Practice Change Research

Working Paper 09/06

Intergenerational equity as market failure

January, 2006

Dr Vic Wright

A report prepared for the Department of Primary Industries, Victoria

Victoria
The Place To Be

Published by the Victorian Government Department of Primary Industries
Tatura, January 2006.

ISBN 978-1-74199-607-4

Find more information about the Department of Primary Industries on the Internet at www.dpi.vic.gov.au

Table of Contents

List of Figures and Tables

Man can't live at this speed!

Miss Minnie Bannister

…two questions:

1) Could it be that technology itself is an expression of the essence of humanity, not merely in a distorted sense, but in all the ambiguity found in man?

2) And, if so, what is the phenomenon of technology such that it so clearly amplifies the very possibilities of that humanity that man may become a threat to himself?

Ihde, Don (1979), *Technics and Praxis*, p. 140

1 Introduction

Intergenerational equity is the most basic expression of the rationale for concern by one generation for the impacts of its behaviour on succeeding generations. It is not new to the world but the impact domains of interest are. This is because the scale of some impacts are now such that the closedness of the system composed of Earth and its Sun have become clear.

A natural question that arises is whether the novelty surrounding the concern implies a need for changes to behaviour and, if so, what changes to whose behaviour?

Market failure is a characteristic that free markets can be identified to possess and which may warrant some form of government intervention. The possibility that intergenerational equity may intrinsically suffer market failure may imply a systemic need for government intervention in resource allocation.

There are two main issues: is there systemic market failure; and, if so, what human responses are appropriate? This review goes to the first of these.

2 The Issue

Intergenerational equity is to do with mindfulness of one generation of the interests of another or others. It is not a new concern in human affairs but it has become a more prominent issue in the past few decades. Superficially, the reasons for this seem to be a variety of factors that are quite new to the world.

One is, after about a century of increasing social welfare interventions by nations, a looming inversion of the proportions of younger, healthy, employed people compared to old, less healthy, retired people. This has posed major threats of inadequate taxation bases for the maintenance of socially-provided welfare for the generation approaching retirement. This is mainly a developed economy problem since it is they that have extensive social welfare commitments as well as declining birth rates.

Starkly put, the prospect is that those who have funded the declining years of their parents are not going to enjoy similar support from their children. (See Kotlikoff and Raffelhüschen 1999; Cutler and Sheiner 2000.)

Another reason is the increasing awareness of the cumulative impact of human activity on both renewable and non-renewable natural resources. There is increasing concern among people that renewable resources are being exploited to the point of destruction of their capacity to persist and that non-renewable resources are being consumed frivolously. 'Sustainability' is the most prominent intergenerational equity issue. It is almost universally connoted to refer to natural resources/resource systems.

The concern is that the current generation is 'stealing from the future' and its people. The depth of concern is manifest in the pressure that governments' sense from their populations which has led to significant policy initiatives related to sustainability.

There is widespread concern that policy-maker optimism about technological fixes for global warming, specifically, has brought the world to the edge of something horrible and that, since so much of the warming phenomenon is linked to characteristics of contemporary production and consumption, radical change in economic activity is possibly required.

This stark, major environmental change has coalesced concerns about the environment and its use with two clear effects: voters in developed economies are aroused by the issue; and the speed with which many perceive global warming to be escaping any human solution has encouraged generalised fearfulness among people as to how sensibly resources are being used.

This is an imminent concern for many of the most concerned and, arguably, not essentially triggered by concerns for generational equity; but it finds its easiest expression in its terms: what sort of a mess are we leaving our successors?

The need for the persuasive communication of rational analysis in the public policy arena is high and, reflecting the depth of public concern, involves engaging with prominent and seemingly coherent competing approaches to rational analysis.

2.1 Why now?

Economists argue that salves for ethical concerns are 'normal goods'; demand for them increases with increasing incomes. Psychologists argue that they will not be sought until 'lower order needs', for food, security, etc, have been satisfied adequately. That is, below some critical level of income ethical concerns will not be attended to. So one factor explaining increasing concern with intergenerational equity could be the profound increase in real incomes in developed economies since WWII.

The possibility that there may be other factors in play for the growth in concern about intergenerational equity arises, in part, from its contrast with the degree of concern for clear and present intra-generational equity issues. For example, government action and popular concern to modify gross inequality in economic well-being and life chances across the world's current generations appears to be significantly less than that concerned with intergenerational equity in the guise of sustainability.

Assuming that ethics is the main driver of equity concerns, an explanation for greater emphasis on one perceived inequity than another could be the perceived price. Resolving intra-generational inequity may be perceived to involve a substantial transfer of current wealth. (This perception has arguably driven the sustained resistance to lowering agricultural protectionism in Europe, the USA and Japan.)

