and sold. The images that surround us everywhere in our daily lives are created to sell products.

Nor can we separate the social afflictions of crime, drug abuse and youth suicide from the societal changes wrought by the market economy. Unemployment, inequality and the pervasive expectation that contentment derives from material acquisition – these are products of the market system and have the most profound effects on our welfare. We now know that an unequal distribution of income has a major effect on the distribution of ill-health, so that the operation of the market can make people sick.

In addition, we have discovered that the natural world is decidedly finite, and that we have exceeded its ability to absorb human impacts. Vast expanses of forest are gone,

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[1] Quoted by Cobb, Halstead and Rowe (1995)
[2] ibid.

or transformed into sterile monocultures. Many of the fish stocks that teemed the oceans have vanished. The soils are being washed into the seas. Critical parts of the natural world are in decline, and we now even threaten the most basic life-support system of them all, the atmosphere.

None of these problems is reflected in our measure of national progress, GDP. The economy values only what it needs, and what it does not need has no value. Contributions to our well-being only count if they are transferred from the household to the market sector; and the 'side effects' of the market that diminish our well-being are sent back to the social and environmental sectors where they no longer count.

Despite its manifest inadequacies, GDP provides the vital piece of feedback that policy makers use to direct the nation. Should a mine or a shopping centre go ahead? Should the labour market be deregulated? Should we sign an international investment agreement? Should we have a GST? If the indicators of national progress are consistently misleading, then we will continue to follow policies that fail, and we will be unable to escape a cycle of decline.

While the major political parties may differ on social policy, they agree that the ultimate aim of national policy is growth of the economy, to keep GDP rising as fast as possible. They fight elections each promising to manage the economy better so that economic growth will be higher. The answer to almost every problem is 'more economic growth'. The problem is unemployment; only growth can create the jobs. Schools and hospitals are underfunded; the answer is faster growth. We can't afford to protect the environment; the solution is more growth. Poverty is entrenched; growth will rescue the poor. Income distribution is unequal; the answer is more growth.

In real terms, GDP per person is three times higher today than it was in 1950. Are we three times as well off? Has this impressive growth solved our problems, or created new and bigger ones? But instead of stopping to look, and challenging the claim that more growth will solve our problems, we are told we must have more growth. It is time we took Simon Kuznets' question seriously: If we want more growth, growth of what and for what?

1.2 A new measure of progress

In 1997, the Australia Institute published its Genuine Progress Indicator or GPI, an alternative to GDP as a measure of national progress.[3] Building on similar studies abroad, the GPI covered the period 1950-1996 and drew on a mass of data from official institutions and economic and social researchers to compile an index of economic progress over time.

The 1997 GPI met with widespread interest. The present paper builds on the previous one, updating the methodology for calculating several of the components, adding some new components and extending the time period by four years to 2000.

[3] See Hamilton (1997) for the full account and Hamilton (1999) for a paper focussing on the methodological issues.

While well-being is a subtle and hard-to-measure concept, the GPI gets much closer than GDP to the impacts of the growth process actually experienced by Australians. It does not include everything that affects our well-being, nor even everything that affects our economic well-being. Only some aspects that lend themselves to monetary measurement are included. But even adding in a few of the factors that clearly affect our daily lives tells a story very different from the national accounts. The results confirmed what some critics and many ordinary people have been saying for years.

The general approach to the GPI is to identify the pitfalls of GDP as a measure of national progress and then to attempt to overcome them. The principal shortcomings of GDP as a measure of changes in national well-being are:

- the failure to account for the way in which increases in output are distributed within the community;
- the failure to account for the contribution of household work;
- the incorrect counting of defensive expenditures as positive contributions to GDP; and
- the failure to account for changes in the value of stocks of both built and natural capital.

The new Australian GPI incorporates 23 aspects of economic well-being that are either ignored or wrongly treated in the official estimates of GDP. While there are many complex conceptual and measurement issues to be dealt with in compiling the new index, most of it makes intuitive sense. We know that an economy growing at 4 per cent but shedding jobs does not leave a community as well off as a similar economy growing at 4 per cent but maintaining employment. We know that an economy that can grow at 4 per cent while minimising pollution is better for us than one growing at 4 per cent but despoiling the air and water.

The GPI provides a balance sheet for the nation that includes both the costs and the benefits of economic growth and includes the extent to which we rely on running down our capital to maintain our living standards. In summary, the principal factors included in it are as follows.

Income distribution Most people would agree that a growing economy contributes more to national well-being if poorer households receive a major share of the new income. The GPI adjusts growth in consumption by a measure of the changing distribution of income in Australia. The 2000 GPI employs a more sophisticated measure of income inequality that includes an explicit parameter reflecting the importance society attaches to inequality.

The household economy Much of the work that contributes to our well-being occurs in the home and the community – caring for children and the elderly, buying for and cooking meals, cleaning the house and coaching the children’s soccer team. Because these activities (traditionally performed mostly by women) are outside of the market their contributions do not appear in the national accounts. Only when the market captures them – as in the spread of paid childcare and fast food and the employment of housekeepers – do they appear to add to our well-being because they now have price tags. The GPI includes an estimate of the value of household and community work.

Unemployment and overwork Unemployment imposes costs on communities and nations well beyond the loss in economic output that enforced idleness entails. Many studies have shown that the health and skill levels of unemployed people decline, their families are more likely to break down, crime rates rise and there are often severe psychological impacts on unemployed people and their families. Paradoxically, in the last decade or so an epidemic of involuntary overwork has also beset Australia and this imposes additional costs. The GPI includes estimates of the financial costs of unemployment and overwork.

Environmental degradation When economic growth causes depletion of stocks of natural resources and decline in environmental quality, the national accounts either ignore the effects or treat them as a gain. The GPI attempts to assess these costs properly. While GDP counts the value of timber from native forests as a benefit, and stops there, the GPI also counts the environmental costs of logging. The damage done by greenhouse gas emissions is not ignored (and left as a problem for future generations to deal with) but is counted in the GPI as a cost of economic activity in the year the gases are released into the atmosphere. The GPI also accounts for the costs of ozone depletion, land degradation, water pollution and water use, depletion of non-renewable resources and noise pollution.

Crime If a crime wave induces us to spend more on household security and insurance premiums then this expenditure is recorded as a positive contribution to our well-being in GDP. In reality we are only trying to maintain our levels of security in the face of a more threatening world. The costs of crime are enormous, over $20 billion each year, and include not only the costs of preventing crime but the health and repair bills for the victims of crime. The GPI deducts from our consumption spending these ‘defensive expenditures’ related to crime. Some other types of spending on health and education are also defensive in character and are deducted to obtain the GPI.

Foreign debt High levels of foreign indebtedness over long periods are unsustainable. Unless the borrowed funds are invested in productive enterprises that will generate the profits required to repay the debts, we leave a burden for future generations. The GPI takes into account the amount of foreign debt that is devoted to consumption rather than invested productively. It is one of the major influences on the course of the Australian GPI over time.

1.3 Some objections to the GPI

While many people have welcomed the GPI – known in some countries as the Index of Sustainable Economic Welfare or ISEW – others have raised objections.[4] Before dealing with these concerns it is useful here to dismiss a common misconception – the claim that the ‘weighting’ of various components in the GPI is subjective. In fact, the GPI uses a range of techniques to attach dollar values to the various components, thus converting every component into a common unit of measurement. For instance, the

[4] Castles (1997), Neumayer (1999)

value of household labour is arrived at by multiplying the number of hours worked in the household by the hourly wage rate of a housekeeper. The value of the loss of ozone is arrived at by assessing the health costs of the damage caused. These are not subjective 'weights' but are dollar values generated in markets of one sort or another – actual markets, related markets or hypothetical markets. Everything is expressed in dollar values via prices generated in markets, so that the weights look after themselves.

Some critics argue that the GPI lacks a sound theoretical foundation; as a result the inclusion of various components is arbitrary (Neumayer 2000). While the rationale has not always been clearly stated in previous GPIs and ISEWs, the selection of components is not arbitrary but follows some rules. The process begins by identifying the deficiencies of GDP as a measure of welfare and asks how it would need to be changed to make it a better measure. In so doing, it builds a framework for measuring sustainable consumption.

Thus the GPI is not 'arbitrary' in the sense that its authors simply add in components at random. In each case, there is an identified problem with GDP as a measure of welfare, and an attempt is made to fix it so far as is permitted by availability of data. When statisticians calculate 'net national product' by subtracting depreciation of capital from GNP and say that it is a better measure of changes in output we do not accuse them of being arbitrary; they are correcting for a known problem.

Moreover, the accusation of subjectivity can be laid more squarely at the door of GDP when it is used as a measure of national welfare. For example, an extra $1 million of income is interpreted as making the same contribution to national welfare no matter who receives it, whether very rich or very poor. This is an implicit subjective political judgement (one that most people would reject). The advantage of the GPI is that it puts everything on the table for debate.

There is one serious problem with the GPI as a measure of national well-being. Aggregating all of the factors into a single monetary index makes many people feel uncomfortable. By converting everything into dollars, doesn't the GPI fall into the same trap as GDP, that of reducing everything to economics? This is perhaps the major flaw in the GPI. The problems with the approach become apparent when we attempt to estimate the costs of climate change, since the greatest costs will be associated with loss of life, which must be given a dollar value if it is to be included in the index. Similar ethical difficulties are encountered when we attempt to place a dollar value on the loss of environmental values due to logging of old-growth forests, values that include loss of local biodiversity and possible extinction of species. Placing dollar values on these things converts ethical values into economic ones, a process that for many people actually devalues the environment and human life. These profound problems with the GPI are acknowledged. But constructing the GPI is the most effective way of pointing out the failings of our current systems of measurement, and refusing to value some things means they must be left out of the GPI, even though it is generally agreed they affect our well-being.

2. Methodological issues

2.1 The broad approach

The methodological foundations of the Australian GPI were laid out in Hamilton (1997). The GPI combines impacts that derive from changes in the natural environment and in social conditions, and it incorporates impacts due to both changes in flows and changes in stocks. It is based on the idea of sustainability. In 1939 the British economist John Hicks defined what is now known as 'Hicksian income' as the maximum amount that a person or a nation could consume over some time period and still be as well off at the end of the period as at the beginning (Hicks 1946: 172).[5] Thus income is maximum *sustainable* consumption. Sustaining consumption over a given period depends on maintaining the productive potential of the capital stocks that are needed to generate the flow of goods and services that are consumed.

The GPI takes this idea and sets itself two tasks:

1. to define and measure 'consumption' in a way that provides a better approximation of actual well-being than the simple measure of marketed goods and services that appears in the national accounts; and

2. to account for the sustainability of consumption by incorporating measures of changes in the value of capital stocks.

Taking account of these two classes of influence on welfare over time, we may end up with a situation in which GDP is increasing while consumption (more broadly defined) is rising or falling, and while capital stocks are growing or declining.

The GPI combines changes in the value of stocks and the values of flows of current consumption. Consistent with the definition of Hicksian income, capital stocks perform two functions in the GPI method of measuring changes in welfare – they yield an annual flow of services and they contribute to the sustainability or otherwise of levels of consumption in the future. In order to prevent the depreciation or depletion of capital stocks a portion of current consumption needs to be 'set aside' to replenish the stocks. The implication of this is that, unlike the way in which changes in GDP are used, year-on-year changes in the GPI are not very meaningful. The main purpose of the GPI is to illustrate trends over time.

2.2 Measuring 'consumption' more comprehensively

For individuals or households, consumption may be defined as annual flows of marketed and non-marketed goods and services. Perhaps the biggest category of non-marketed goods and services comprises those produced in the home by unpaid household work. Non-marketed goods and services also include services provided by the natural environment, such as the aesthetic and recreational services of old-growth forests and the health-sustaining properties of clean air.

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[5] Hicks also wrote that 'the practical purpose of income is to serve as a guide for prudent conduct' (Hicks 1946: 172), a comment that has particular relevance for today's concern with ecological sustainability.

A more comprehensive definition of consumption that takes account of non-marketed goods and services is particularly important because measured GDP growth may reflect nothing more than the transfer of activity from the non-market to the market sector, a problem long recognised in the development literature. This is most apparent in the case of household work, but applies equally to any other ‘free’ service. Just as, in the well-known observation, GDP declines ‘if a man marries his housekeeper’, GDP rises if an entrance fee is levied on visits to a national park or a family decides to eat out more often.

Consumption includes negative flows or ‘bads’. Some monetary expenditures by final consumers – which are therefore included as expenditures in GDP – represent not additions to welfare but attempts to offset some change in social, environmental or individual circumstances which is causing a decline in welfare. These are known as defensive expenditures and are deducted from the value of personal consumption expenditure that provides the starting point of the GPI.

The GPI assumes that personal consumption spending by individuals on marketed goods and services is the major component of welfare and that an increase in this spending represents, *ceteris paribus*, a corresponding increase in welfare. There is a large literature critical of the assumption that there is a close relationship between changes in consumption spending and changes in individual welfare (see e.g. Dodds 1997). Many studies have shown that, at least beyond a certain level of income, perceived well-being depends more on the level of one’s income relative to other people’s incomes, or to previous or expected levels, than on absolute levels.[6] But the purpose of the GPI is to demonstrate that, even using conventional economic methods, a more comprehensive attempt to account for changes in welfare may show large deviations from GDP over time. Consequently, we adopt the assumption that increases in personal consumption (adjusted for the distribution of income) reflect increases in welfare.

2.3 Accounting for changes in the value of capital stocks

Sustaining levels of consumption requires that the productive potential of capital stocks be maintained. Capital stocks can be divided into five forms, which we discuss in turn. While GDP accounts for changes in none of them, the GPI attempts to incorporate changes in the value of the first three.

Built capital This covers the stocks of physical machinery, buildings and infrastructure that are essential to sustaining levels of GDP. These stocks deteriorate and a portion of income must be set aside each year to invest in them to maintain and improve their productive potential. The GPI adjusts consumption spending to take account of net capital growth that, if positive, adds to sustainable economic welfare.

Financial assets A nation’s ability to sustain investment in built capital assets is diminished if it is accumulating foreign debts, since some part of future income must be devoted to repaying the debts. If those loans are being invested productively then future income will be higher and it will be possible to repay the debts without

[6] For a formal treatment of the roles of relative incomes, aspirations and environmental quality in welfare see Ng and Wang (1993).

additional burden. To the extent that foreign debt has been invested productively in the past, current consumption will be higher. The GPI adjusts consumption spending to account for net foreign liabilities.

Natural capital Maintaining the stocks of natural capital is essential to sustaining consumption in the future, especially when consumption is defined more broadly. These stocks take two forms. The first are stocks of renewable and non-renewable resources used as inputs in production, such as minerals, fossil fuels and soils. The second take the form of waste sinks that are provided by the natural environment and are essential for dissipating waste products so that they do not represent a danger to humans. The GPI takes account of the depletion of natural capital. However there are some difficult methodological issues concerning the substitutability of built for natural capital that are discussed in the next section.

Human capital This represents the accumulation of health, skills, knowledge and experience in humans that makes them more productive than brute labourers. Technology is partly embodied in humans. The GPI does not account for human capital because of the conceptual and measurement difficulties involved. If it did, the GPI would be adjusted to account not for annual investments in human capital but for the annual services provided by the stock of human capital. This is an area for future work.

Social capital A nation that possesses sound and stable political, legal and commercial institutions and cohesive, supportive and trusting communities will be in a better position to generate flows of goods and services than one that does not. This form of 'capital' is difficult to define precisely and to measure and is thus excluded from the GPI. However, some of the impacts of changing social capital are reflected in some the components of the GPI

2.4 Substitutability among capital assets

The depletion of one form of capital does not represent a decline in sustainable consumption if other forms of capital are accumulating and can be substituted for the disappearing asset. Thus the issue of substitutability within and between these classes of assets is critical. For instance, the run-down in physical capital is not necessarily a problem if financial wealth that could be used to rebuild it (or could be used to invest in assets in other countries) is being accumulated outside of the country.

More controversially, the run-down of one type of natural asset will not necessarily impose a cost if built capital or another type of natural asset can perform, at the same or similar cost, the same functions. The question of the degree of substitutability of built for natural capital is perhaps the most strongly contested issue in the economics of the environment. We have taken the view that for three classes of natural assets complete substitutability between built and natural assets is not a valid assumption. These classes are:

1. certain natural resources that are irreplaceable and form essential inputs to continued productive activity – soils and supplies of fresh water are examples;

2. waste sinks, i.e. those components of the natural environment which absorb or process wastes and render them benign, particularly the atmosphere (covering the climate system and the ozone layer) and the oceans; and

3. assets whose services are consumed directly by final consumers and which are valuable because of their unique natural features – old-growth forests and the Great Barrier Reef are examples.

In addition to these, there may be some natural resources for which there are, or probably will be, substitutes, but for which the substitutes are likely to be significantly more expensive. Fossil fuel based energy is the most pertinent category here. Energy is essential for economic activity, yet the evidence (discussed under Column T in Section 4 below) suggests that the market for energy may not adequately reflect the likely scarcity of fossil fuels (especially oil and natural gas).