It is apparent that a similar perception is not popularly applied to sustainability. Australia's formal commitment to sustainability makes no reference to consideration of the cost that sustainability initiatives may incur[1]. (The State of Victoria Department of Sustainability and Environment (2005, p. 19), suggests that there may be short-term reductions in economic growth to be borne and they will be.) It may be that widespread absence of cost consciousness

---

[1] The Core Objectives of the National Strategy for Ecologically Sustainable Development are: 'to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations; to provide for equity within and between generations; to protect biological diversity and maintain essential ecological processes and life-support systems.' (Department of Environment and Heritage 1992, p. 1)

reinforces tendencies to view the minimisation of human impact on resources as intrinsically and overwhelmingly meritorious.

The concern for intergenerational equity commonly attracts an absolutist, even religious, commitment. This is reinforced to the extent that there is a perception that sustainability is being undermined by clumsiness and imprudence rather than as a rational response to a mix of incentives. That is, relevant change in behaviour is more about style than costs.

This is not fond territory for those whose wish is to optimise decisions relating to resource consumption.

2.2 Generational proximity

Intergenerational equity can refer to imminent future generations or more distant ones. In the resource use context the latter is presented as being more the case. Explicit consideration of the interests of people who the current generation can never meet has an abstract character different to that applying to contemplation of the interests of defined heirs and successors. Specifically, there is no prospect that the more distant generations can inform the current generation of their likely preferences.

The discussion in literature dealing with intergenerational equity in resource use is plainly focused on distant, and very distant, future generations. This engenders two significant problems immediately. First, extrapolating from the present to project the prevailing technological base of distant future generations is an absurdity. The identification of 'resources' is thus brought into question.

Second, the compounded direct costs of economic growth foregone today to sustain 'resources' will be considerable, without even considering the possible compounded costs of consequential delaying of innovation.

For analytical purposes it is necessary to assume that we know nothing about distant future generations that bears on their valuation of various inputs and that they will, in our terms, be extremely affluent. (We could reasonably project a greater aesthetic interest in Nature together with a dramatically enhanced ability to fund its preservation or restoration.)

It is perhaps illuminating to reflect on how poorly we understand similar characteristics of the lives of our predecessors. What was the income level of our families six generations ago; what resources did they use?

2.3 Spaceship Earth

Borrowing the term from Buckminster Fuller, Kenneth Boulding (1970) published a seminal work in this domain promoting the notion that Earth is a spaceship whose larder is given. A vigorous proponent of systems theory, Boulding proposed that Earth is a closed system. This implies its ultimate demise but also indicates a need, meanwhile, to manage it holistically with sensitivity to the interrelationships of constituent parts given that the parts comprise a defined set. To do otherwise would accelerate its demise as a system capable of sustaining human life.

Strictly, Boulding is in error with respect to the closedness of Earth as a system. The Universe is a closed system. Given current technology, the Sun and the Earth comprise a smaller closed system with the Earth being critically reliant on the Sun for energy. It will continue to provide energy until Earth ceases to be inhabited. So, from an analytical perspective, and importantly, the Sun is an utterly reliable source of new energy to Earth.

Boulding's proposition yielded a plausible boundary to Earth as a complex system. Its conceptual tidiness emphasises the possibility of significant negative externalities arising from temporally local optimisation of human activity. The implicit, if not explicit, past assumption of boundless earthly resources inevitably leads to human behaviour and aspirations which may need review in a future of bounded resources. Boulding argued that, with this awareness, 'the essential measure of the success of the economy is not production and consumption … but the nature, extent, quality, and complexity of the total capital stock, including in this the state of the human bodies and minds included in the system' (Boulding 1970, pp. 281-2). Much more recent work by Arrow et al. (2004) continues this theme.

The image is created of man as a species succeeding in evolutionary terms so well that, quite suddenly, the boundaries of the system begin to manifest; non-renewable resources are seen to be running down materially and renewable resource processes are seen to be being damaged by human activity. Quite suddenly, the prospect appears that current activity could very seriously impair the resource base available to distant generations.

In 1958 Boulding (1958, p. 21) asked 'are we to regard the world of nature simply as a storehouse to be robbed for the immediate benefit of man? ... Does man have any responsibility for the preservation of a decent balance in nature, for the preservation of rare species, or even for the indefinite continuance of his race?'

Boulding's judgement was that the then current economic emphasis on growth was part of the problem with much too little regard being paid to capital-stock ideas. His work is intellectual foundation to the current interest in sustainability.

The qualitative shift contained in his advocacy of a concern for stocks is profoundly important. It can be summarised in cybernetic terms. As Hicks (1980, p. 94) has asserted 'liquidity is freedom'. Completely fungible reserves maximise flexibility both in terms of specific response, and the timing of same, to opportunities and threats. The implicit assumption that natural resources were effectively infinite granted high flexibility to human action. Rejecting this assumption collapses this flexibility. How far it collapses it depends on how one 'reads' the reserves and how one decides to manage them.