2.5 Defensive expenditures

Whereas GDP counts them as additions to output, the GPI deducts defensive expenditures undertaken by consumers and governments because, by definition, they are undertaken to offset some decline in social welfare. One issue that has not been canvassed to date is the question of the relationship between economic growth and defensive expenditure. If defensive expenditures are made to offset the effects of something that is unrelated to the growth process (i.e. economic activity captured in the national accounts) is it legitimate to deduct these expenditures in the GPI?

In the GPI, defensive expenditures are deducted from private and public consumption expenditure as the latter should unambiguously confer welfare benefits on citizens. Thus, if some part of consumption expenditure does not represent an addition to welfare, but is undertaken to offset some other impact, it is quite legitimate to deduct it irrespective of whether the decline can be attributed to the growth process itself.

In principle, most defensive expenditures are reactions to a decline in the value of the stock of social, human or natural capital, as long as they are broadly defined. This applies to private defensive expenditures on health and personal security and public defensive expenditure on social welfare. If we could adequately account for changes in stocks of human and social capital then it would not be necessary to deduct defensive spending.[7]

A more difficult question is that of how much of a given expenditure is defensive and how much makes a net contribution to welfare. This is particularly relevant to some public expenditures, on social security and law and order for instance. An increase in spending on policing, courts and prisons due to a crime wave is clearly defensive, yet some basic level of spending on crime prevention and punishment is essential and makes a large contribution to national well-being. Ultimately judgements about how much spending is defensive and how much makes a positive contribution to welfare will be somewhat arbitrary.

[7] We are indebted to Max Neutze for this point.

Neumayer makes a more general point about the arbitrariness of including defensive expenditure (2000: 7-8) “If health expenditures are defensive expenditures against illness, why should food and drinking expenditure not count as defensive expenditures against hunger and thirst?” Neumayer records Daly and Cobb’s response, which is the same as ours above: defensive means a defence against unwanted side effects of other production, not a defence against normal baseline environmental conditions. This seems to be the only way around what is a tricky issue. If we are using GNP or ISEW as a measure of welfare, and we want an increase in GNP or the ISEW to reflect an increase in welfare, then we must account for changes in welfare that elicit defensive expenditure.

2.6 Time accounting

The Australian GPI attempts a systematic approach to valuing time. The value of time is a very important aspect of various components of the GPI, including the value of household and community work and the costs of unemployment and of overwork. In the Australian GPI we have adopted the principle that the value of time devoted to voluntary activities counts as a positive in the GPI and the value of time engaged in involuntary activities counts as a negative. The following voluntary activities contribute to our welfare:

- paid work (except the involuntary component referred to below as ‘overwork’);
- household work;
- community work; and
- leisure activities.

The following activities diminish welfare and, as such, impose costs on the community:

- involuntary leisure, i.e. the times when we are unemployed but want to be employed; and
- involuntary work, i.e. the times when we are doing paid work but would prefer not to be.

The distribution of these activities varies between different groups inside and outside the labour force, partly by choice and partly involuntarily. For our purposes, the groups in question are the fully employed full-time workers (who may be overworked), fully unemployed workers, underemployed part-time workers, fully employed part-time workers, and those outside the labour force. This issue discussed in more detail in section 4.

The value of leisure is not included in the Australian GPI. This departs from the US GPI (Cobb, Halstead and Rowe 1995) but is consistent with the UK and Swedish ISEWs (Jackson *et al.* 1995; Jackson and Stymne 1996). Cobb, Halstead and Rowe justify their inclusion of loss of leisure time by arguing that working hours in the USA have been getting longer and that this represents an involuntary loss of leisure. To measure this cost they deduct from the GPI the value of the leisure hours lost relative to leisure enjoyed in 1969, the year of greatest leisure since 1950. While the Australian GPI does not include an estimate of the value of lost leisure time, it does include the obverse – an estimate of the costs of overwork. The costs of overwork are discussed below (Column H). This leaves us with the costs of unemployment and underemployment, which are included in the Australia GPI (Columns F and G).

2.7 Components of the GPI

The components of the GPI are shown in Table 1, along with an indication of whether each is added to or subtracted from the indicator. A brief description is also provided. A full discussion of each component, including rationale, method of calculation and data is provided in Part 2 of the paper.

Table 1 Components of the Australian GPI

	Column name		Description of indicator
A	Personal consumption	+	Private final consumption expenditure
B	Income distribution		Atkinson index
C	Weighted personal consumption		Personal consumption weighted by Atkinson
D	Public consumption expenditure (non-defensive)	+	Value of non-defensive government consumption spending
E	Value of household and community work	+	Hours of household and community work performed each year valued by the housekeeper replacement method
F	Costs of unemployment	–	Value of hours of idleness of the unemployed
G	Costs of underemployment	–	Value of hours of idleness of part-time employees who want to work full-time
H	Costs of overwork	–	Value of hours of work done involuntarily
I	Private defensive spending on health and education	–	Health and education spending that offsets declining conditions
J	Services of public capital	+	Contribution of public investment in non-defensive works (eg. roads)
K	Costs of commuting	–	Time spent commuting valued at opportunity cost
L	Costs of noise pollution	–	Excess noise levels valued by cost of reducing noise to acceptable level
M	Costs of transport accidents	–	Costs of repairs and pain and suffering
N	Costs of industrial accidents	–	Costs of pain and suffering etc.
O	Costs of irrigation water use	–	Damage to environment measured by the opportunity cost of environmental flows
P	Costs of urban water pollution	–	Damage to environment measured by the control cost of improving water quality
Q	Costs of air pollution	–	Damage to humans and environment from noxious emissions measuring mainly by health costs
R	Costs of land degradation	–	Costs to current and future generations from soil erosion, salinity etc. measured by forgone output

			etc. measured by forgone output
S	Costs of loss of native forests	–	Environmental values denied to future generations measured by willingness to pay
T	Costs of depletion of non-renewable energy resources	–	Costs of shifting from oil and gas to renewables
U	Costs of climate change	–	Annual emissions valued by future impacts on humans and environment
V	Costs of ozone depletion	–	Annual emissions valued by future impacts on humans and environment
W	Costs of crime	–	Measured by property losses and household spending on crime prevention
X	Costs of problem gambling	–	Expenditure on gambling by problem gamblers
Y	Value of advertising	–	Non-welfare improving advertising expenditure
Z	Net capital growth	+	Growth in net capital stocks per worker
AA	Net foreign lending	–	Change in net foreign liabilities

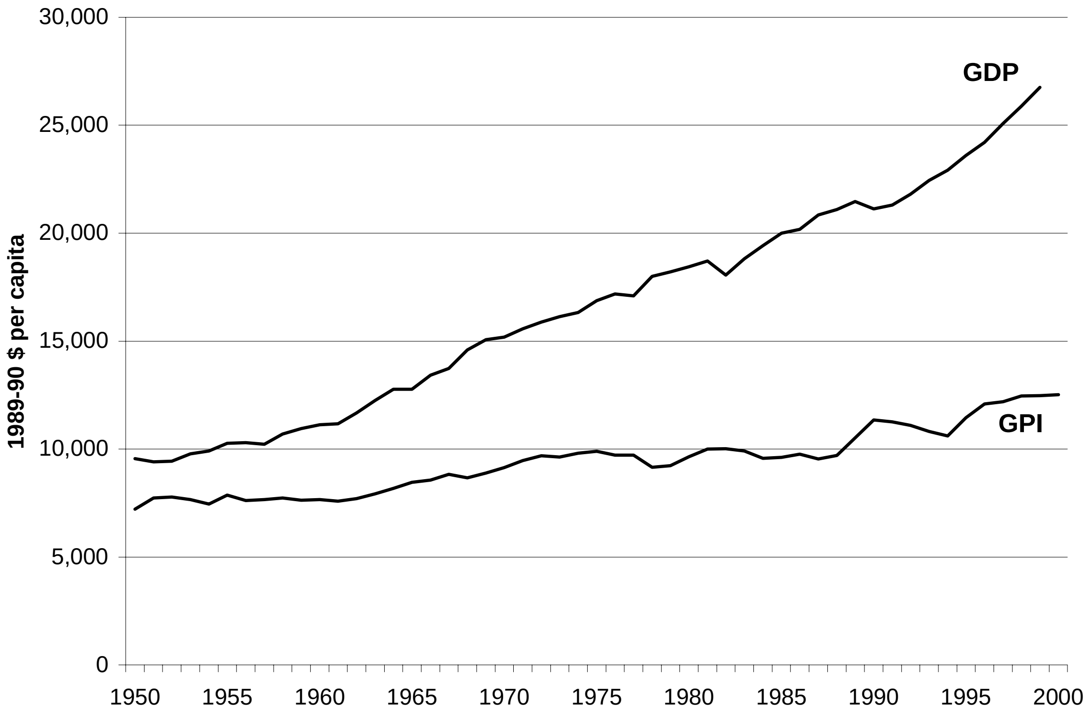
3. What the GPI Shows

3.1 GPI and GDP 1950-2000

The GPI and GDP have been calculated for the period 1950-2000 on a financial year basis (i.e. 2000 is the year 1999-2000). They are both adjusted for inflation, with all values presented in 1989-90 prices. The GPI and GDP per capita are presented in Figure 1. The data series for all components of the GPI are presented in Appendix 1.

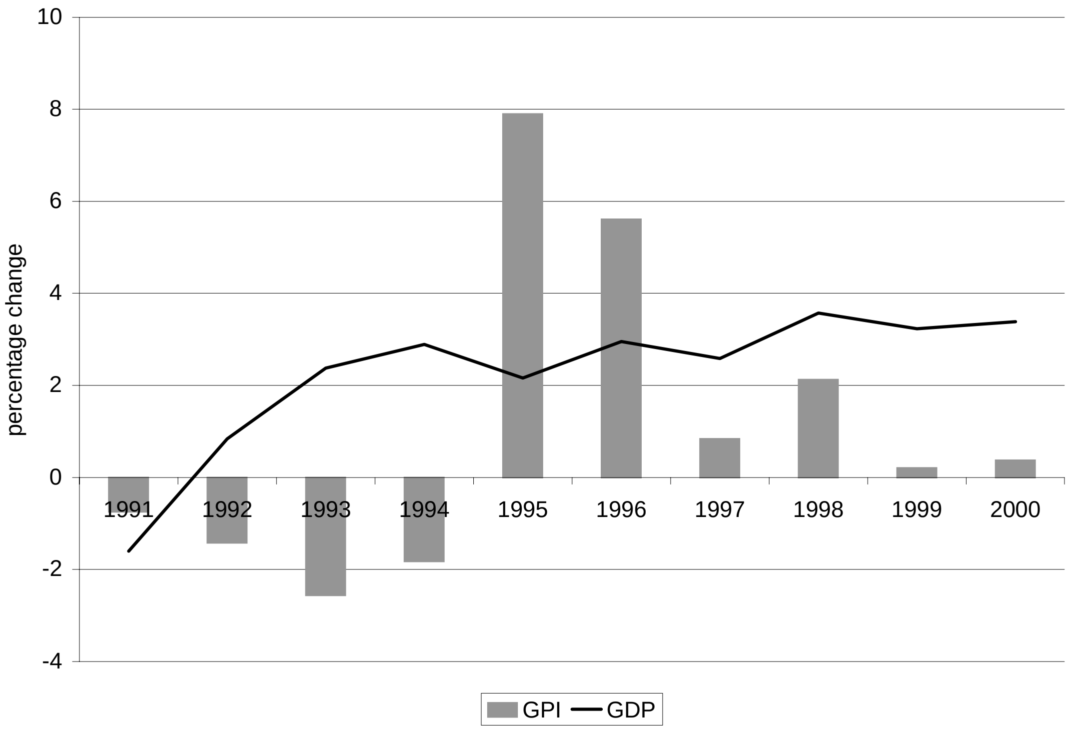
Since 1950, real GDP per capita has increased from $9,126 to $26,755 in real terms, a threefold increase. Over the same period, however, welfare as measured by the GPI has increased from $7,218 to $12,527, an increase of only 73%. Over the entire period, while real GDP per capita has grown at an average annual rate of 2.2 per cent the GPI has grown at only 1.2 per cent.

Figure 1 GDP and GPI per capita, 1950-2000



In more recent years, growth in welfare has more or less stopped. Since 1991 the economy has grown strongly, with GDP per capita rising by 26%. However, when welfare is measured by the GPI, the rise in welfare is 11%. Since 1996 while GDP has grown by 13.4 per cent welfare per capita has increased by only 3.6% In other words, the higher rates of economic growth experienced over the last few years have failed to have an appreciable impact on the welfare of Australians. Annual changes in GDP and GPI since 1991 are shown in Figure 2.

Figure 2 Changes in GDP and GPI per capita, 1991-2000



Following the recession of 1991 the GPI fell for three consecutive years, largely due to the rising costs of unemployment and underemployment. Growth in welfare did not resume until 1995. In contrast, GDP growth rebounded strongly. While strong growth in welfare was recorded during 1995 and 1996, this was short-lived and due mainly to reductions in the costs of unemployment and overwork. In recent years the costs of overwork have grown strongly as the average working week has lengthened. Strong economic growth combined with deregulation in the electricity industry also saw a substantial increase in the costs of climate change (see Hamilton and Denniss 2000).

Another feature of recent economic growth has been its dependence on foreign borrowings. While foreign borrowing has grown rapidly, new investment in the capital stock has been weak, ensuring that debt repayment will be funded via reduced future consumption rather than increased future earnings.

The following sections provide an analysis of some of the key components that have affected the GPI. The results for all components are presented in Appendix 1.

3.2 Some important influences on the GPI

The labour market

The welfare of most Australians is directly or indirectly affected by labour market conditions. Wage rises, overwork, unemployment, underemployment, insecurity and the labour market circumstances of friends and family all play an important role in determining well-being. While GDP captures the output that is lost through unemployment or underemployment, it fails to capture many of the social and financial costs experienced by the unemployed themselves. Similarly, GDP measures the increased output associated with overwork, but fails to consider the costs imposed on workers, their families, and society more generally of overwork.

Figure 3 shows the costs of unemployment and overwork for the period 1978-2000. While unemployment existed in the economy in the 1950s and 1960s it was in the nature of 'frictional unemployment'. Substantial amounts of involuntary unemployment were absent. This issue is discussed in greater detail in Part 2.

Figure 3 The costs of unemployment and overwork

An interesting feature of Figure 3 is the extent to which the decline in the costs of unemployment in recent years has been offset by the costs of overwork. This finding is consistent with evidence of increases polarisation of both work hours and incomes in the new deregulated labour market (see Burgess and Watts 2000). The costs of overwork have grown by 47 per cent since 1996 as employers require longer and longer hours from workers, often without additional pay.

Overwork is estimated by comparing average weekly hours worked to the hours worked in 1982, the year in which full-time employees worked the fewest hours. Part 2 provides more details on the method used for valuing overwork.

While employment has been growing steadily since 1991 (though slowly in comparison to the 1980s), the benefits of that growth have been unevenly distributed. At one extreme, average working hours for full-time workers continue to grow, while at the other, large numbers of part-time jobs are being created with fewer hours than those desired by employees.

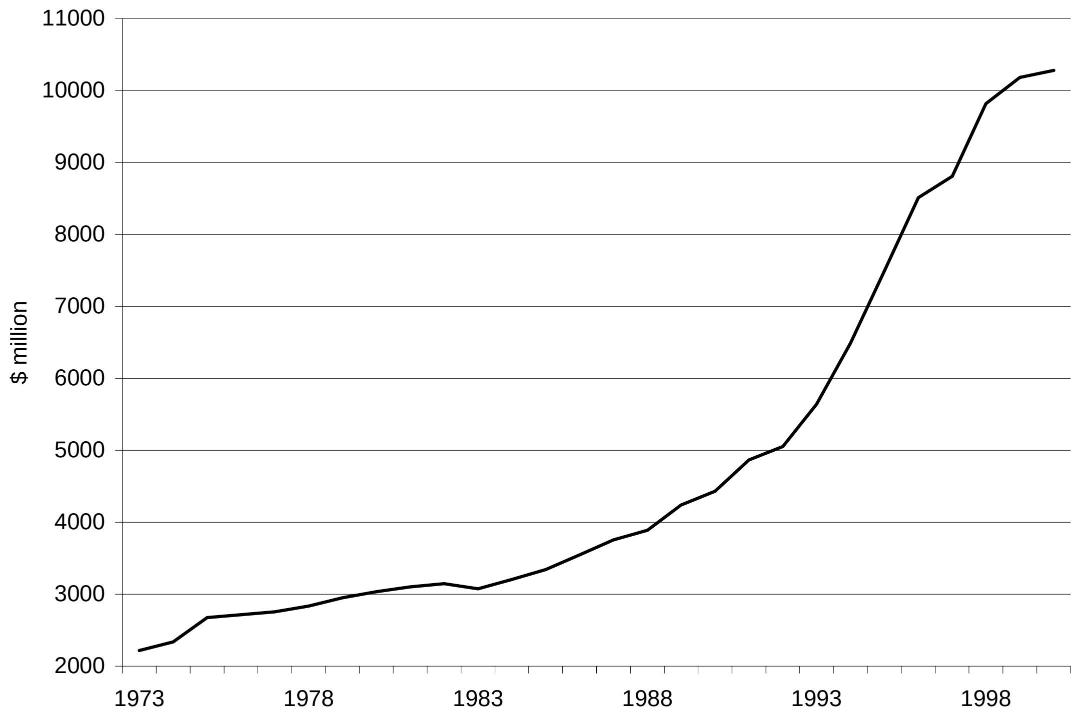
While the Federal Government has expressed its desire for an increased focus on the role of families in both preventing and solving social problems, deregulation in the labour market is reducing the time available for families to spend together. Similarly, with the breakdown in the notion of a 'standard' working week, it is increasingly difficult for individuals to participate in organised community activities such as sporting and religious activity.