The sustainability discourse is entirely about this issue. Arguably, the equity focus is a rhetorical flourish to inject heat into the debate between those with different perspectives on the status of reserves and/or their management.

As well, the closed system model has become a touchstone for responses to any and all clear and unappealing manifestations of the human footprint on the planet. Many people are poised for hyperbole.

3 Economic Perspectives

Boulding was an economist. Many for whom his work on Spaceship Earth resonates are not. His criticism of prevailing paradigms seems to have led to an unfortunate inclination for many people interested in this broad topic to attribute low relevance to economic constructs and analytical frameworks. A central issue to be dealt with in this report is the adequacy to the task of alternative frameworks that have been proposed.

In economic terms, as Boulding (1970) observes, many current pollution problems exist as a result of market failure: negative externalities associate with underpricing of the resource being consumed (eg, clean air or water). Possible remedies are well understood by economists.

Dealing with posterity-related problems in similar ways is fraught with difficulty, principally as a result of the absence of contextual information that is needed for resources and outputs to be valued.

In economic analysis a conventional approach to dealing with the passage of time is to apply a discount rate to future values of inputs and outputs on the basis that there is perceived to be an opportunity cost to delaying their use or arrival, respectively. There is an arrogance here, born of assumed knowledge of future preferences. In essence, the preferences of the decision maker, the discount rate chooser, are assumed to be the right preferences to apply. This is fine when capital investment decisions are being made by a manufacturer. It is not fine when a different entity not well known to the decision maker (eg, a future generation) will own the relevant preferences.

Compounding the problem is the rapid decay in values through time. At a 5% p.a. discount rate, which is an unexceptional rate, a unit of value halves in 14 years and declines to 1.5% in 100 years. The effect of this is that discounting causes the future value of current resources, for instance, to be insignificantly different from zero for the fourth generation from the current one. Distant generations simply drop out of consideration in current resource allocation decisions.

Whether this is an artefact of the discounting technique, revealing some logical flaw in its application, or not is a central question. Boulding's view was that the ethical thing to do was to employ a discount rate of zero since 'time-discounting is mainly the result of myopia and perspective' (1970, p. 284). He also acknowledged that this would be unlikely to happen.

The opposing view (eg Landsburg 1997) is that concerns we might have about this quirk of discounting are utterly naïve and fail to recognise the 'other side of the coin': future generations will be much, much more affluent than we via the same time-dependent processes and it is absurd for current generations to donate resources to such rich folk.

The qualitative dimension to do with squandering resources (ie, the possible irreversibility of the impacts) is not captured in this conversation. This is the burden of Boulding's point that capital-stock issues are under-emphasised. The emphasis in economic aspirations in society is on growth, output enhancement and input productivity enhancement. Discounting is principally used to evaluate alternative applications of resources to production. Resource *preservation* is not an alternative application unless it produces defined outputs such as environmental amenity (unless all applications considered yield negative returns).

In this analytical culture a typical response to expressions of concern about intergenerational equity is to contemplate ways in which resources might validly be valued. One approach is contingent valuation of 'existence values' for resources for factoring into decisions bearing on their use. This contains the same intergenerational arrogance as discounting: the valuing is undertaken by current generations. Bennett (2005) makes plain the distance yet to be travelled for non-market valuation to achieve relevance to environmental policy in Australasia. It is possible that the journey is endless.

A fundamental question arises from contemplation of how the preferences of the unborn can be accommodated: is there clearly market failure? If there is, and if attention to property rights cannot deal with it, there is a case for government intervention in resource markets to represent the interests of future generations.

Von Amsberg (1995) has published what amounts to a thought experiment related to a market in risk between generations. The introduction of risk into the consideration is an attempt to deal, at least partly, with the lack of relevant knowledge surrounding the issue. A notional insurance market is imagined in which there is information asymmetry. The earlier generation does not know what the state of the world will be for the subsequent generation which, of course, does. Preservation of resources, investment in dams, etc comprise insurance investment by the earlier generation for the subsequent generation. It comes at the cost of reduced consumption.

By considering the possible, if simplistic, alternative states of the world the later generation actually encounters, and rational behaviour by both generations in the notional market, von Amsberg demonstrates intrinsic market failure quite independent of any matters related to externalities. Assuming the possibility of trade between the two generations, market solutions would be inefficient. That is, they would fail to lead to equalised risk across the generations.

The direction of market failure effect is symmetrical; the current generation may over-invest or under-invest in insurance for the next generation. The former outcome arises when current risk exceeds the risk facing the next generation. Von Amsberg argues that natural capital depletion commonly has greater long-term than short-term risk. Sustainability, as one 'coordinated', rather than market, solution, is thus a solution offering greater efficiency than any market solution, since even the most appropriate market would be inefficient, in this assumed context of expanding risk through time.

The significance of this work is considered later in this report.

It seems clear, though, that the spectre of 'market failure' has caught the attention of those who know enough economics to realise that this can legitimately trigger government intervention in markets.

3.1 Market failure

Market failure refers to circumstances where there exist contextual characteristics that are judged to deny validity to the result of the free interaction of demand and supply in terms of resource and/or output allocation. It is used properly to describe a situation only when breaches can be identified of assumptions underlying the efficient operation of markets as allocative devices.

Market failure can arise from a variety of sources and can trigger careful analysis of implicit assumptions made by the market analysis experts, economists. For example, rationing by price under circumstances of sudden, short-term reductions in supply of a product (such as fuel) is typically quite unacceptable to most drivers in Australia. No such response occurs in the face of secular, long-term reductions in supply and increases in price. There is clearly a different preference function operating in each case with equity concerns being much more prominent in the former case. That is, the market efficiency construct has to cope with time-related, or duration-related, characteristics of market outcomes. That is, reliance on price to ration product may be perfectly efficient normally but inefficient when supply fluctuates aberrantly. Such issues are not explicit in economic theorising about markets.

A consequence of the fact that implicit assumptions may comprise a broad church is that market failure can have many sources. This does not enable 'market failure' to be used to describe any and all market outcomes that an individual dislikes. The source of the failure has to be fully specifiable. This is not least the case because the only alternative approach - command-based, rather than market-based, resource and output allocation - is so fraught with difficulty and risk of extreme inefficiency.

This is important because the natural ease with which most people seek rent[2] means that it is quite common for properly-functioning markets to deliver outcomes not to our personal taste and which we feel are therefore 'failing'. As well, most people do not understand the virtue of properly-functioning markets as allocative mechanisms.

A market fails, is 'inefficient', when there are grounds to project a difference between the market-determined levels of production and consumption and the socially-optimal levels. This implies that society's resources are being misallocated relative to society's preferences and its resource base.

Market failure does not automatically imply that there should be a response. It signals the need, arguably, to consider a response but whether a response is appropriate is another matter. This will depend on the damage done to efficiency, the reliability of responses as solutions to the problem and the cost of the solution relative to the damage done.

3.2 Market failure between generations

Among the variety of possible sources of market failure, of which Amsberg's information asymmetry is one, the most relevant to this topic relates to excludability in consumption.

Excludable goods are goods where consumption is controlled; access is not unfettered. Rationing exists. Non-excludable goods are those the access to which is not controlled. There is no rationing; non-payers can consume. Examples are large fireworks displays and star gazing.

[2] To seek rent is to seek privileging of one's own preferences in market operations.

While these terms seem to go to 'ability', this can change since excludability relates to institutional frameworks.

Market failure arises when goods are non-excludable. The absence of an institutional framework, whether market or enforced regulation, means that property rights to the good are either undefined altogether or fragile and not defensible. The implications for resource allocation depend on the rivalric quality of the good in consumption.

Rival goods are goods where consumption by one person denies the possibility of consumption of the same output by another. An ice-cream is an example. Non-rival goods are goods which can be consumed mutually by many consumers. A radio broadcast is an example. The rivalry status of a good is grounded in physical reality. It does not lead to market failure.

Ocean fish are an example of a good which is rival and non-excludable, the latter usually due to the cost of policing 'national' waters. The consequence is over-consumption, quite possibly to extinction. A common can be another example and the 'tragedy of the commons' the same over-consumption outcome (although a total absence of social norms must be assumed for the tragedy to manifest). Consumption is excessive because the economics and physical reality of production of the good (fish and agricultural resources, respectively) is not reflected in the price of the good because its 'owners' cannot enforce their property rights. Not all relevant costs inform the supply curve.

The only way the market can be made a valid allocative device in this circumstance is for property rights to be clarified and enforced. That is, for excludability to be created.

When a good is non-excludable and non-rival the outcome of market failure is the opposite (under-production) due to the ease with which consumers can consume for free. 'Free riding' exists when goods can be had at zero price. The fact that many can consume the product and none are impeded by institutional means implies that consumption does not involve property rights. While production will incur costs the unenforceability of property rights removes the ability to control who consumes and how many consume. The physical reality which causes star gazing to be non-rival in consumption troubles the capacity to make the good excludable. The cost of doing so is likely to be significant.

Wills (1997, p. 100) observes that '[i]f a non-rival good is non-excludable … market coordination of production and consumption is practically impossible.' Intervention is required directly to encourage desired production. There is no way for property rights to be reinforced such that a market mechanism can be used.

Recall, however, that excludability can change. As technology, costs and the perceived merit of excluding consumers change, identifying and excluding consumers can become feasible and acceptable.