Gambling

Over the last decade Australian governments have received a steadily growing proportion of their revenues from taxes on all forms of gambling (Smith 1998; Productivity Commission 1999). Whether or not this has provided an incentive for governments to encourage gambling is debatable, but what is certain is that the costs of problem gambling have grown exponentially.

Figure 4 shows the extent of the increase in expenditure on gambling (the difference between amount wagered and amount won) since 1973. According to the Productivity Commission (1999), the most rapidly growing form of gambling is gaming machines, also the form of gambling preferred by most problem gamblers.

Figure 4 Expenditure on gambling



Source: Tasmanian Gaming Commission (1999)

Continued reliance on gambling as a source of revenue may provide governments with an expedient source of revenue growth, but it comes at a high price, both in terms of the social costs and in reduced progressivity in the tax system (see Productivity Commission 1999). While increased expenditure on gambling by problem gamblers is recorded as an increase in GDP, it actually leads to a reduction in community welfare.

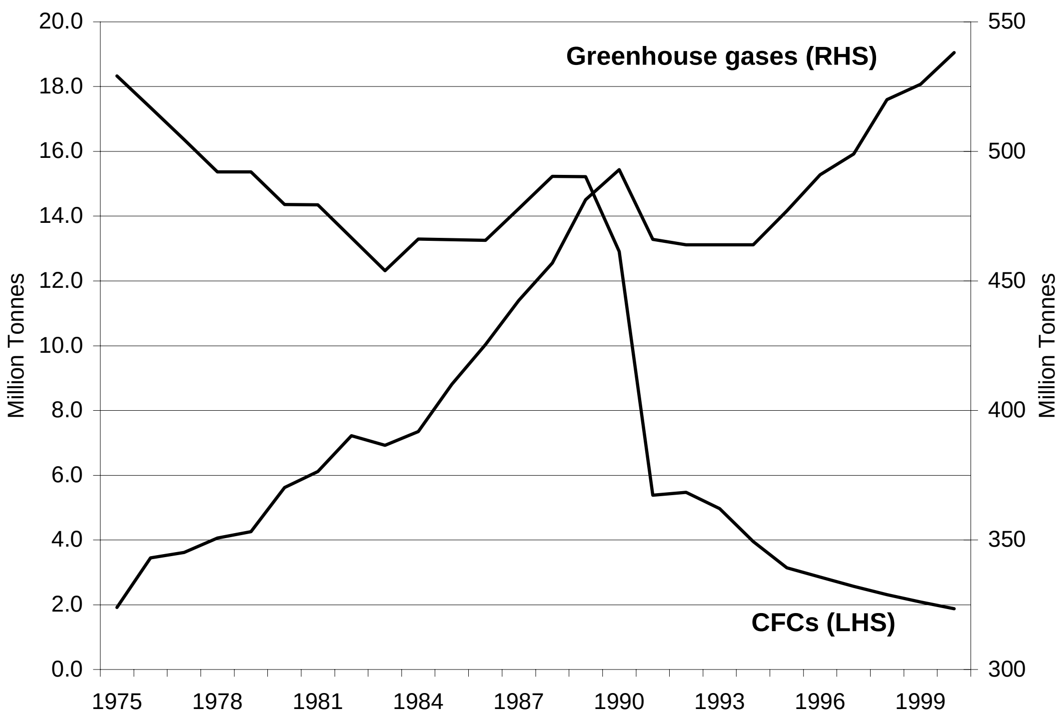
Ozone depletion and greenhouse gas emissions

While debate about the need to act on global warming continues, it is interesting to note the success of arrangements to restrict the emissions of chlorofluorocarbons (CFCs) which harm the ozone layer. The ozone layer plays an important role in filtering the sun's rays that reach the earth, ensuring that much harmful ultraviolet radiation is reflected back into space.

International agreements to limit the use of CFC gases for both refrigeration and as a propellant in aerosol cans have resulted in emissions falling from over 18 million tonnes per annum in 1975 to less than 2 million tonnes today. This decline is shown in Figure 5. In addition to helping ensure the health of both humans and the environment more generally, the success of the CFC reduction campaign provides important evidence that international agreements can work, and that while costs may be incurred in the short run, in the long run new technologies can provide cleaner, cheaper solutions to environmental problems.

While international agreements have helped to reduce CFC emissions, emissions of greenhouse gases continue to grow rapidly. While strong economic growth has been a major contributor, government policies such as the deregulation of the electricity industry and cuts in the price of diesel have contributed significantly to increased growth in greenhouse gases (Hamilton and Denniss 2000).

Figure 5 Annual emissions of CFCs and greenhouse gases, 1975-2000



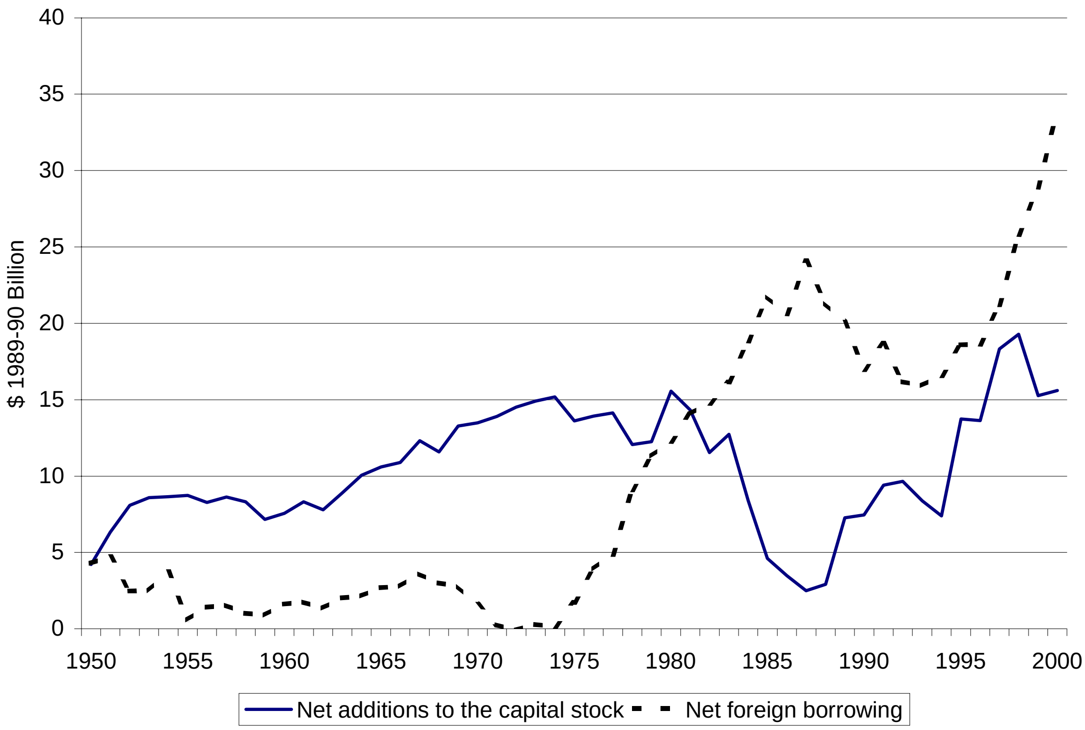
The current account deficit

Australia, like most developed countries, allows it citizens and companies to borrow freely from abroad. Access to foreign funds ensures that Australians can, at a point in time, be net borrowers. That is, in a deregulated foreign exchange market, Australians can borrow more than other Australians are willing to save.

There are a range of benefits associated with providing citizens with access to foreign funds, the main one being that real investment in Australia is not constrained by the capacity of Australians to fund that investment. This is particularly beneficial for a small, rapidly growing country.

However, as can be seen from Figure 6, while Australians have been borrowing more and more heavily in recent years, net additions to the capital stock have begun to slow. The implication is that foreign borrowings are increasingly being used to fund consumption expenditure rather than new productive investment. If growth in the net capital stock were as rapid as growth in borrowings then future returns on investment could be expected to repay debt. However, as the growth in borrowing is increasingly being used to fund consumption expenditure, future consumption expenditure (and in turn welfare) will have to be reduced in order to repay current debts.

Figure 6 Net foreign borrowing and additions to the capital stock, 1950-2000



3.3 Environmental and social factors in the GPI

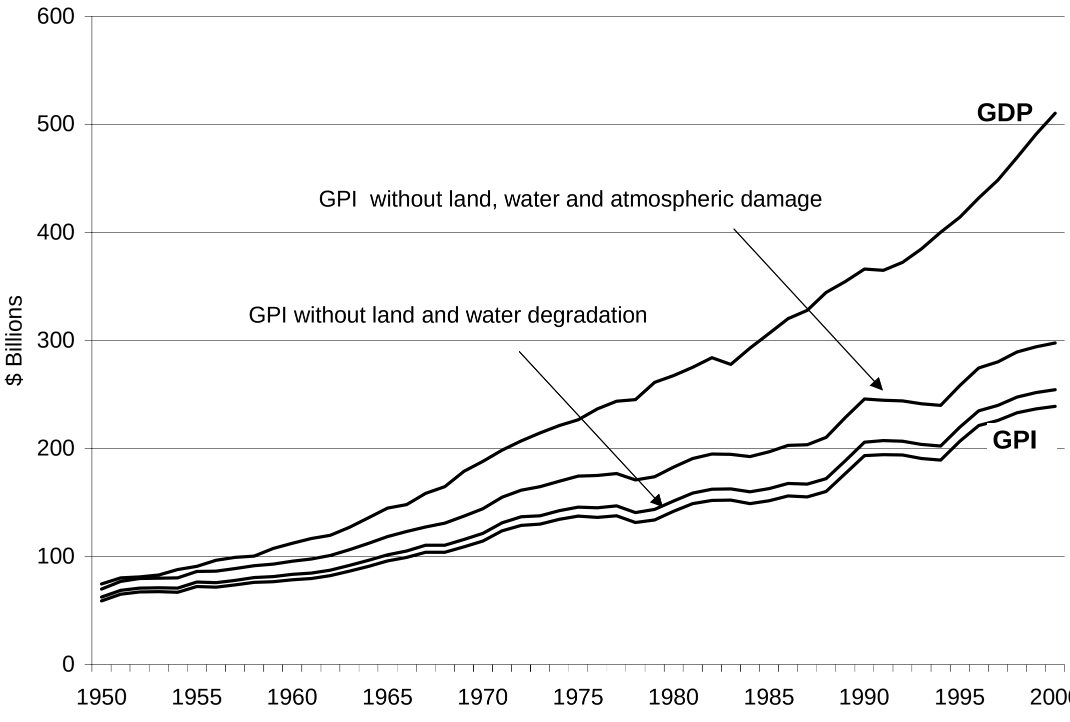
The impact of environmental costs

Figure 7 shows the effect on the GPI of excluding, first, the costs of land and water degradation and, second, the costs of atmospheric damage.

The impact of land degradation, loss of native forests and water use collectively caused over $15 billion dollars worth of damage in 2000. In addition, atmospheric pollution reduced welfare by around $45 billion.

While the importance of protecting the natural environment has been highlighted in recent times with reference to the costs of salinity, policy response lags well behind our understanding of the extent of the problems. Better policies to protect water, land and air have the capacity to boost welfare by around $60 billion dollars per year. Policies aimed at achieving these goals would also ensure that the productive capacity of Australian agriculture would be maintained in the future.

Figure 7 The GPI excluding environmental costs



The impact of social costs

The GPI includes estimates of the costs of a number of social factors. Unemployment, underemployment, overwork, gambling and crime all impose substantial costs on society, costs that are not adequately captured by GDP. Figure 8 shows the impact of these costs on the GPI.

In 2000 these factors reduced welfare as measured by the GPI by more than $43 billion. While the rate of unemployment fell sharply in 1999 and 2000, the 1990s were characterised by high unemployment following the recession of 1991/92. More recently, the costs of overwork have begun to offset the falling costs of unemployment, ensuring that the net effect of changes in the labour market over the last five years has been small. Spending by problem gamblers has also risen sharply in recent years.

Figure 8 The GPI excluding some social costs

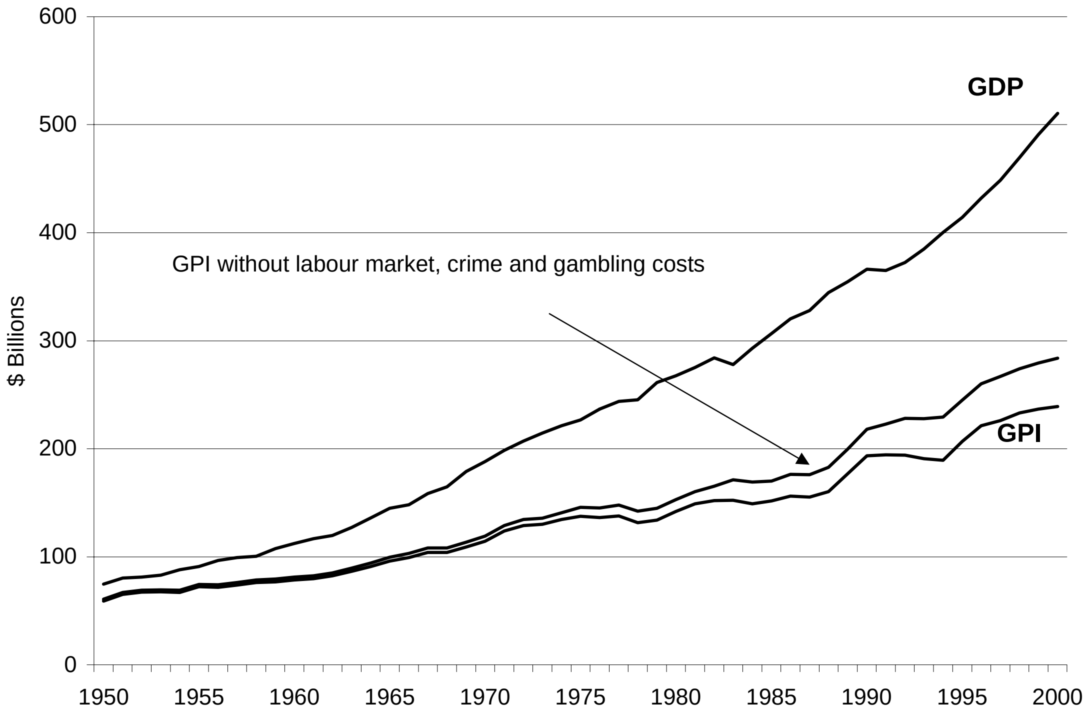
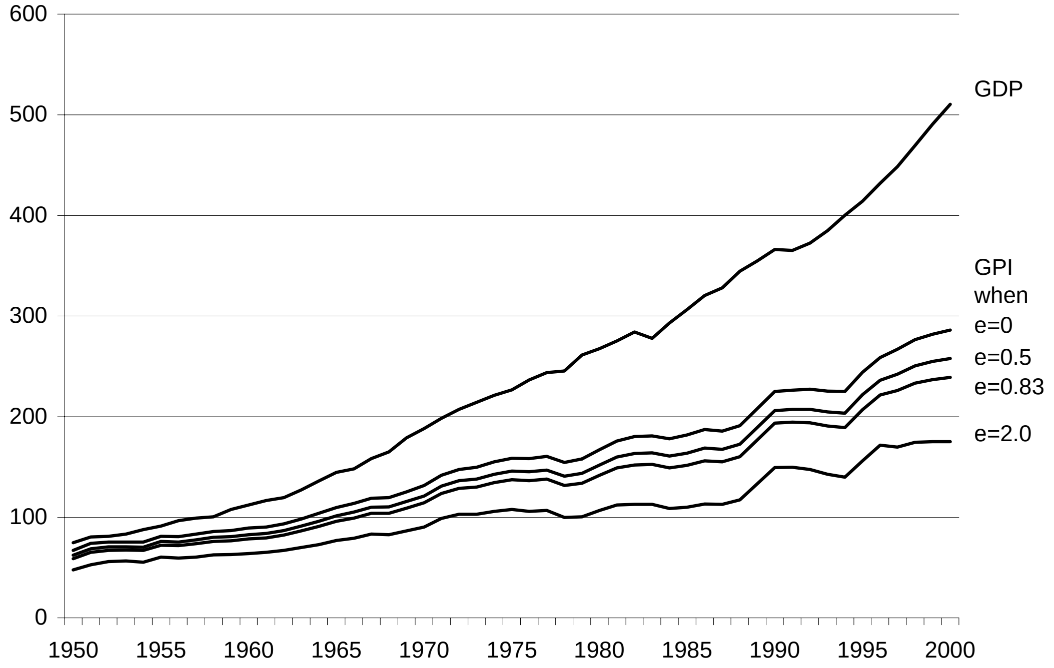


Figure 9 shows the effect on the GPI of varying the assumed level of aversion to inequality. As explained in the discussion of Column B in Part 2, the GPI employs the Atkinson index to measure the effect of changes in the distribution of income. The Atkinson index recognises that a measure of inequality should reflect not only the distribution of income between income groups but also society's preferences for more or less equality. The parameter e captures society's aversion to inequality, and in the GPI we use a figure of e = 0.83. Figure 9 shows the GPI with different levels of e. There e = 0 represents a situation in which society has no aversion to inequality, e = 0.5 represents a situation of less inequality aversion that we have assumed, and e = 2 a situation in which society is substantially more averse to inequality than we have estimated. These represent reasonable boundaries (with some UK studies suggesting the e may be as high as 4.) Clearly, since the distribution of income in Australia is very unequal, the more averse society is to inequality the lower the GPI will be.

Figure 9 The GPI under different assumptions about aversion to inequality



PART 2 The GPI 2000 column by column

The full list of components of the Australian GPI appears in Table 1 on pages 12 and 13 along with an indication of which components are added to, and which are deducted from, the index as well as a brief description of the indicator. The references to columns below refer to the table in Appendix 1, which contains the full set of final estimates used to construct the Australian GPI.

Technical details and data sources for each column have been placed at the end of each discussion.

Year

The index has been calculated for the period 1949-50 to 1999-2000. The financial year has been used as a basis for calculations because the national accounts that provide much of the data are presented that way. For simplicity of presentation, however, the years are identified only by a single date. Thus for the financial year 1999-2000 we simply write 2000. All components of the GPI are converted to 1989-90 constant prices using appropriate deflators.

Column A Personal consumption

This is measured by private final consumption expenditure at constant 1989-90 prices as compiled by the Australian Bureau of Statistics (ABS). The series for the period 1949-50 to 1999-2000 has been compiled and adjusted for inflation by the Reserve Bank of Australia (RBA 1996: Table 5.2a), The RBA has deflated using the relevant implicit price deflator for expenditure on GDP (RBA 1996: Table 5.6a). For recent years the data comes from ABS (2000b: Table 1.2).

Column B Income distribution

The standard measures of welfare, GDP and GNP (Gross National Product), treat each additional dollar of expenditure as an equal contribution to national well-being irrespective of who spends it. Yet most people would agree that an extra dollar to a poor family will increase national welfare by more than an extra dollar to a wealthy family. Economics recognises this in the notion of the diminishing marginal utility of consumption.

In the GPI, personal consumption spending is adjusted for the distribution of income. In the US GPI and UK ISEW inclusion of a measure of changes in distributional inequality has been a major factor explaining the divergence of the estimated GPI from real GDP per capita. In the Swedish ISEW it has had the opposite effect.

Measurement of changes in distributional equality is often difficult; it is particularly awkward when an index covering the period 1950 to 2000 is required since no robust data are available prior to1979-80. In the 1996 GPI we constructed an index of income distribution using the share of taxable income of the lowest quintile of income earners. This index was based on unpublished tax data stretching back to 1950. We acknowledged that there are serious problems with using tax data to estimate changes in distribution (Hamilton 1997).

In the 2000 GPI we employ a more sophisticated approach to measuring changes in income distribution, the Atkinson index, a method used by Jackson *et al.* (1997) in the up-dated UK ISEW. This appears to be the first time the Atkinson index has been used as a measure of income inequality in Australia.

In contrast to most other measures of inequality, such as the Gini coefficient, the Atkinson index recognises that a measure of inequality should reflect not only the distribution of income between income groups but society's preferences for more or less equality. Thus in two countries with the same (unequal) distribution of income, social welfare will be lower in the country with a greater aversion to inequality. Put another way: for a single country, an increase in inequality (through, for example, adoption of a less progressive tax system) may be offset by a decline in society's aversion to inequality, so that social welfare may be unchanged.

The Atkinson inequality index is given by:

$$I = 1 - 1/\overline{X}[\sum X_i^{1-\varepsilon}]^{1/1-\varepsilon}$$

where X_i is the mean equivalised income of income unit i (i.e. the mean income of households in the *i*th decile adjusted to account for the number of people in each household), $\overline{X}$ is the mean of all equivalised income groups (in this case deciles), and ε is a parameter. The parameter ε captures society's preference for equality, or aversion to inequality. It can be interpreted as the amount that society would be willing to see lost in the process of transferring income from a richer person to a poorer person (Cowell and Gardener 1999).

The Atkinson inequality index I can be used to convert total income Y into a measure of total welfare W that reflects the degree of inequality and the weight society places on inequality. Thus

$$W = Y(1 – I)$$

It is apparent from the definition that I will vary with changes in the distribution across income groups (the X_i values) and the parameter ε. In a society in which income is distributed perfectly evenly, I = 0 and social welfare is equal to income. Similarly, if society has no aversion to inequality then ε = 0 and I = 0 so that W =Y.

The parameter ε is especially important for it allows us to capture society's level of preference for equality. However, it is not easy to measure. Cowell and Gardener (1999) discuss the various possible approaches, including direct inquiry (through survey evidence), inference from private behaviour (such as expressed risk aversion) and revealed social values. Evidence for the UK suggests that the value of ε lies in the range 0.5 (weak inequality aversion) to 4 (very strong aversion to inequality).

An argument can be made that social values are revealed or can be inferred from public policy decisions, particularly those aimed directly at redistribution. The income tax scales can be interpreted this way if one assumes that they are based on a principle such as equal absolute sacrifice in which the higher tax paid by a rich person has the same impact on their welfare as the lower tax paid by a poorer person (Cowell and Gardiner 1999: 24). An objection to interpreting the income tax scales as an expression of society's preference for equality might be that wealthier individuals have more influence over income tax policy, in which case the estimated ε value would be an under-estimate of society's aversion to inequality.

In the absence of alternatives, the Atkinson index of inequality used in the GPI employs an estimate of ε using the 1997-98 tax scales and the distribution of disposable income that applied in 1997/1998, the latest for which data are available (see below for details of the method of calculating ε). The estimated value is 0.83.

The Atkinson index also requires data on the distribution of disposable income. Disposable income data by decile (equivalised using the OECD method) have been supplied by the ABS from unpublished sources for the years 1986, 1990, 1994, 1995, 1996, and 1997.

Applying the estimated value of $\varepsilon = 0.83$ to 1997 income distribution data gives an Atkinson index of 0.154. Thus W = 0.846Y for 1997/98. Using a constant $\varepsilon = 0.83$ the Atkinson index has been estimated for each of the years for which data on income distribution are available. For other years back to 1968 an index has been formed using estimates of Gini coefficients as supplied by the ABS, and prior to 1968 an index is estimated employing the one used in the 1996 Australian GPI (i.e. based on the share of the lowest quintile in taxable income). It is assumed that the index value for years after 1997 is unchanged.

How is ε calculated from the tax scales? The principle of equal absolute sacrifice can be expressed as follows assuming a constant elasticity of marginal (social) utility:

$$y^{1-\varepsilon} - [y - T(y)]^{1-\varepsilon} = \text{constant}$$

Where y is taxable income and T(y) is the tax function.

Cowell and Gardiner (1999, Appendix A2) show that ε is given by the slope of a curve estimated by applying ordinary least squares to the following equation

$$-\ln(1 - T'(y)) = \varepsilon \ \ln [y/(y - T(y)]$$

where T'(y) is the marginal tax rate. Cowell and Gardiner indicate that in estimating the best fitting curve the intercept should be constrained to zero. Using Australian data, constraining the intercept increases the estimate of ε from 0.83 to 2.8, a very large change. We have not constrained the intercept. While constraining the intercept has some appeal, we can regard the estimate of ε without constraining the intercept as the estimate of equality aversion over the relevant range of incomes.

Column C Weighted personal consumption

This column weights personal consumption in Column A by the index of income distribution in Column B. Note that the other components of GDP – public final consumption expenditure, gross fixed capital expenditure (private and public) and exports less imports[8] – are dealt with elsewhere in the GPI (under 'Net foreign lending' (Column AA), 'Net capital growth' (Column Z) and 'Services of public capital' (Column J)).

Column D Public consumption expenditure (non-defensive)

Public sector outlays are divided by function into the following categories: general government services, defence, public order and safety, education, health, social security and welfare, housing and community amenities, recreation and culture, transport and communication, and other. These outlays include capital and recurrent expenditure. Some part of the recurrent expenditure includes transfer payments, which are excluded from GDP.

Clearly, some government functions make a net contribution to national well-being. What are they? Expenditure on *defence*, *public order and safety*, and *social security* (which account for around 35% of total expenditure (ABS 1999a) are best regarded as for the most part defensive expenditures. Although a base level of outlays undoubtedly contributes to national well-being, increases in these expenditures are generally responses to a deterioration in national well-being – such as increasing insecurity or rising unemployment. The question is thus whether decisions to increase spending are made in order to provide a net increase in levels of well-being or are made to offset declining levels of well-being. This is almost impossible to determine, but we feel that treating these expenditures as mostly defensive is more justifiable than not, particularly given rising levels of perceived insecurity and rising levels of unemployment since the 1970s. It is assumed that 25% of spending on *defence* and *public order and safety* advances well-being rather than offsets increasing insecurity. The great bulk of outlays on *social security* are in the form of transfer payments, which already appear under personal consumption.

Expenditure on *housing and community amenities* and *transport and communication* (around 10% of total outlays (ABS 1999a)) are in large measure capital spending (adding to both physical and social capital) and are recorded in the GPI under 'Net capital growth' (Column X) and 'Services of public capital' (Column J) or are excluded from the index. However we include 50% of spending on transport and communications as consumption.

Expenditure on *education* and *health* account for around 29% (ABS 1999a) of total outlays. The first issue to consider is whether expenditures on education and health contribute to current consumption (and add to well-being experienced at the time of the expenditure) or represent accumulation of human and social capital. To the extent that they add to stocks of human capital we should in principle count, not the annual

[8] GDP also includes changes in stocks, but since they more or less balance out over time, changes in stocks are not considered in the GPI.

expenditures, but the services yielded by the stocks. Since the GPI does not account for stocks of human and social capital we exclude the value of their services.

To the extent that spending on education and health can be considered to be consumption spending, that is, adding to annual welfare, we need to deduct from the GPI the share of that spending that is defensive. To what extent do increases in consumption spending on health and education make a net addition to well-being rather than compensate for declining well-being due to other factors? Consistent with the treatment of private spending on health and education (Column I), essentially we count most *public education* spending as investment in human capital (and therefore excluded from the index) while public *health* spending is treated as consumption spending, but 50% of it is considered to be defensive (and is thus deducted).

Spending on *recreation and culture* is regarded as wholly consumptive and wholly non-defensive and is therefore fully included in the GPI.

In the case of spending on *general government services*, these expenditures cover general administrative costs of government – including basic functions such as tax collection and policy advice – that are essential for good government. However, part of this expenditure is devoted to servicing defensive expenditures and should therefore not be included. We assume that 50% of spending on general government services makes a positive contribution to welfare rather than simply off-setting falling conditions.

Column E Value of household and community work

Unpaid household work has always made a large contribution to human welfare. Indeed, the history of industrialisation has in large measure been the history of transferring activities out of the household sector into the market sector. This trend continues. With changes in the workforce – and in particular the entry of women into paid labour – more tasks that were previously performed unpaid and in the home are now purchased in the market. These include housekeeping, take-away food, restaurant meals, gardening services and paid childcare. Transfers from the household to the market sector are recorded as increases in GDP, but this exaggerates the true increase in well-being. The GPI is therefore adjusted to account for the value of household labour in Australia.

The amount of household work and voluntary community activity is known from the time-use surveys carried out by the ABS. However, in the GPI not all hours of household work are valued and added to the index. Time devoted to some activities is excluded because it is in the nature of leisure rather than work that produces household goods and services. There are a number of ways of applying a dollar value to an hour of household and community labour. We have chosen the housekeeper replacement method – the most conservative method – and have used the hourly wage rate for cleaners to value household and community work ($13 in 1999).

The question of what to include in household work involves some difficult choices. The key question is which activities in the household are properly considered to produce household goods and services rather than to contribute to leisure. Researchers in this area have generally adopted the rule, developed by Margaret Reid in 1934, that household work includes those activities which 'might be replaced by market goods or paid services, if circumstances such as income, market conditions and personal inclinations permit the service being delegated to someone outside the household group' (quoted in ABS 1994).

Thus meal preparation is work while consumption of meals is not. Shopping for household items is work but window shopping is not. Some elements of childcare involving parental love cannot be bought in the marketplace. Under the heading 'household work' Jackson and Stymne's (1996) Swedish ISEW includes childcare, housework, odd jobs and shopping for necessities but excludes recreational shopping, travel for shopping and gardening. The latter are regarded as essentially leisure activities.

The source for data on amounts of household and community work in Australia is Ironmonger (1994), which provides data for the years 1974, 1987 and 1992. Data on number of hours worked has been updated using the 1997 ABS time use survey (ABS 1997b) along with the follow up ABS publication that values household and voluntary work (ABS 2000a).

Table 2 shows the allocation of time among various household activities and voluntary work for 1992 and 1997. It is apparent that the total number of hours worked per week for each household remained unchanged at 27.65.

Table 2 Unpaid time use per household 1992 and 1997

Activity	1992	1997
Domestic activities	140	139
Child care	32	31
Purchasing	45	45
Voluntary work and care	20	22
TOTAL (min/day)	237	237
TOTAL (hours/week)	27.65	27.65

Source: ABS 1997b, Cat. No. 4153.0, pp. 17-18
Note that the figure in the 1997 publication for 1992 has been revised a little due to reclassification – down from 27.78 hours to 27.65 hours.

Combining the latest ABS data with the analysis by Ironmonger (which also relies on ABS data) provides the data in Table 3.

Table 3 Hours of household and community work in Australia

Year	1974	1987	1992	1997
Total hours per week (million)	249	322	380	404
Population 15+ (million)	9.899	12.577	13.679	14.604
Hours per person per week	25.15	26.60	27.65	27.65

Source: Derived from Ironmonger (1994); updated from ABS (1997b)

To cover the GPI study period, estimates of total hours of household work per annum are derived from interpolation and extrapolation of the estimates in Table 3 for hours per person per week and from changes in the population over 15. For the years between 1974 and 1992 we interpolate linearly. For the 2000 GPI we use the 27.65 figures for 1992 and 1997 and assume that the same number applies for the intervening and subsequent years through to 1999-2000. For the years prior to 1974 the evidence is thin, but as it seems likely that weekly hours declined slightly in the 1950s and 1960s we assume that they declined in a secular trend from 28 hours per person per week in 1950 (D. Ironmonger, *pers. comm.*). Figures for the adult population are derived from RBA (1996; Table 4.2), updated using ABS (2000e)

There is a good case for arguing that the comprehensiveness of Ironmonger's definition overstates what may reasonably be regarded as 'household work' under the definition given by Reid. GPIs for other countries have excluded certain activities from their definitions of household work because they are better defined as leisure activities which confer value on the household through the activity of performing them rather than by way of the product at the end. It would be difficult to argue that parents regard an hour of looking after their own children as in all cases equivalent to an hour of paid childcare. Some gardening (whether for ornamental or vegetable reasons) and some household repairs may also fall into this category (the shed is a sanctuary as well as a workplace), as would window shopping. In constructing the Swedish ISEW, Jackson and Stymne (1996) exclude gardening and recreational shopping. They also omit travel, arguing that travel for shopping does not represent an increase in welfare.[9] Indeed, elsewhere in the GPI (Column K) we *deduct* the costs of commuting, regarding them as defensive expenditures. The same exclusions have been made in constructing the ISEW for the UK (Jackson and Marks 1994).

[9] They conclude that the 'average time spent in domestic labour fell by over 15% from about 23 hours per week in 1963 to about 19 hours in 1984/85' and remained stable thereafter (Jackson and Stymne 1996: 16).

The Australian GPI excludes 100% of gardening, lawn care and pool care, and 50% of home maintenance, pet care, shopping and associated travel and childcare. According to the breakdown of household work by activity in ABS (1994: Table B) these proportions account for around 30% of total household work in 1992. Assuming that this proportion remained constant from 1950 to 1996 (a strong assumption), we adjust our estimate of the value of household labour downward by 30%.

The value of household and community work is derived from the number of hours worked per annum and a 'shadow wage rate' representing the value of an hour of work. There are a number of ways of deriving such a shadow wage rate. They are reviewed and applied to 1997 data in ABS (1997b). We have adopted the 'housekeeper replacement cost method', derived by applying the wage rate for housekeepers to the hours worked.