When we consider the planet's resource base, and contemplate possible consumers as current and future generations, we plainly have market failure arising from non-excludability. If, in an ethical sense, the view is taken that distant future generations have entitlements to the planet's resources, to any degree at all, we have a situation where those property rights are unclear and unenforceable. Even within the current generation non-excludability is an issue. The already mentioned ocean fish, a renewable resource, and light crude oil, a finite resource, are non-excludable.

A priori, any belief that posterity has a legitimate property right in current resources, including renewable resource systems, directly implies market failure. Amsberg's paper is not seminal in this regard.

More interesting is the implication of the Spaceship Earth notion. It implies that, in contrast to the previous mainstream view, resource consumption across generations should be regarded as rival. As well, even resource consumption that might reasonably be conceptualised as non-rival within a generation, such as sand mining or land reclamation from the sea, should be viewed as rival between generations. The fact that it is not possible to know which current resources will be valued in future only emphasises the rationale.

The introduction of rivalry in consumption (of resources) between generations invites contemplation of ways in which property rights might be clarified and enforced. The situation is less 'desperate', in terms of relying on markets, than non-rival non-excludable consumption would have implied. That is, government intervention is not mandated a priori.

The key issue becomes one of creating excludability in consumption.

3.3 Creating intergenerational excludability

Excludability relies on controlling access to goods: making goods rationable. This can be achieved by either, or both, physical exclusion and penalisation of unauthorised users (Wills 1997, p.81).

Perhaps predictably, this notion crashes immediately into constraints arising from ignorance of future technology and preferences: which goods, which resources, are of interest here?

Meaningful consideration of this issue cannot proceed until adequate precision is introduced to the notion 'resources'. Physical resource scarcity of direct inputs is no longer widely contemplated to be a constraint on global living standards. Human population is still seen by many to be the key driver of pressure on resources but the major pressure is seen to be on resources that have historically been perceived to be part of the production context rather than direct inputs. 'We are now concerned with nonpoint-source pollution, habitat fragmentation, global climate change, ozone depletion, loss of tropical forests, and reductions in biodiversity' (O'Neill 1996, p. 1031). These resources and resource-producing systems appear to be groaning under the collective weight of the scaling up of economic activity across the planet over the last century, particularly.

Much of the concern relates to previously unwitting aggregate impacts on fundamental components of core ecological systems. It is the moving of these into our notion of inputs, recognising these as reserves rather than infinite flows, that validates Boulding's proposition.

The key word is 'scale'. A central related matter is the locus of relevant policy. Assuming resources are well-defined, excludability from resources is most problematic when we are contemplating resources at a large scale. In such circumstances our understanding of interactions between economic activity and the resource in question is most likely weak, and the vast multiplicity of users is likely to impede mechanisms to achieve excludability.

Generally, the more local the scale of a resource issue, for example, water catchment problems or salinisation of water tables and rivers, the greater the prospect of excludability and of the ability to use market-based instruments to manage rationing.

In terms of intergenerational equity, matters of local scale are irrelevant except to the extent that each is positively correlated with large-scale matters. This points to another complication: '[t]here seems no practical way to tell whether a farming practice [for example] which is apparently unsustainable by some local criterion is inconsistent with sustainability at the large scale' (Pannell and Schilizzi 1999, Section 3.1).

As the focus of concern moves to resource domains defined at increasingly large scales, the prospect that each will have some resource value to future generations increases but so does the likelihood that single components will not: substitution possibilities increase with the number of components. This means that optimal management by current generations must be based, inter alia, on information about substitution possibilities.

As scale increases, too, the locus of management decision making about resources inevitably needs to be elevated to some form of global or near-global institution.

From a practical, public policy perspective what sustainability implies for decision makers at different levels is a question of some moment. This is particularly so to the extent that non-excludability attracts non-market governance.

Von Amsberg's paper relates to this, making it plain that asymmetric information, which is part of the temporally special feature of intergenerational analysis, destroys the prospect of optimal market solutions even if property rights were in place and the generations could interact via an insurance market.

This means that there may be no basis available for valid exclusion from consumption; supply and demand cannot properly and fully be specified.

This is an extremely important consideration. The optimistic outlook for economic analysis created by the fact that resources can reasonably be regarded as rival is dashed by von Amsberg's insight. Analysis is being aspired to which must incorporate decision making about unknowables. The central issue is thus to do with decision making under uncertainty. Responses to the core issue can be evaluated in terms of their adequacy to this task.

Mainstream economists have sought to accommodate the problems posed by the endemic market failure in this domain. A recent review (Bennett 2005) reveals mixed success. Popular interest in specific component issues (eg, global warming, threats to species), the move to a higher profile than historically true of concerned physical scientists and the medium-term impossibility of political indifference to some of the issues have reduced the perceived relevance of mainstream economists to policy. Various parties are seeking answers *now*.