Column F Costs of unemployment

The costs of unemployment are several, and in this component of the GPI we need to be particularly mindful of the dangers of double counting. The costs of unemployment are the following:[10]

1. loss of output in the economy due to underutilisation of factors of production;

2. loss of human capital due to declines in levels of skills, especially as a result of long-term unemployment;

3. declining levels of health and increasing suicide among the unemployed;

4. increasing levels of crime associated with higher unemployment;

5. increasing rates of family breakdown;

6. psychological impacts on the families of unemployed people; and

7. trauma, stress and loss of self-esteem associated with being unemployed.

The first two of these factors, the resource costs of unemployment, are already reflected in the GPI through personal consumption and public consumption (via lower tax revenues). The next two (health and crime) are partly accounted for elsewhere in the index, under public and private defensive spending on health (Columns D and I) and the costs of crime (Column W).

This leaves us with the last three factors, which might be characterised as the psychological costs of unemployment. Some of the evidence relating unemployment to various personal and social problems is reviewed in Junankar and Kapuscinski (1992). These effects are extremely difficult to measure in monetary terms. However

[10] Sometimes it is argued that these costs are partly offset by benefits, including a more efficient economy due to lower inflation and current account deficits, and increased leisure for the unemployed. The former is the subject of considerable debate among macroeconomists, and in any case the efficiency effects are recorded elsewhere in the GPI. It is doubtful that the unemployed count increased leisure as a benefit.

they represent large costs in social and personal terms and should be taken into account in any attempt to assess changes in national well-being.

The US GPI assigns a value of US$8 (about A$14) to each hour of unemployment, but the rationale is opaque. The authors argue that an hour of involuntary leisure should be valued the same way, but with a negative sign, as an hour of foregone leisure (Cobb, Halstead and Rowe 1995: 23). Thus, if the unemployed derive benefits of leisure but are willing to give them up to obtain a job, the price of an hour of leisure might be seen as the 'willingness to pay' to obtain work (assuming that the wage received is compensation for the work actually performed).

Elsewhere in the Australian GPI we have used an assessment of the value of foregone leisure in measuring the time component of the costs of commuting. The Bureau of Transport and Communications Economics (BTCE 1996: 484) values a person-hour of travel time at $15.19 across major Australian cities in 1995-96. (In the same publication it also uses $9 per hour.)

Another method of obtaining a rough estimate of the monetary value of an hour of unemployment may be to consider the costs of attempting to overcome some of the psychological damage caused by unemployment. If an unemployed person decided to visit a counsellor once a week, the cost would be at least $80. On this basis (an admittedly crude one), the psychological costs of an hour of unemployment have a value of at least $2.

Thus we have a number of methods of evaluating the psychological costs of unemployment, and a range of estimates from $2 to $15.19. In the Australian GPI we adopt a middle figure of $8 per hour for 1995-96.

The next step is to apply this figure to the amount of unemployment over time. Only unemployment in excess of a rate of 1.7% is considered to be costly. This figure can be regarded as the rate of 'frictional' unemployment arising from the normal processes of job change in a full-employment economy. It is the approximate rate for most of the 1950s and 1960s. Thus unemployment that imposes a cost is estimated by adjusting the number unemployed by this rate. Under this definition, unemployment among those seeking full-time work does not start to impose a cost until 1972, although according to Commonwealth Employment Service data the rate of unemployment exceeded 1.7% in the period 1961-1963 (RBA 1996).

To calculate the number of unemployed hours we assume that an unemployed person seeking full-time work forgoes 40 hours of work each week while an unemployed person seeking part-time work foregoes 20 hours of work per week. (Note that the shortest average working week for full-time workers was 39.9 hours in 1982.)

However it is well-known that official unemployment statistics significantly underestimate the true level of unemployment, principally because of the discouraged worker effect. Discouraged workers are those jobless individuals who have given up the search for work, not because they do not want a job, but because they consider the chance of success to be low or zero. The number of discouraged workers is highly dependent on the state of the economy. In times of recession, the number of discouraged workers rises dramatically. Our estimate of the number of discouraged workers relies on Mitchell (1999: Table 3). For the year 2000 the number of hidden unemployed was assumed to decline at the same rate as actual unemployment. All labour market data came from ABS (2000d: Table 1). The unit cost of unemployment of $8 per hour in 1995 was deflated against a series for average weekly earnings back to 1950 from RBA (1996).

Column G Costs of underemployment

Underemployed workers are defined as those who work part-time but would like to work full-time. ABS estimates of the number of part-time workers seeking more hours and of the average number of hours sought (ABS 1999b) were used to estimate the number of hours of underemployment that exist in the economy. It should be noted that only the hours of underemployment are captured, not the underutilisation of human capital. Workers performing tasks which do not take full use of their skills and experience are also, in another sense, underemployed. The absence of reliable time series data on the quality of work means that the estimate used in the GPI is likely to underestimate the extent of underemployment.

It would be unreasonable to assume that the cost of an hour of unemployment for a partly employed person is the same as that of an hour of unemployment for a wholly unemployed person. On the other hand, many part-time employees are employed in casual jobs for short periods. We therefore value an hour of unemployment for an underemployed person at half of the rate for a fully unemployed person, i.e. $4 in 1995/96.

Estimates of the number of part-time workers came from ABS (2000d: Table 1), with the share of part-time workers seeking more hours, and the average number of hours sought, coming from ABS (1999b)

Column H Costs of overwork

Contrary to the post-war trend – which saw average working hours decline – in recent years full-time employees have been working longer hours each week. There is strong evidence that much of this additional work is involuntary (Australia Institute 1996). In other words, these workers would prefer to be engaged in other activities, mainly leisure or household work, during these hours.

This overwork imposes a cost on workers and their families. The cost of overwork in the GPI is measured by assessing the amount of involuntary work and applying the appropriate wage rate to the hours worked. The extent of overwork is estimated by totalling the hours worked each year per full-time worker over and above the annual hours worked by full-time workers in the year of lowest hours of work. That year was 1982 when full-time workers worked an average of 39.9 hours each week. In other words, we assume that when the downward trend in hours worked turned upward, it did so not because workers wanted to work longer but because they were forced to by changes in the labour market or by economic insecurity.

The data do not permit a detailed breakdown by occupation and wage rate so we assume that the value of an hour worked involuntarily is approximated by the average hourly wage rate. One difficulty with this is that some of the extra hours worked are paid at overtime rates. The additional payment might be seen as reflecting the additional cost in terms of leisure foregone. On the other hand, to count all of the value of involuntary work as a cost fails to account for the benefits workers obtain from the wages earned. However in 1995 two-thirds of overtime work was unpaid, so there would be no financial cost for not working these hours (ACIRRT 1996). In addition, it is not valid to assume that workers were induced to work extra time by employers offering an hourly wage just high enough to compensate for lost leisure. Most workers have no choice but to work longer because their jobs would be jeopardised if they refused. Thus the 'reservation wage' that would be required to induce them to work longer if they had a free choice may well be substantially higher than the wage they actually receive (where they receive any additional wage at all). Thus valuing overwork at the average wage rate does not seem to be an unreasonable approximation.

Data on employment and hours came from ABS (2000d: Tables 1 and 9) while earnings data came from ABS (1999c) and RBA (1996 Table 4.17)

Column I Private defensive expenditure on health and education

Consistent with the approach taken with public spending on health and education, we count 50% of private spending on health and 50% of private spending on post-secondary education as defensive and deduct these amounts from the index (since these expenditures have been included in personal consumption).

Data for private expenditure on health and education are available for the period 1960-1999 and come from ABS (2000b). For earlier periods it was assumed that the proportion of GDP spent on these items remained at their 1960 levels. Growth in expenditure on these items was assumed to be equal to the rate of economic growth to generate an estimate for the year 2000.

Column J Services of public capital

The discussion of this component should be considered in conjunction with the discussion of net capital growth in Column Z. There we note that the services of private capital stocks are reflected in the national accounts through the prices paid by consumers for goods and services produced by firms using the capital. In the case of public capital stocks, where these stocks are owned by public trading enterprises which sell goods or services to consumers (such as electricity, gas, water and publicly owned housing) the services rendered each year by the capital are captured in the national accounts in consumption spending (directly in final consumption or indirectly to the extent that these items are purchased by firms as intermediate inputs).

This leaves us with the capital stocks owned by government and provided free of charge to the public. A time series for the stock of public capital was constructed from RBA (1996: Table 5.23) and (ABS 1997c: Table 8). The estimates for 1995-1999 were calculated by inflating the stock by the real growth rate of the net capital stock using the chain volume measures given in (ABS 2000b: Table 4.8) . For the year 2000 the average of the growth rates in 1998 and 1999 was used.

However, the story does not end there. Some part of this capital stock will have been created to sustain various defensive expenditures discussed in Section 2.5 and Column D above. Thus their services to national welfare should be excluded from the GPI. Data for attributing capital investments by function are not available, so (bearing in mind that only 45% of public capital is owned by general government as opposed to public enterprises) we assume that the services of only 25% of publicly owned capital stocks should be added to the GPI. In other words, the benefits conferred by this public investment contribute to national welfare and have not been accounted for elsewhere in the GPI.

We must now ask how much this public capital contributes to national well-being each year. These forms of capital are assessed by the ABS as having life-spans of around 50 years (Walters and Dippelsman 1985), so, if we assume a straight-line depreciation function, these capital stocks contribute 2% of their value each year. Cobb, Halstead and Rowe (1995) argue that we should also include the opportunity cost of funds tied up in these fixed assets and apply an interest rate of 7.5%. A real interest rate of 5% is closer to the cost of capital for government, and is the one used here. This means that the community benefits each year to the tune of 7% of the non-defensive freely provided stock of public capital.

Note that all of the capital stock must be maintained to ensure that income flows are sustainable, including the part devoted to defensive purposes. In its absence, the welfare of future generations would decline.

Column K Costs of commuting

The costs of commuting can be divided into two components. The first is the costs associated with travel to work due to urban sprawl. In order to have the same quality of housing and private space at comparable prices, households have had to move further away from city centres where a large proportion of workers continue to work. These costs can be seen as the defensive expenditures aimed at maintaining a lifestyle.

The second component is the costs associated with urban congestion, i.e., the additional time and financial expense of travelling to work due to congestion on the roads. We will refer to the first as the costs of commuting and the second as the costs of congestion. Commuting costs are those associated with travelling to work even if all traffic were to run smoothly.

The financial costs associated with commuting and congestion are recorded in the national accounts as additions to GDP. Thus the financial and time costs incurred by consumers in getting to work are deducted from the GPI.

A number of studies have estimated the costs of congestion in Australia by comparing the additional vehicle costs and the travel time incurred by commuters due to traffic congestion. The BTCE (1995) estimates the costs of congestion in Australia at $5.164 billion per annum, while another estimate puts it at $5 billion per annum (ABS 1997a: 121). The Victorian Transport Externalities Study (EPA 1994) puts the cost for

Melbourne at $2.0 billion in 1991, suggesting a national figure in the order of $5-6 billion.

However some of these congestion costs fall on businesses rather than final consumers and are therefore intermediate input costs that are reflected in the national accounts through higher prices for goods and services. The Victorian study (EPA 1994) estimates that 70% of congestion costs fall on business and commercial vehicles. This is largely due to the fact that the value of time dominates the cost estimates and the value of a vehicle-hour is estimated at $6 for private cars, $33 for business cars and $13 for trucks. However a large share of the travel done in business vehicles is in fact commuting time by employees in company cars. These costs fall on commuters, in the form of erosion of leisure time, rather than on businesses. On the other hand, as they fall on commuters, the value of each hour is that for an individual rather than for a business. We will assume that two-thirds of the travel time spent in business cars (but none of the travel in other commercial vehicles) is expended by commuters, but that this time is valued at $6 per hour. This means that the overall estimate of congestion costs is reduced by 26% but the share that falls in private commuters increases to 50%. We thus estimate the costs of congestion imposed on private commuters at $1.85 billion in 1991.

To this we must add the costs of commuting. In the absence of information on the amount of commuting time we will make the conservative assumption that the travel time (and financial expenses) of commuting to work on uncongested roads is equal to the addition travel time (and financial expenses) due to congestion, i.e. half of travel time is due to congestion. Thus we double our point estimate to obtain an estimate of the total costs of commuting (including congestion) in 1991 at $3.7 billion.

EPA (1994) indicates that congestion costs were rising at a rate of 8% per annum. Thus our point estimate (for 1991) of the costs of commuting and congestion is $3.7 billion, rising at 8% per annum thereafter. For years prior to 1991 we note that vehicle kilometres travelled by cars increased at a flat rate of around 4.6% per annum from 1971 to 1991 (ABS 1997a: Table I.2). We will assume that the costs of commuting rose at a rate of 7% in the 1980s, 6% in the 1970s, 4% in the 1960s and 2% in the 1950s.

Column L Costs of noise pollution

Noise is an uncompensated cost imposed on people mostly as a result of increasing traffic volumes, especially heavy vehicles. The costs take the form of costs of building noise barriers along roads and in homes, and falling property values of homes as well as the loss of amenity.

Various point estimates are available for the costs of noise. They are summarised in ABS (1997a: 120). A detailed study for Melbourne can be found in EPA (1994). The Interstate Commission estimated the cost of noise to be $534 million in 1990, but the NRMA estimated in 1991 that traffic noise in Sydney could be reduced to the point where all private houses would experience noise levels at close to the OECD recommended level of 57 dB at a cost of $750-880 million (ABS 1997a: 120). This suggests a national figure of around $2.4 billion, the figure used in the GPI. A series is formed by indexing this number by vehicle kilometres travelled by trucks, buses and light commercial vehicles (ABS 2000f).

Column M Costs of transport accidents

A nation that has more accidents is worse off; yet additional economic activity generated by accidents is recorded as an addition to GDP. The classic case is the damage caused by the Exxon-Valdez oil spill disaster. In this section we account for the costs of transport accidents. In principle we should account for all accidents but, with the notable exception of industrial accidents evaluated in the next section, data limitations prevent this.

The monetary costs associated with transport accidents are defensive as they involve repairing damage to both property and humans. These costs, which are added to national income, should be deducted. Non-market costs include losses to victims and their families from pain and suffering. To the extent that monetary values can be assigned to these, they too are deducted from the GPI because they represent a decline in welfare. However, not all costs of accidents should be deducted as that would involve double counting. Thus lost earnings and medical expenses are already reflected in the national accounts and, in the case of health costs, have been dealt with elsewhere in the GPI.

A number of studies of the costs of transport accidents have been conducted by the BTCE and the results are summarised in ABS (1997a: 109-110). For 1993, the cost of road, air, rail and sea accidents in Australia amounted to $6.597 billion, of which $6.136 billion was due to road accidents. Excluding the costs of lost earnings and hospital, medical and rehabilitation costs,[11] the cost of accidents in 1993 was $4.858 billion.[12] Deflating by the price index for private final consumption, this is $4.428 in 1989-90 prices. To form a time series, we assume that the real cost per accident has varied with changes in real GDP (ABS 1996b). A consistent series on the number of accidents is not available as the definition changed in 1980, so we employ number of deaths as a proxy (Australian Transport Safety Bureau 2000). This may be preferable because a large part of the costs of accidents are due to deaths and because the relationship between number of accidents and number of deaths has diverged in the early 1980s (Vamplew 1987: 174; ABS 1997a: 106).

Column N Costs of industrial accidents

In Australia, up to 2700 people are killed each year through workplace accidents – more fatalities than on the roads. In addition, around 650 000 workers each year suffer a work-related injury (Industry Commission 1995: 9-10). The costs of these deaths and injuries are enormous. Excluding pain and suffering, work-related accidents are estimated to cost between $20 billion and $37 billion each year.[13]

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[11] The data also exclude costs associated with search and rescue, accident investigation and losses to non-victims.

[12] Made up of family and community losses ($0.629 billion), pain and suffering ($1.531 billion), vehicle damage ($2.064 billion) and insurance administration ($0.635 billion).

[13] The first figure is from the Industry Commission (1995: 17), the second from WorkSafe Australia (1994).

Some of these costs are reflected in the national accounts. The Industry Commission (1995: 18-19) divides the costs into three groups.

Costs borne by employers. These include workers' compensation, loss of productivity and additional overtime, damage to equipment and legal penalties. They amount to around 40% of total costs but are best regarded as 'intermediate inputs' that are reflected in prices paid by consumers and are thus already included in the GPI.

Costs borne by the community. These include social welfare payments, medical and health costs and loss of human capital and are estimated to account for 30% of the total. They are for the most part dealt with elsewhere in the GPI, in the treatment of public health spending and social security.

Costs borne by injured workers. These include loss of income, pain and suffering, loss of future earnings, medical costs, losses of leisure, self-esteem and social status, and costs imposed on family members. They are estimated to amount to about 30% of the total. While medical costs and loss of income are reflected elsewhere in the GPI, the other costs are not measured in the Industry Commission's estimate of $20 billion per annum. In the case of road accidents, these costs, along with family and community losses, amount to a third of the total.[14]

We therefore estimate that the costs of work-related injuries in 1992-93 was 30% of $20 billion, or $6 billion ($6.384 in 1989-90 prices). In the absence of historical data, this figure is indexed by the size of the labour force. It is also indexed by real GDP to reflect changes in the real cost of an accident.

Column O Costs of irrigation water use

The costs of water use measured here are those associated with environmental damage due to diversions of water for irrigation purposes from Australia's river systems, particularly the Murray-Darling Basin which accounts for 75% of irrigation water in Australia (ABS 1996a, Table 6.5.3). The costs of water pollution included in the next component (Column P) are those associated with waste water disposal in urban areas.

The environmental impacts of water diversions from Australia's rivers include:

- loss and degradation of habitat resulting in disturbance to flora and fauna;
- declining conservation and recreational values associated with riverine ecosystems;
- downstream impacts of salinisation on household water users; and
- downstream impacts on industrial and other agricultural water users.

The last-mentioned set of costs includes loss of forest growth and grazing productivity, and additional costs due to salt build-up in industrial boilers, reduced service life of pipes, fittings and machinery and the costs of softening and

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[14] Only a small proportion of work-related accidents are road accidents (Industry Commission 1994: J2), so double counting with the costs of transport accidents is minimal.

demineralising water. These are intermediate costs that will be reflected in the prices of final goods produced.

Downstream impacts of salinisation on households include reduced service lives of pipes, fittings and machinery, increased use of household cleaning products (soaps, detergents and water softeners), and reduction in yields of garden produce (River Murray Commission 1984). These require defensive expenditures that in principle should be deducted from the estimate of the GPI.

The only feasible way of estimating the environmental costs of water use and salinisation is by use of the control cost method. This involves estimating the loss in agricultural output from reductions in water diverted to irrigation. The rationale behind the control cost method is that, by agreeing to spend a given amount on controlling an environmental problem, society 'effectively' demonstrates a willingness to pay for a certain amount of reduction in environmental damage. One implication of this is that amelioration measures will be adopted from an array of possibilities from the cheapest to the most expensive up to the point where the control cost is equal to the damage avoided.

In this case the argument is that the value of the environmental damage done by the diversion of the last gigalitre of water is equal to the value of the additional agricultural output. This would be a far-fetched interpretation since in the past the environment has been treated effectively as a free good, so that the environmental costs greatly exceed the economic benefits. Nevertheless, the control cost approach may be considered to provide a lower bound to the environmental costs of excessive water use.

In order to provide for adequate environmental flows in the Murray-Darling Basin, it is estimated that current diversions will need to be reduced by around 30%, from 10,684 GL/year (the mean for 1988-89 to 1992-93) to 7500 GL/year (Hamilton, Hundloe and Quiggin 1997: 22-3). If diversions are reduced to around 7500 GL/year (along with some changes to the seasonal flows to make them more in harmony with natural cycles) then a high proportion (perhaps 80%) of the environmental damage will in time be ameliorated. We thus assume that environmental costs began to exceed 'acceptable' levels (a form of safe minimum standard) when diversions began to exceed 7500 GL/year, an event that occurred for the first time in 1968.

Using farm budgets, the Murray-Darling Basin Commission estimated the value of water to irrigators at $56.40/ML in 1988 (MDBC 1989: 4). To estimate the costs of water use we apply this figure, adjusted for inflation, to each megalitre in excess of 7500 gigalitres for each year since 1967. Using this procedure, the cost of environmental damage from excessive water use for 1996 is estimated at $233 million. This is a very low figure.

In order to obtain a better approximation we make two adjustments to our estimate so far. First of all, since the Murray-Darling Basin accounts for only 75% of total irrigation water in Australia, we scale up our estimate by 33%. Secondly, since the control cost method is likely to seriously underestimate the environmental damage (for the reason given above) we arbitrarily double our estimate. This gives an estimated cost of environmental damage from irrigation water diversions in 1996 of $621 million. As a justification for the doubling of the initial estimate it might be pointed out that one study which evaluated the costs and benefits of reduced diversions in the Barmah-Millewa red gum forests of the Murray-Darling Basin concluded that the costs to agriculture from managed floods involving additional dam releases are exceeded by the benefits to the timber industry *alone* (MDBC 1992). In other words, using our control cost valuation, the increase in the health of forests reflected in higher timber yields – without any account of ecological and recreational values – is alone enough to account for the foregone agricultural output.

Column P Costs of urban water pollution

The environmental costs of urban water pollution include damage to habitat, decline in conservation and recreational values and impacts on downstream users. After reviewing the available information on the environmental costs associated with waste water treatment and disposal, a study by the National Institute for Economic and Industry Research (NIEIR) settled on a control cost approach as the only feasible method. Extrapolating from data for Sydney, NIEIR estimates the annual cost of internalising waste-water externalities in Australia in 1994 at $3.5 billion (DEST 1996a: 80-81). This estimate – $3.58 billion in 1989-90 dollars – is adopted for the GPI. It translates into a cost of $2.20/ML.

To derive a series for 1950-2000 we make the assumption that the real environmental cost of a litre of waste water remains constant over the period. The series is thus derived from estimates of the volume of waste water in Australia and a price deflator. The price deflator employed is the implicit price deflator for public expenditure on fixed capital (RBA 1996: Table 5.6a).

Estimates of the volume of waste water in Australia are difficult as until recently no national figures have been collected. As a rule of thumb, each person generates 250 L of waste water per day (Chris Davis, Australian Water and Wastewater Association, *pers. comm.*). Currently around 85% of households are sewered. In 1950, around 50% of households were sewered. However the environmental problems associated with waste water disposal from non-sewered households are worse than those from sewered households. Therefore the volume of waste water used to form a series is taken to be 250 L per day for the whole population. Note that this method of estimating total sewage volumes gives a figure for 1993-94 of 1.63 million ML, which compares with the estimate by the Australian Water and Wastewater Association of 1.67 ML, of which 1.18 million ML is metropolitan and 0.49 million ML non-metropolitan (AWWA 1996).

Column Q Costs of air pollution

This component is concerned with the costs of so-called noxious air pollutants, which are poisonous or otherwise damaging to humans, other animals and plants and therefore damage human health, agricultural production and natural ecosystems. Some of these pollutants also cause corrosion and aesthetic degradation (e.g. soot deposition) to buildings and other structures. The most important pollutants in this group include sulfur dioxide, carbon monoxide, lead, particles of various sizes and compositions, oxides of nitrogen, and volatile organic compounds other than methane (DEST 1996b: 5-7). The two last-named groups of pollutants are joint precursors of photochemical smog, the most important constituent of which is ozone. The principal sources of these pollutants are combustion of fuels (including both fossil fuels and biomass fuels such as wood) and some specific industrial processes, such as the smelting of metal ores and the manufacture of certain chemical products.

In general terms, as with other pollutants, these noxious air pollutants only impose measurable costs when the quantities emitted by human activities clearly exceed the capacity of the natural environment to absorb them. In Australia, both human populations and sources of emissions are both highly concentrated in a relatively small number of discrete areas within which measurable costs are imposed. These areas include the larger cities and a small number of non-urban regions which contain a high concentration of power stations, metal smelting and other large polluting industries.

The National Environment Protection Council has recently released a lengthy discussion paper, which draws on a series of commissioned studies to examine the costs and benefits of proposed new uniform national ambient air quality standards for the principal noxious pollutants (NEPC 1997). The discussion paper contains estimates of the annual health and other human costs that would be avoided if concentrations of the major air pollutants throughout Australia were reduced to the levels specified in the proposed new standards. In very general terms, the data presented in the paper suggest that the proposed new standards approximate the levels at which the marginal cost of further control of each pollutant would equal the marginal avoided health cost. Therefore the estimates of avoided costs given in the discussion paper approximate the human costs of air pollution not included in conventional national accounting aggregates.

The six pollutants proposed to be subject to stricter standards are carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, particulates and lead. The estimated annual avoided health cost from the first five of these is approximately $1.1 billion. Particles account for about three quarters of this total. In addition, it is estimated that reducing ambient particle levels would result in more than 500 avoided deaths each year. One study quoted in the discussion paper values these avoided deaths at $3.8 billion.

In the case of the sixth pollutant for which new standards are proposed – lead – the major human cost is reduced measured intelligence, resulting in loss of lifetime earnings. The NEPC discussion paper presents data derived from a 1995 national survey of lead in Australian children, from which it can be calculated that the current cost of reduced IQ caused by lead pollution is approximately $1.5 billion per annum.

Allowance has already been made for defensive expenditure on health, which include the direct health costs of all sources of air pollution. However this adjustment does not make allowance for the costs of additional deaths caused by particulates, or for the cost of reduced IQ caused by lead pollution, or for any of the other damage costs of noxious air pollution, such as to crops, garden plants, natural vegetation and buildings. Such damage arises not only from pollutants, such as ozone, included in the proposed new ambient air quality standards, but also from other pollutants such as fluoride. There are no published estimates at the national level of the costs of damage to crops and other vegetation, or to buildings and the like.

The annual health costs of particle emissions in Brisbane have been estimated to be between $255 million and $462 million (arising from an additional 46-83 deaths). However this study used a lower cost of increased mortality than accepted by the NEPC (Simpson and London 1995, p. 6.2; NEPC 1998, p. 132). The NEPC uses a methodology similar to that used by the US EPA, applying an economic value of $7 million for each additional death.

A more recent assessment of fine particle pollution in Sydney has estimated that 397 premature deaths per year (out of a total of 21,500) are caused by particles (NEPC 1998, p. 127). By extrapolating to the entire Australian population the NEPC attributes 2,400 deaths each year to particles. To account for differences in particle levels between major urban areas and the rest of Australia the NEPC suggests that half of this figure (1,200) is a more reasonable estimate (NEPC 1998, p. 132). Using the NEPC's estimates of the cost of a lost human life, the annual economic cost of exposure to particles in Australia is estimated to be $8.4 billion per year.

This is a point estimate derived from current or recent past ambient levels of the various pollutants, and has been scaled up by 50% to account for the effects of pollutants other than particles. To obtain cost estimates for previous years we have used total consumption of fossil fuels (coal, petroleum and natural gas) plus biomass fuels (wood and bagasse) as a proxy. This measure of pollutant level has been chosen because combustion of these fuels is by far the largest single source of emissions. Data sources used are Bush *et al*. (1999) for the period 1974-1999, Department of National Development and Energy (1982) for the period 1961-1973, and Saddler (1981) and the sources referenced therein for the period 1950-1960. The figure for 2000 is estimated using the mean growth rate for the previous three years.

Finally, we note that current ambient levels of air pollutants in some areas are much lower than they were in previous decades, as a result of previous control measures imposed on sources of pollution. These measures include both successively stricter motor vehicle exhaust emission standards, and control measures imposed on major point sources of air pollution, such as power stations and factories. Our figures may therefore underestimate the cost of air pollution in earlier years.

It should be noted that global costs of air pollutants, including greenhouse gas emissions and depletion of the stratospheric ozone layer, are not included in this column but are costed separately in Columns U and V respectively.

Column R Costs of land degradation

Soil is a resource for which there is no substitute. Moreover soil loss and changes in soil structure are effectively irreversible. As such the soil may be classified as 'critical capital' (Diesendorf 1997: 90). Current agricultural practices are unsustainable; the current generation is leaving a depleted and less productive resource for future generations, a resource that is essential for maintaining living standards and ecological processes. The Standing Committee on Agriculture defined sustainable agriculture as 'the use of farming practices and systems which maintain or enhance:

- the economic viability of agricultural production;

- the natural resource base; and
- other ecosystems which are influenced by agricultural activities' (quoted in Derrick and Dann 1997: 189).

While there is a continuing debate over the economic viability of some types of farms, it is clear that the natural resource base is being depleted and other ecosystems have been seriously degraded.

The principal environmental problems associated with the land use in Australia are soil structure decline, salinity and waterlogging, acidification, nutrient loss, weed infestation, habitat loss and various forms of erosion. Some of the environmental impacts have already been assessed in our evaluation of the environmental costs of irrigation water use. The costs of degradation of native forests are also assessed elsewhere (Column S).

Some of the environmental costs associated with land use are reflected directly in lower agricultural outputs and higher costs of inputs – the on-farm costs. For example, weed infestation costs around $3.3 billion annually (excluding the health and environmental costs associated with weeds), mainly due to lost production and control costs (DEST 1996b: 6-23). The control costs are intermediate inputs that are reflected in final prices.

The off-farm costs include both costs imposed on other farmers – through, for example, the spread of weeds or salinisation of waterways – and damage to natural systems.

The question of how to value the loss of natural capital of the land is difficult. There are two types of costs – loss of productive potential, and environmental damage. One method of estimating the loss of productive potential would be to use the proportion of the value of agricultural output that is denied future generations through irreplaceable soil loss. Estimates of the annual losses have been made in the form of the production equivalent of land degradation. In a recent review, the Industry Commission reports a number of studies for the early to mid-1990s which indicate that land degradation across Australia results in an annual loss of output equivalent to around 5-6% of the value of agricultural production (Gretton and Salma 1996: E4-E7). This amounted to around $1.2 billion in 1992-93 (RBA 1996: Table 5.18). The figure of 5-6% is an underestimate because it takes account of only some forms of land degradation – acidification, soil structure loss and erosion – and accounts only for production losses and not ecological damage. We therefore estimate total damage at double that amount, i.e. $2.4 billion in 1992-93 (although farm prices and output were low in that year due to recession). The figure is $2.6 billion in our base year 1989-90.

More recently, a study by the ACF and NFF estimated that the cost of land and water degradation amounts to $1.4 billion annually, made up mainly of the costs of salinity, acid soils and poor water quality. Adding some more difficult to quantify impacts, such as degradation of ecosystems and coastal sedimentation, brings the figure to more than $2 billion (Virtual Consulting 2000).

In addition to the annual loss of environmental quality experienced by the current generation, we need to account for the losses imposed on future generations by the irreversible depletion of a critical resource. The costs imposed on future generations are estimated by the present value of the future losses, which at a discount rate of 5% amount to 20 times current losses ($52 billion), distributed back over the years according to the contribution of each year to the current level of depletion. Very little data exist to indicate the trends over time in land degradation. In the absence of data, we assume that land degradation has proceeded at a rate of 2% per annum over the study period, so that for each year of the study period the capitalised future costs of land degradation amount to $1.04 billion at 1989-90 prices. This can be thought of as the amount that the population would have needed to set aside each year to compensate future generations for losses due to land degradation. This same rate of change of land degradation is used to estimate the losses in each year to the current generation.

We saw above that weed infestation costs around $3.3 billion annually (1986 data). Around $3 billion of this is reflected in lost or contaminated production (DEST 1996b: 6-23). This represented 19.4% of gross farm production in 1986. Since weed infestation does not represent an irreplaceable loss, its costs represent annual costs only. In addition, the cost of weeds is already reflected in the national accounts through a lower value of output. Weed control expenditures are defensive, but since they are intermediate inputs they too are reflected in the accounts.

Column S Costs of loss of native forests

When forests are cut the value of the timber products made from the logs is added to GDP. But the environmental costs associated with logging are not recorded anywhere. These costs include loss of biological diversity, falls in aesthetic and recreational values and diminution of non-use values, which are characterised by environmental economists as existence, bequest and option values.[15] To the extent that old-growth forests are able to return to their original state, the process may take 200 years or more. In Australia, the length and bitterness of the dispute over logging of old-growth forests (where conservation values are particularly high) suggest that Australians place a high value on these losses.

How should these losses be valued for the purposes of the GPI? We take the view that it is inappropriate to place economic values on loss of biodiversity and the losses experienced by people when they see an old-growth forest destroyed. These are ethical issues rather than economic ones. However, since loss of old-growth forests may represent a large impact on well-being, we have decided to include a monetary estimate of the losses for comparison with the GDP measures of changes in welfare. Rather than attempting to value each component of loss, a comprehensive approach to monetary valuation can be obtained by estimates of willingness to pay for preservation of environmental values. (This approach is based on an anthropocentric ethic, one that many would regard as inappropriate.)

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[15] In addition, where it occurs, overcutting diminishes the productivity of the forests and reduces the future timber values of the forest. The ability of the forests to renew their timber values is damaged. This factor is not included in the analysis.

In 1991, the Resource Assessment Commission carried out a study of the environmental values of National Estate forests in Southeast NSW and East Gippsland. These forests cover an area of 130 000 hectares and had been declared by the Australian Heritage Commission to be of high conservation value. A contingent valuation survey revealed that adult residents of NSW and Victoria were willing to pay $22 per annum to preserve these forests (RAC 1992: U15).[16] This translates into a total valuation for these forests of $156 million, or $1700/ha/annum, by the residents of the states in which the forests are located. Loss of old-growth forests is also felt by residents in other states, as campaigns over logging in Tasmania and the Queensland wet tropics illustrate. We might then scale up this amount by, say, 100%. On the other hand, these National Estate forests are of particularly high value, so a conservative approach may be to halve this estimate of the environmental values of a hectare of old-growth. Thus we estimate that the logging of each hectare of old-growth forest results in a loss of environmental values of $1700 per annum. Since the losses are effectively irreversible, the value of each hectare lost needs to be capitalised. At a 5% discount rate, the present value of the environmental losses from each hectare logged is $34 000.