There is no sign amongst mainstream economists that a comprehensive revision of mainstream economic models and analytical frameworks is regarded as necessary to the task of dealing with intergenerational equity. The challenges posed are regarded as being to do with information, both about economy-environment interactions and about future contexts. Few economists seem to take the view that these challenges are resolvable by the construction of new theory.

4 Alternative Responses

To some observers economics thus appears to offer only unpalatable answers to the intergenerational equity question. Either discounting denies the issue altogether or ignorance of key parameters destroys the prospects of meaningful economic analysis: market failure exists but no reliable response can be identified. The pressure for policy that meets growing public concern has spawned some more appealing responses.

One class of response to this situation is to turn attention directly to the resource base itself. This has a certain appeal given that existing resource issues seem to be linked to questionable assumptions about how resources should be modelled for decision analysis in economics; economics seems to be part of the problem and economists loath to hear the systems theory story. The analytical framework, economics, seems to have displaced the reality it was intended to model: 'economics … is about to change the world to its own image' (Mattessich 1978, p. 239).

The core of this response is 'sustainability'. This is a broad church but one that is unified by the notion that economic activity should act on the environment in a way that is sustainable. Sustainability has been readily and widely adopted as 'a good thing'. This is hardly surprising. It is the answer to the rival good nature of the environment: it means 'take what you need until the capital stock is threatened'. That is, avoid rivalry in consumption of the resource. It requires that environmental goods be consumed in a way that carries no cost for future generations. It is a delightfully simple solution to the intergenerational rivalry problem.

Wills (1997, p. 53) has defined sustainability, from an anthropocentric perspective, as 'the maximum level of consumption (and hence well-being) that an economy can sustain forever, assuming that it is possible to substitute renewable natural resources and human-made assets for exhaustible resources.' The notion is absolute with no contemplation of short-term variation about the critical level.

The information poverty characterising the very resource threats to which such a goal might be applied causes this rubric to be useless as a policy guide. It can only work when missing information is assumed, implicitly or explicitly, to be irrelevant. In economic terms this means that relevant opportunity costs, financial and otherwise, are assumed away.

The implementation of policy predicated on naïve responses to the evaluation of resource management is beneath logical contempt. Responses which fail to contemplate the array of opportunity costs that bear on decisions about rates of resource use offer nothing to the discourse. Indeed, commonly it is the case that naïve admonitions to preserve the pristine nature of aspects of Nature imply increased rates of death in the developing nations of the world as a result of reduced economic growth (see below). Rational policy options related to sustainability are much less simple than most people presume. This is a public discourse being conducted by those in the front of Spaceship Earth, not the majority in the back.

Physical scientists are vulnerable to such naiveté because the focus of their knowledge is not optimising human-environment interactions. Their focus, rather, is on the physical world. It is not easy to avoid ecological fundamentalism when analysing the ecology is one's career.

Balancing this is fundamentalism amongst technological optimists who reject any prospect of irreversible impacts on the planet's resource base. This includes some economists who know only the technology of economic optimisation.

4.1 Ecological Economics

Ecological economics is said to be 'the science of sustainability'. It is a reaction against mainstream economic analysis of resource issues (natural resource and environmental economics) and protagonists aspire to a more coherent approach than simple advocacy of sustainability allows. Explicit recognition of the greater whole offers the prospect of optimisation of behaviour in a more holistic sense. If better framing of the issues is possible than mainstream economics offers, it will be in ecological economics or nearby.

Explicit modelling of economy-environment interactions may eliminate the danger of partial analysis when the economy and environment are modelled distinctly. Systems simulation (also called 'system dynamics' and 'industrial dynamics') plays a central role in the analytical orientation of this discipline (see Mattessich 1978). *The Limits to Growth* (Meadows et al. 1972) was an early manifestation.

Ecological economics is firmly rooted in epistemological argument for holism in applied research. This, in turn, is driven by the need to expose all subjectivity in science, and hence create an evaluative context for partial analysis, in the interests of transparency. Even in the face of the impossibility of comprehensive modelling of environments, such an approach is argued to be preferable to less transparent, seemingly more powerful, partial approaches (Mattessich 1978).

Thus, Costanza (2001, p. 459), a founding father of ecological economics, discusses 'preanalytic visions' as being central to 'uncertainty about current environmental policies'. These visions capture our perceptions of the way the world works. The hypothetico-deductive approach is explicitly rejected and the identification of useful, quality models, rather than truth, is proposed to be a valid and meaningful scientific objective. Use and quality is tested on '(1) testability, (2) repeatability, (3) predictability, and (4) elegance [parsimony]' (Costanza 2001, p. 460) against real world applications. It is only possible to model small parts of the world.