Remarkably, data on areas of old-growth forest logged over the study period, or indeed for any year, are not available. We have therefore been forced to make some rough estimates. The area of native forest available for logging in 1990 was around 22 million hectares (ABS 1995: Table 4.3). However, not all of this area is suitable for logging, so we estimate that only 15 million hectares are available in practice. If these forests are managed on a 100-year rotation,[17] this means that 150 000 hectares are logged each year. We assume that when logging of native forests reached its peak in the late 1980s this was the area logged. For other years we are forced to make a rough estimate using data on timber volumes extracted from native forests as reported in DEST (1996b: 6-41). The estimated cost of environmental damage due to logging of old-growth forests for the year 2000 is $5.7 billion (in 1989-90 prices). As a result of the uncertainties in estimating both the areas logged and the environmental values lost due to logging, the estimates of the costs of logging native forests should be viewed as only very rough approximations.

Column T Costs of depletion of non-renewable energy resources

It is often argued by environmental economists that economic growth will run into constraints imposed by depletion of finite natural resources such as minerals and fossil fuels and that therefore current consumption patterns are unsustainable (e.g. Daly and Cobb 1990). This claim is the subject of vigorous and continuing debate amongst some environmental economists and scientists on the one hand and more conventional neoclassical economists on the other. The latter argue that, while it is true that some natural resources that are vital to continued economic growth are finite, we will never run out of resources since the price mechanism will ensure that substitutes will always be found for inputs in short supply. More specifically, price movements and technological change will do one or more of three things: increase the available reserves through new discoveries, permit substitution of new resources for old ones, and induce greater economy of usage. While particular resources may become scarce,

[16] This figure is a median willingness to pay rather than a mean. The mean is not reported.
[17] See Streeting and Hamilton (1991).

there will never be any general resource constraint. Thus current market prices adequately reflect the current and expected future scarcities of these resources.

The debate is not so much about whether substitutes will be found as about what the costs will be of the substitutes (including the requirement for consumers to change their consumption patterns) that must be used when resources approach full depletion.

In other GPIs, the assessed costs of depletion of non-renewable resources comprise the largest, or one of the largest, 'deductions' from the index. Yet the methodological foundations employed are shaky. Cobb and Cobb (1994: 264) reject the use of current market prices as a proper measure of future scarcity on the grounds that the current discount rate fails adequately to express the interests of future generations. This may be so, but the use of discount rates in dealing with intergenerational equity is an area littered with methodological traps (see, for example, Norgaard and Howarth 1991).

In the US GPI, Cobb, Halstead and Rowe (1995) also reject the view that current prices adequately reflect future scarcity. In their estimate of the costs of depletion of non-renewable resources, they include only energy and not minerals because of the importance of energy as an input and the ease of aggregating across energy resources. To measure the cost of depletion of non-renewable energy resources the authors use an estimate of the cost of replacing fossil fuels and nuclear energy with renewable alternatives, in particular the costs of producing 'gasohol' from biomass. The price they settle on is US$75 per barrel of oil equivalent (boe) in 1988, a figure that increases at a rate of 3% per annum from 1950 to 1994 around the 1988 figure (Cobb, Halstead and Rowe 1995: 31). The UK and Swedish ISEWs adopt the same approach and the same unit value.[18]

This debate revolves around opinions based on two sets of beliefs:

- whether one believes that 'competitive' markets adequately reflect future scarcities well beyond the time frames of any actual discount rate (beyond around 30 years); and

- related to this, whether one takes an optimistic or pessimistic view of the ability of technological change to solve any emerging scarcities.

If one believes in the efficacy of markets then one is *ipso facto* a technological optimist. Thus one must take a position on the spectrum in order to decide how to assess the costs of depletion of non-renewables, one in which the optimists assess the costs at zero. Our own view is that current prices fail to reflect adequately future scarcities but that, nevertheless, both induced and autonomous technological change have provided, and will continue to provide, many substitutes to emerging scarcities.

These considerations apply especially in the case of minerals. There is a much stronger case for arguing that substitutes for, and efficiency in the use of, minerals such as iron ore, bauxite and copper ore (three of the non-energy mineral products used in greatest quantity in Australia) will mean that no binding or serious constraint

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[18] Although in the Swedish GPI the replacement cost in 1988 (US$75/boe) is in 1972 dollars rather than in 1988 dollars (Jackson and Stymne 1996: 29).

will be imposed on global consumption growth. Already there is a significant shift towards the dematerialisation of consumption activity in developed countries, and recycling technologies are advancing rapidly in some activities which remain resource intensive.

We take a less optimistic position with regard to energy resources. While a continuously growing economy in the absence of any particular non-energy mineral resource is conceivable, consumption of energy is essential to all economic activity, including those activities required for the most basic level of subsistence. Many renewable energy substitution possibilities for finite fossil fuels clearly are available, and there are also many options to extend the life of fossil fuel resources by increasing the efficiency with which they are used. Moreover, the unit cost of renewable energy has fallen substantially over the last decade or two and will continue to do so (see the examples in Grubb *et al.* 1991). The replacement cost used in the US GPI is thus a significant overestimate if applied, as it is, to consumption of all fossil fuels.

On the other hand, it is difficult to envisage that an economy based entirely on renewable energy will be able to use energy in such quantities and at such low cost as our present fossil fuel based society (Trainer 1995). Finding alternative energy sources which do not contain fossil carbon for cars and aircraft will provide a particular challenge. Although some authors suggest that fuel cell vehicles powered by hydrogen produced with solar electricity may one day be cost competitive with current petrol fuelled internal combustion engine powered vehicles (e.g. Lenssen and Flavin, 1996; Johansson *et al.* 1996), most authors are much less optimistic (e.g. Michaelis and Davidson 1996; Chapman 1996). In 1995, after fifteen years of industrial development and a nearly three-fold reduction in cost, sugar cane fuel ethanol in Brazil still costs around US$57 per barrel, which is approximately twice the international price of petrol (Goldemberg 1996). It seems unlikely that this gap will ever be fully closed. Moreover, Brazil is uniquely well-endowed with abundant low-cost, fertile land. It is conceivable that the world's entire current consumption of transport fuels could be supplied by synthetic fuels sourced from biomass on a sustainable basis, but if so it would be at a significantly higher price.

Michaelis and Davidson (1996) present vehicle operating cost figures from a variety of recent studies. The studies compare a conventional petrol-fuelled car with vehicles using fuels derived from renewable energy sources, including methanol from wood, ethanol from sugar cane and wood, solar hydrogen used in either internal combustion engine or fuel cell vehicles, and electric vehicles. The data presented imply additional costs for these fuel/vehicle systems, ranging from about US$60/boe for methanol from wood to several hundred dollars for the hydrogen-fuelled and electric-powered vehicles. In the long run it is only this latter group of fuels which could be considered to be truly sustainable, in that they would be ultimately sourced from renewable electricity.

It should be noted that much of the additional cost of using these sustainable fuels derives from the higher costs of the vehicle and supporting infrastructure and only part is attributable to the hydrogen or electrical energy.

These considerations have led us to adopt a middle position between the energy pessimists, who attribute a replacement cost of US$75/boe (1988 prices) to all fossil fuels, and the optimists, who attribute a replacement cost of zero. For the Australian GPI we have attributed a depletion cost of US$75/boe in 1995 dollars to the consumption of petroleum and natural gas, but not to coal. This approach recognises the uniquely valuable attributes of petroleum as a transport fuel, for which no truly sustainable substitutes would appear to be available except at much higher costs, as detailed above. This figure converts to approximately A$17.4 million/petajoule in 1990 prices (1 petajoule equals approximately 158 000 boe).

We should add one more vital point in this debate. The discussion in the GPI literature about the finiteness of resources focuses entirely on limits to those resources that are inputs into production processes. In our view, by far the most serious environmental constraints on continued growth are not provided by inputs but by the absorptive capacity of waste sinks. These are the aspects of ‘natural capital’ that most need to be accounted for in an evaluation of sustainability. While the atmosphere and the waterways are renewable resources, their assimilative capacities are in many cases being greatly exceeded. As these ‘resources’, or rather life-support systems, lie outside of markets, the accuracy or otherwise of current prices is largely irrelevant and the available evidence suggests that an attitude of technological pessimism is well founded. We have attempted to assess the environmental costs of the depletion of these systems elsewhere in the index.

The immediate relevance of this issue to considerations of fossil fuel depletion is that large-scale use of one of the three major fossil fuels, coal, imposes such severe damage on the assimilative capacity of the global atmosphere, in the form of greenhouse gas emissions, that it is most improbable that we will ever be able to use all known resources of coal. Moreover, relative to present rates of consumption, known resources of coal, both globally and within Australia, are far larger than known resources of the other two major fossil fuels, petroleum and natural gas. These considerations provide a further rationale for applying a depletion cost only to consumption of petroleum and natural gas.

Petroleum consumption figures are derived from the same sources as used for Column Q (Costs of air pollution).

Column U Costs of climate change

Emissions of carbon dioxide, methane and other gases resulting from human activities are causing an increase in average global temperature and thereby changing the climate of the earth. Even if emissions were reduced overnight to a fraction of their current rate, so that there were no further increases in atmospheric concentration of these gases, further climate change would occur. Climate change is expected to have a range of damaging impacts, including inundation of land due to sea level rise, destruction from more frequent and powerful hurricanes, loss of crops due to changes in temperature and precipitation and spread of vector borne diseases such as malaria.

The largest source of greenhouse gas emissions in Australia, as in most other countries, is the combustion of fossil fuels. However, many other activities make significant contributions, including enteric fermentation in the gut of domesticated animals (cattle, sheep etc.); breakdown of animal manure; application of nitrogenous fertilisers; clearing of native vegetation; breakdown of organic waste material in landfills; cement manufacture and other industrial processes; and fugitive emissions (leakage) of methane and other gases derived from fossil fuels.

Emissions from fossil fuel consumption can be estimated over the entire period covered by this study much more readily than emissions from any other source. We have compiled a time series for consumption of black coal, brown coal, petroleum and natural gas from the same sources used to compile the similar series for estimating the costs of air pollution (Column Q).

Emissions of greenhouse gases associated with combustion of each of the fossil fuels are calculated by use of emission factors for each fuel. Emission factors take account of emissions not only of carbon dioxide but also the two other principal greenhouse gases, methane and nitrous oxide, which are equated to carbon dioxide by use of the global warming potential for each gas. Total emissions per unit of each fuel consumed are expressed in terms of carbon dioxide equivalent (CO_2-e). The unit for emission factors is kilotonnes of CO_2-e per petajoule (equivalent to kilograms per gigajoule).

It should be noted that carbon dioxide arising from oxidation of the carbon atoms contained in fossil fuels accounts for by far the largest proportion of all greenhouse gas emissions resulting from fossil fuel combustion. Some fossil fuel consumption arises from the use of petroleum and natural gas as feedstock for the manufacture of chemical products and some carbon in fuels is not oxidised. Emission factors were therefore reduced by 5% to allow for this effect.

Fossil fuel consumption figures are derived from the same sources as used for Column Q (Costs of air pollution). Emissions for 1990 to 1999 have been taken from the National Greenhouse Gas Inventory (AGO 2000) (and include all sources and sinks). The figure for 2000 is an extrapolation using the average growth rate over the last three years.

For previous years, we have good data on fossil emissions, but none on emissions from other sources. Based on the share of fossil in total emissions for the years around 1990, we have assumed that, on average, over the period from 1950-1989, fossil fuel combustion accounted for 55% of total Australian greenhouse gas emissions, i.e. we multiplied estimated fossil fuel combustion emissions by 1/0.55 to obtain an estimate of total emissions in each year.

The final step in calculating the cost of greenhouse gas emissions is to attribute a unit cost to each tonne of CO_2-e emitted. In the 1997 GPI we used a control cost approach, in which it was asked how much it would cost to reduce greenhouse gas emissions to some specified level, in this case the stabilisation of emissions at 1990 levels by the year 2010. This price can be thought of as the cost of buying a permit to emit a certain amount of carbon dioxide. We noted a number of studies that suggested that such a restriction would result in a tonne of carbon dioxide being priced at around A$36/tonne of CO_2.[19]

[19] The price of a tonne of carbon is converted into a price for a tonne of carbon dioxide by multiplying by a factor of 0.273.

The control cost approach, also adopted by other ISEWs and GPIs, is only a proxy for the measure we really want, which is the damage caused by each tonne of CO2-e emitted. Pricing carbon emissions by the cost of reducing them to a certain level understates the true cost because climate change will still cause damage. The Kyoto Protocol, for instance, requires industrialised countries to reduce their emissions to 5% below 1990 levels by 2008-2012, yet climate scientists say that we must cut global emissions to around 30% of current levels merely to *stabilise* climate change.

In the 2000 GPI we take a different approach, one based on the estimated contribution of each tonne of emissions to the damage it is expected to cause in the future. Drawing on the work of the Intergovernmental Panel on Climate Change, Sorenson (1997) estimates the costs of climate change in the 21st century as a result of the expected doubling of CO_2 concentrations (from 280 ppmv to 550 ppmv). He notes in particular that developing countries will not be in as strong a position as developed countries to take measures to cope with extreme weather events and changing crop zones. The major impacts are increased mortality and morbidity due to failure of crops, and to the spread of malaria and schistosomiasis (Sorenson 1997, Table 9.3). Sorenson notes that the European Commission recommends using a statistical value of life of US$3 million and that this value should apply equally to developed and developing countries.

On this basis, Sorenson estimates the damage cost over the 21^{st} century of a doubling of the concentration of greenhouse gases in the earth's atmosphere at about US$$10^{15}$ (or US$$10^{13}$ per annum). The amount of carbon as CO_2 in the atmosphere before industrialisation stood at 750 Gt (IPCC 1995:. 77) or 2750 Gt CO_2 (2.75×10^{12} t CO_2), an amount that will double with a doubling of concentrations. Thus the damage cost in the 21st century as a result of a doubling of greenhouse gases is US$364/t CO_2 ($10/2.75 \times 10^3$), or around A$700/t CO_2 (at the current exchange rate of A$1 = US$0.52). This is clearly much higher than the A$36/t CO_2 used in the 1997 GPI.

How should we interpret this number? The best way is to think of it as the amount that would need to be 'set aside' to offset or compensate for the damage from climate change in the next century. Setting aside money at the time of emission would generate a fund that would compound over time. How much would need to be set aside in order to cover the damages when they occur? This depends on the time elapsed between the emission and the damage and the interest rate used. It is not possible to know the time lapse with any accuracy; the emissions in question will occur for the most part over the period 1950-2050 (2050 being the expected point at which doubling will be reached), while Sorenson's estimates of damage cover the period 2000-2100. As an approximation, we can estimate the amount that would need to be set aside to generate an *average* return of $700 over the subsequent 100 years. The calculation reveals an answer of $55 for an interest rate of 4%. Table 2 shows the amounts that would need to be set aside for different interest rates.

Table 4 Set-aside value of CO_2 emissions needed to generate an average return of A$700 over 100 years

Interest rate	Set aside

3%	$113
4%	$55
5%	$26

There are various adjustments that in principle should be made. For instance, carbon dioxide is withdrawn from the atmosphere over time, so that 100 years after the emission of one tonne only 330 kg remain in the atmosphere,[20] so that more than 750 Gt will need to be emitted for there to be a doubling. In addition, the amount of damage is associated with the increase in concentration, so early emissions will not do as much damage as later emissions. But we take the view that to carry out these temporal adjustments would imply a spurious level of accuracy in the basic numbers, and have therefore decided to apply a flat real value of A$55 (US$29) to each tonne of CO_2 equivalent emissions at the time of emission. Given the uncertainties about the timing and impact of climate change, this figure should be regarded as only a rough approximation.

It should be pointed out that estimating damage on the assumption of a doubling of concentrations of greenhouse gases is conservative. Most climate scientists believe that a doubling is unavoidable and we should be aiming at avoiding a trebling. The damage associated with a trebling is expected to be much higher than that for a doubling.

Column V Costs of ozone depletion

Depletion of the ozone layer, principally as a result of the release of chlorofluorocarbons (CFCs) into the atmosphere, presents a serious environmental problem. DEST (1996b) notes that increased levels of UV radiation reaching the land increase the incidence of sunburn, eye damage, skin cancer and damage to immune systems, especially among fair-skinned people. Many other organisms, including plants and insects, are also at risk (DEST 1996b: 5-11). Australia may be particularly prone to the impacts of ozone depletion because the largest of the ‘holes’ in the ozone layer form in the Antarctic and sometimes subsequently pass across southern Australia (the most populated areas) in late spring (DEST 1996b: 5-18).

CFCs have been used since the 1930s as refrigerants, propellants and industrial solvents. Once released into the atmosphere they are dispersed globally and remain airborne for many decades. Thus the annual release of CFCs has a cumulative environmental impact.

Global concern about ozone depletion led to the Montreal Protocol of 1987, which introduced a timetable for phasing out ozone-depleting substances. Consumption of CFCs has declined sharply since 1989 and should cease by the end of 1997. However, it will take several decades before UV radiation returns to its natural level (DEST 1996b: 5-45).

[20] Put another way, over a 100 year period, the forcing caused by a tonne of carbon dioxide is only 46% of what it would be if it were infinitely lived.