This 'pragmatic' approach to scientific enquiry begins with Boulding's point: 'remaining natural capital is a limiting factor' (Costanza 2001, p. 459), a rival good.

The proposed 'preanalytic vision' among ecological economists is argued to be an elaboration of the predecessor conventional economic vision. The latter is described as follows.

> *The primary factors of production (land, labor, and capital) combine in the economic process to produce goods and services, usually measured as gross national product (GNP). GNP is divided into consumption, which is the sole contributor to individual utility and welfare, and investment,which goes into maintaining and increasing the capital stocks. Preferences are fixed. In this model, the primary factors are perfect substitutes for each other, so "land"*

> *(including ecosystem services) can be almost ignored, and the lines between all the forms of capital are fuzzy. Property rights are usually simplified to either private or public, and their distribution is usually taken as fixed and given.*

Costanza (2001) p. 460

In an ecological economics vision

> *the key elements of the conventional view are still present, but more has been added and some priorities have changed. There is limited substitutability between the basic forms of capital in this model, and their number has expanded to four. Their names have also changed to better reflect their roles: (1) natural capital (formerly land) includes ecological systems, mineral deposits, and other aspects of the natural world; (2) human capital (formerly labor) includes both the physical labor of humans and the know-how stored in their brains; (3) manufactured capital still includes all the machines and other infrastructure of the human economy; and (4) social (or cultural) capital. Social capital is a recent concept that includes the web of interpersonal connections, institutional arrangements, rules, and norms that allows individual human interactions to occur (Berkes and Folke 1994). Property rights regimes in this model are complex and flexible, spanning the range from individual to common to public property. Natural capital captures solar energy and behaves as an autonomous complex system, and the model conforms to the basic laws of thermodynamics. Natural capital contributes to the production of marketed economic goods and services, which affect human welfare. It also produces ecological services and amenities that directly contribute to human welfare without ever passing through markets. The model also accounts for waste production by the economic process, which contributes negatively to human welfare and has a negative impact on capital and ecological services. Personal preferences are adapting and changing, but basic human needs are constant. Human welfare is a function of much more than the consumption of economic goods and services.*

Costanza (2001) pp. 460-2

The appropriate objectives to be pursued are contrasted to that said to obtain in conventional economic analysis, the maximisation of individual utility.

> *There are at least three broad goals that have been identified as important to managing economic systems within the context of the planet's ecological life support system (Daly 1992):*
>
> *1. assessing and ensuring that the scale or magnitude of human activities within the biosphere is ecologically sustainable*
>
> *2. distributing resources and property rights fairly, both within the current generation of humans and between this and future generations, and also between humans and other species*
>
> *3. efficiently allocating resources, as constrained and defined by the two goals above, including both marketed and nonmarketed resources, especially ecosystem services*

Costanza (2001) pp. 462

The proposition that '[c]onventional economic value is based on the goal of individual utility maximization' (Costanza 2001, p. 462) is misleading. Utility maximisation is the model of human behaviour assumed and adopted in 'conventional economics'. It is a mechanistic model with analogues in psychology (eg Sigmund Freud), political science (eg Machiavelli) and management (eg Douglas McGregor).

The contrasting of this 'goal' with those above in ecological economics is logically fallacious. It is a confusion of preferences with utility and leaves dangling the question every social science must answer: what is the mechanism that links purposive human behaviour and the phenomenological world? A listing of one group's perceptions of what mankind should prefer does not comprise an answer.

To caricature economics in this way is unhelpful and self-serving. It reflects ignorance of the works of Adam Smith, the father of the notion that self-love drives economic activity (see Evensky 2005 and Ashraf et al. 2005), and obliterates the need to contemplate competing modes of analysis of sustainability issues, such as conventional economics. It is a mere rhetorical device rather than epistemological argument.

'Conventional' economists have displayed considerable noblesse oblige, perhaps unfortunately: '[d]ifferences between [conventional economists and ecological economists] centre on concerns of those adhering to the neoclassical framework about the "breaches" made by ecological economists. For instance, some ecological economists object to the concept of trade-offs accepted by neoclassicists in instances when they have a prior objection perhaps on ethical grounds to a potential outcome' (Bennett 2005, p. 250). (Not all have been quite so dispassionate; see Ben-Ami 2004.)

Ecological economists focus explicitly on sets of assumptions (Table 1) which they believe comprise the extreme positions of technological optimists and pessimists (or skeptics).

Table 1. Some characteristics of two basic worldviews.