How do we estimate the costs of ozone depletion? The US GPI multiplies US production of CFCs by US$30/kg (in 1982 prices). The authors do not have a persuasive reason for this choice. They observe that no definitive studies of the impacts of ozone depletion exist but that, given the potentially catastrophic effects, 'we made an estimate reflecting our expectation of the order of magnitude of the problems' (Cobb, Halstead and Rowe 1995: 34n). Cobb and Cobb (1994: 273) note that the total costs estimated this way 'may be thought of as the amount that would need to be set aside to compensate future generations for having made their planet less habitable'. The US GPI cost estimate has been adopted for the UK and Swedish indexes, although in the Swedish case the unit cost is applied to consumption rather than production of CFCs, which seems more appropriate since the damage is done by the release into the atmosphere from appliances that use CFCs in their manufacture.

In the Australian GPI we have adopted a different approach, by using data from a study of the estimated health costs of enhanced UV-B radiation in Australia in each year over the period 1990-2030, measured in constant 1990 dollars (Bryant *et al.* 1992). This study assumed that the level of UV-B would remain constant at the level in 2010 for every year thereafter. This level, although higher than the peak of a few years earlier, was estimated to be considerably higher than the 1990 level, with consequent continuation of significantly higher health costs. Following the adoption in 1992 of the Copenhagen Amendment to the Montreal Protocol, it is now expected that restoration of the ozone layer will occur more quickly and that UV-B levels will therefore fall more rapidly (DEST 1996b: 5-44). We have therefore amended the annual health costs estimated by Bryant *et al.* by assuming they will fall steadily after 2010, reaching zero by 2030. We then summed costs over the whole 1990 to 2030 period to obtain an estimate of total costs over the entire period in 1990 dollars. This figure is $37.3 billion.

Two further adjustments were then made. Firstly, measurable damage to the ozone layer, and consequent increase in UV-B radiation, began some years before 1990. The use of 1990 as the base for the study therefore both fails to include the costs incurred in earlier years and, more significantly, measures the *increase* in health costs against a base which already includes some increased costs. It is also highly likely that increased costs will continue to be incurred for many years after 2030. We have therefore doubled the estimate of total costs to take account of these factors.

Secondly, we recognised the need to take account of the damage caused by enhanced UV-B radiation to plants, including both terrestrial and aquatic plants, and hence to agricultural and fisheries production and to natural terrestrial and marine ecosystems. In the absence of any readily identifiable estimates for these costs, we have assumed that they would equal the cost to human health, i.e. we doubled the estimate of health costs to obtain a total cost estimate.

The next step in the calculation was to relate these costs to emissions of CFCs. We based our estimate on the assumption that damage to the ozone layer affecting Australia is caused by emissions of CFCs and other ozone-depleting compounds from Australia. This is clearly invalid, in that ozone layer depletion is a global phenomenon caused by the world-wide increase in atmospheric concentrations of ozone-depleting compounds. To the extent that, to date, ozone layer depletion has been mainly a southern hemisphere phenomenon, it might be argued that Australia is suffering damage disproportionate to other countries, i.e. that part of the damage imposed on Australia is imposed by emissions from other countries. However an offsetting factor is that Australia contains only a small proportion of the total world population and plant production. Therefore, in the absence of any guidance as to an alternative relationship between Australian CFC emissions and Australian damage costs from ozone layer depletion, we have assumed that the costs are directly related to the emissions.

Estimated annual emissions of CFCs are derived from CFC consumption data provided by Dr Paul Fraser of the CSIRO Division of Atmospheric Research (*pers. comm.*). These are the data which are presented graphically in the *State of the Environment Report* (DEST 1996b: 5-44). These data extend back to 1975 and are disaggregated into consumption from aerosols and from all other applications. For a few years the latter category is further broken down to show consumption in refrigeration. We made the following further assumptions to construct an estimated set of annual emissions figures stretching back to 1950.

- ‘All other’ consumption is separated into refrigeration and the remainder (mainly foams and solvents) by assuming the same proportionate split as in the years for which data are available.

- Consumption prior to 1975 is estimated by assuming that aerosol use rose by equal annual increments from zero in 1960 to the 1975 level, that non-aerosol use rose similarly from zero in 1950, and that refrigeration use accounted for all consumption up to 1960, and then increased by equal annual increments to 1987 (the earliest year for which a specific refrigeration consumption figure is available).

- To estimate emissions from consumption we assumed that in all uses other than refrigeration CFCs were emitted to the atmosphere in the same year in which they were consumed. For refrigeration it was assumed that in each year 10% of the stock of CFCs in refrigerators leaked to the atmosphere; replacement of this leakage accounted for part of the consumption of CFCs for refrigeration. The balance of consumption went into new refrigerators, and thus contributed to the build up of stock. It was further assumed that all refrigerators were scrapped upon reaching 20 years of age and that their whole content of CFCs was emitted to the atmosphere. Although new additions to the stocks of CFCs in refrigerators and other sources had stopped by 1995, leakage and scrappage continues to occur (at assumed rates) through to and beyond the year 2000.

By this means estimates were made of total emissions in each year from 1950 to 2000. It was assumed that these account for almost the total of all emissions ever occurring from Australia, and they were then summed over the whole period. By dividing this sum into the estimated total costs, a unit cost of $214 per kilogram of CFC (in 1990 dollars) was obtained (considerably higher than the US estimate). This figure was applied to the estimated emissions in each year to yield an estimated cost for each year.

Column W Costs of crime

The costs of crime are various. They include property loss, medical expenses, pain and suffering, feelings of insecurity, and lost opportunities to undertake various activities because of risks of exposure to criminal acts. There are also considerable resources devoted to defending persons and property against crime – locks, alarms and security guards.

Some of these costs, notably medical costs, have been deducted elsewhere in the GPI or are reflected in lower economic growth (such as the lost income of victims of violent crime). Property loss is a 'transfer' and might be thought to confer as much benefit on the thief as on the legal owner. However it is more accurate to regard stolen property as invalid contributions to well-being because society deems them so. Alternatively, we might use the proceeds of crime as a proxy (perhaps a lower bound) for the pain and suffering caused by crime, a factor which is undoubtedly large but not accounted for in estimates of the costs of crime.

Walker (1995) has made the most comprehensive estimates of the costs of crime in Australia. The total for 1994-95 is around $19 billion, but some of these costs have been counted elsewhere in the GPI. Thus we deduct from this total the expenditure on the criminal justice system (police, courts and prisons) ($6.4 billion) and the costs of violent crime ($1.25 billion) since the latter are mostly in the form of medical expenses and lost income. We also deduct half of the costs attributed to drug offences ($1.0 billion) as these too are medical expenses. The remainder, $10.3 billion, includes property losses, insurance costs, and the costs of crime prevention and 'target hardening' (mostly non-government). The latter are thought to be seriously under-estimated, so the figure of $10.3 billion, or 2.3% of GDP in 1994-95, should be seen as a lower bound.

How have these costs changed over time? There is no time series available for the costs of crime. It is not possible to say whether the costs of crime as a proportion of GDP have changed over time, although it is possible that the scope for fraud involving very large sums of money has increased in more recent years (John Walker, *pers. comm.*). Therefore we assume that the costs of crime have been 2.3% of GDP over the whole study period. Using this approach, the costs of crime stood at $11.74 billion in 2000.

Column X Costs of problem gambling

In 1999, more than 80% of Australians gambled at least once, with 40% doing so regularly. In total, more than $11 billion were spent (lost) on gambling (Productivity Commission 1999). While such a high rate of participation in gambling indicates that it is considered to be enjoyable by the majority of people, problem gambling causes enormous harm to both addicted gamblers and their friends and families

Around 290,00 people are considered to be problem gamblers. While accounting for only 2.1% of the adult population, these gamblers lost around $3.5 billion in 1999, approximately one third of the total expenditure on gambling (Productivity Commission 1999).

That 2.1% of the population can be responsible for over 30% of gambling losses indicates the existence of a major social problem. For the purposes of the GPI expenditure on gambling by problem gamblers is assumed to provide no improvement in well-being to the addicted individual. We therefore deduct the proportion of expenditure on gambling attributable to problem gamblers.

While such an approach goes some way to capturing the costs of problem gambling it does not include other costs, such as counselling, that problem gamblers may incur. Similarly, it does not include the costs that problem gamblers impose on their friends and families. The estimate of the costs of problem gambling used in the GPI is therefore likely to be an underestimate of the actual costs.

While good time series data are available on the amount spent on gambling, this is not the case for the number of problem gamblers. In constructing a time series of the costs of problem gambling we have assumed that problem gamblers have always accounted for some proportion of total expenditure on gambling. We have assumed arbitrarily that in 1950 10% of expenditure on gambling was associated with problem gambling. This proportion is assumed to increase over time to reach the Productivity Commission's (1999) estimate of 33% in proportion to the rate of growth in gambling expenditure on gaming machines (the form of gambling favoured by problem gamblers). That is, problem gambling is assumed to have increased more rapidly in the past 10 years than in earlier periods due to the rapid growth in expenditure on gaming machines.

Total expenditure on gambling (the difference between the amount wagered and the amount won) was sourced from Tasmanian Gaming Commission (1999: Table 109) for the period 1972-73 to 1997-98. These data were projected back to 1950 by assuming that gambling as a percentage of GDP (which was stable through the 1970s) remained constant. Estimates for 1999 and 2000 were similarly derived by inflating real expenditure on gambling by the rate of growth of GDP. estimates of the amount spent by problem gamblers comes from Productivity Commission (1999).

Column Y Value of advertising

Information plays an important role in any economic system. Awareness of products, their locations, features, advantages over other products, durability and prices allow consumers and producers to make informed decisions about the best way to fulfil their needs. Expenditure on advertising, therefore, has the potential to improve the welfare of society to the extent that it leads to more informed decisions being made.

However, not all advertising is informative. Much advertising is designed to be persuasive, relying on artificial linkages between the goods or services being promoted and desirable emotions. Particular brands of margarine, for example, may be associated with the enjoyment of a happy family, but to the extent that advertisements such as these convey no information about price, location or ingredients then it can be argued that no useful information has been conveyed.

Of more concern are advertisements that provide disinformation. Many advertisements are for products that are harmful to both ourselves and the environment. However, rather than communicate scientific information about the likely effects of consuming large amounts of high fat food or petrol, advertisements are likely to associate such consumption with healthy, clean images. Green coloured 4WD cars, for example, may be shown allowing the occupants to achieve contact with pristine environments or fit healthy people may be shown consuming high-fat take away foods. In some cases, producers of low cost, high nutrition foods such as fruits and vegetables cannot afford to advertise on television, leaving consumers with a biased perception of a balanced diet. Infant formula is heavily marketed to new mothers despite the evidence showing mothers milk has significant health advantages (American Academy of Pediatrics 1997)

Much advertising is also ‘defensive’. That is, a firm may spend money on advertising simply because its competitors are doing so. In most cases the net effect of the combined expenditures will be the maintenance of market share that existed before the ‘advertising war’ broke out. Alternatively, the firm with better advertisements, rather than better products, may achieve some advantage. Defensive expenditures on advertising, like defensive expenditures elsewhere in the GPI, should not be considered to result in an increase in welfare.

There is debate in the GPI literature as to whether a portion of expenditure on advertising should be deducted. Zolotas (1981) was the first author to make such a deduction in his calculation of an Economic Aspects of Welfare Index. Zolotas deducted half the total expenditure on advertising. Following Zolotas, Cobb (1994) deducted the portion of advertising defined as ‘national’ arguing that local advertising was much more likely to convey economic information than advertisements run on national television.

In a critique of Cobb, Eisner (1994) argued that the deduction of advertising was unnecessary for two main reasons. First, he argues that any increase in consumer prices resulting from increased expenditure on advertising will be captured as inflation, and therefore removed from estimates of real (after inflation) measures of consumption. Secondly, he argues that advertising pays for free-to-air television and radio, the benefits of which are not captured in personal consumption expenditure.

Mishan (1994) on the other hand, favours the deduction of advertising expenditures on the grounds that many advertisements, particularly ones for products such as alcohol and tobacco, cause substantial harm to the communities they influence.

The concerns raised by Eisner have some validity, but it is unlikely that the effects he outlines are sufficiently large to offset the expenditure of more than $20 billion on advertising, marketing, promotion and sponsorship by Australian companies (CEASA 2000). In particular, the restriction on the number of television and radio licensees in Australia ensures that those owning a license can earn ‘monopoly rents’. That is, in a competitive market, with a large number of channels, the price of placing an advertisement would fall substantially. Current prices for advertisements do not, therefore, reflect the ‘cost’ to the television station of screening, nor do they represent the ‘benefit’ to the consumer of watching the program. There are also serious questions about the benefits of watching commercial television, and the impact on television watching if viewers were required to pay directly.

In our view it is valid to deduct a portion of the expenditure on advertising to reflect the fact that not all advertising expenditure increases community well-being. Time series data are available for expenditure on the placement of advertisements in the main media (television, radio, print, outdoor, cinemas). In 1997, main media advertising accounted for 36.5% of total expenditure on advertising, with direct marketing (35.1%) and promotion marketing (25.1%) capturing most of the remainder (Advertising Federation of Australia 2000). Data on the production costs of advertisements, such as recording, editing and graphic design, are not available. We have assumed that expenditure on main media advertising accounts for one third of total expenditure on advertising and marketing (including production costs). We have chosen to deduct 50% of the expenditure on the placement of advertisements in the main media from consumption expenditure in order to offset both the increase in prices caused by advertising that provides no information and also to offset the harm done by the placement of advertisements which provide disinformation. Given that the time series for main media covers only around one third of total advertising we feel such an adjustment is conservative.

Finally, in 1998 Australia spent around 1.22% of GDP on advertising. Canada, on the other hand spent 0.81% while Japan spent only 0.79% (CEASA 2000). If Australian firms relied on advertising as heavily as Canadian firms they could have saved over $2.5 billion in 1999. Such a saving on advertising could free up over 85,000 jobs at $30,000 per annum to provide welfare-improving goods and services.

Data for this column come from (CEASA 2000). This provides a time series from 1960 to 1999. For the period 1950-1960 expenditure on advertising is assumed to be equal to 1.3% of GDP (based on the actual proportion over the period 1960-1970). For 2000, real advertising expenditure was assumed to grow at the same rate as GDP.

Column Z Net capital growth

The notion of Hicksian income requires that the value of a nation’s capital stocks be maintained. Capital stocks yield two potential benefits – they contribute to the current year’s production of goods and services (measured by their depreciation) and they contribute to the sustainability of income for future generations. We consider each of these, beginning with the latter.

In the GPI, the sustainability function is measured by net capital growth (i.e. net of depreciation). Thus the net capital stock is estimated from changes in the series of capital stocks net of depreciation adjusted to account for growth in the labour force. Estimates of the real value of the net capital stock for the years 1966-67 to 1993-94 are from RBA (1996: Table 5.23) and updated from ABS (1997c) and ABS (2000b Table 4.9). For the years 1949-50 to 1966-67 we have extrapolated backwards from an index derived from estimates of Australia’s capital stocks taken from Butlin (1977). Labour force data is from ABS (2000d: Table 1). All capital stock data is smoothed using a 5 year moving average, except for 2000, which is an average of the last 2 years and 1999 which is a 3 year moving average.

Let us now consider the annual services provided by the capital stock. The services of private capital stocks are reflected in the national accounts through the prices paid by consumers for goods and services produced by firms with the capital, so there is no need to consider it further. But what about the contribution of public capital stocks? Where these stocks are owned by public trading enterprises which sell goods or services to consumers – such as electricity, gas, water and publicly owned housing – the services rendered each year by the capital are captured in the national accounts in consumption spending (directly in final consumption or indirectly to the extent that these items are purchased by firms as intermediate inputs).

This leaves us with the capital stocks owned by government and provided free of charge to the public. These are discussed under Column J (Services of public capital). In summary, Column X is a measure of the annual growth in the value of the nation's built capital stocks net of depreciation and adjusted for growth in the labour force.

Column AA Net foreign borrowing

Sustainable consumption requires that a nation does not accumulate debts over a long period. Foreign borrowing can contribute to sustainable consumption if it is invested productively. But if it is used for consumption purposes then a debt is left for future generations to repay without the increased capacity to pay for it. This component of the index interacts with Column X (Net capital growth) in a way that takes account of the productive contribution of foreign investment in Australia, since the latter adds to the stock of national capital. Thus the net foreign lending column reflects net foreign borrowing for the purposes of consumption. This column is measured by the real value of net foreign liabilities (borrowing less lending) taken from RBA (1996) with estimates for recent years coming from the RBA Bulletin database (RBA 2000)

Columns AB-AE Aggregate indexes

Column AB is the GPI, in billions of 1989-90 dollars. It is constructed by summing all those components which add to welfare (those represented with a '+' in Table 1) and deducting the sum of all the components which detract from welfare (those represented with a '-' in Table 1). Column AC shows GDP in billions of 1989-90 dollars.

Column AD and AE are GPI and GDP per capita in constant 1989-90 prices. They are derived simply by dividing columns AB and AC by the total population of Australia.

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