Technological optimist	**Technological skeptic**
Technical progress can deal with any future challenge	Technical progress is limited, and ecological carrying capacity must be preserved
Competition is guiding principle	Cooperation is guiding principle
Systems are linear, without discontinuities or irreversibilities	Systems are complex, nonlinear, with discontinuities and irreversibilities
Humans dominate nature	Humans are in partnership with nature
People are out for themselves	Community comes first
Market is guiding principle	Market serves larger goals

Adapted from Costanza (2001) p. 464

Implicit in this schema is the notion that conventional economists are optimists, as is evident from their failure to deal with major uncertainties that ecological economists focus on (and seek to deal with using their set of goals). There is certainly validity in the charge that uncertainty has yet to be addressed adequately in mainstream environmental economics, particularly in non-market valuation research (Bennett 2005, p. 255) which is where much of 'the action is' with respect to intergenerational concerns, of course.

Based on these sets of assumptions and their concordance or not with reality, a set of alternative scenarios can be derived. These are described in Table 2.

Table 2: Four visions of the future based on two basic worldviews and two alternative states of the real world

	Real State of the World	
Worldview and Policies	***Optimists are Right*** (Resources are unlimited)	***Skeptics are Right*** (Resources are limited)
Technological Optimism	**Star Trek:** Fusion energy becomes practical, solving most economic and environmental problems. Leisure time increases because robots do most work. Humans colonize the solar system, where population continues to expand.	**Mad Max:** Oil production declines and no affordable alternative emerges. Financial markets collapse and governments weaken, too broke to maintain armies and control desperate, impoverished populations. The world is run by transnational corporations, whose employees live in guarded enclaves.
Technological Skepticism	**Big Government:** Governments sanction companies that fail to pursue public interests. Fusion energy is slow to develop because of strict safety standards. Family planning programs stabilize population and progressive taxes equalize incomes.	**Ecotopia:** Ecological tax reform favors ecological beneficent technologies and industries and punishes polluters and resource depletion. Habitation patterns and increased social capital reduce need for transportation and energy. A shift away from consumerism reduces waste.

Source: Costanza (2001) p. 465

For Costanza the value of this speculation is captured in the following.

> *The major source of uncertainty about our current environmental policies is at this level of visions and worldviews, not in the details of analysis or implementation within a particular vision. By laying out four alternative future histories of the Earth, the critical assumptions and uncertainties underlying each vision can be more easily seen and a rational policy can be set to assure sustainability.*
>
> *A cooperative, precautionary policy set that assumes limited resources is the most rational and resilient course in the face of fundamental uncertainty about the limits of technology.*

Costanza (2001) p. 467

It could be argued that ecological economics is a long-winded way of assembling compulsory elements of objective functions and constraints to be employed in analysis of resource use. To this extent it comprises a specific decision strategy rather than a theory and offers no novel solution to the information poverty problem. It is difficult to detect the 'science' it brings to the sustainability notion

4.2 An evaluation

Leaving aside non-renewable resources for the moment, the notion of 'carrying capacity' of resources is central to sustainability and ecological economics. In the context of intergenerational equity sustenance is a clearly anthropocentric idea. Indifference to the persistence of humankind does not exist and the notion that sustainability may relate to the equal rights of all species (the 'deep green' approach) is irrelevant to this analysis.

In this pragmatic context our concern is to not excessively impact on the output possibilities facing future generations. The popular conceptualisation of sustainability refers to the maintenance of levels of input availability to successive generations. However, this is too casual an inference. Implicit in this specific translation of a concern not to steal from future generations is a variety of assumptions: that 'inputs' are well defined and thus technology is well defined; that preferences for outputs are well defined; and that the impact of resource-consuming activity on resource levels is well defined.

Defining theft from the future hinges on the fact that it is possible to know what the future will value and that we can judge excessive current use. Neither is true for the near future, much less the distant future. We face uncertainty in the present which increases the farther ahead we look.

Exhaustible or non-renewable resources can be dealt with under sustainability only by their replacement by other exhaustibles, renewable resources or recycling. There is no metric that can allow us to optimise intergenerational consumption of non-renewable resources. (The only conceivable guide is that contained in the Hartwick rule: all rent (the scarcity value) from exhaustible resources harvested must be invested in reproducible capital. But see Asheim et al. 2002 and Brätland 2005 for challenges, respectively, to its operability and consistency with acceptable treatment of property rights.)

Superficially, the key issues to sustainability as a rational policy objective are irreversibility and substitution. These are closely related. Also involved is factor productivity. These are the key determinants of appropriate ways to contemplate the interaction between economic activity and natural resources.

The scarcity of any input is a function of the level of output desired, the amount of the input required per unit of output (factor productivity) and the amount of the input available at the prices likely to be paid for it. Factor productivity varies with technological change.

Much that needs to be known to move towards rational resolution of the intergenerational equity issue is not known. A good deal is known, however, about productivity.

5 The Cost of Slowing Growth

Increased economic well-being has been driven substantially by increasing total factor productivity. In 1800 US GDP per capita has been estimated (Johnston and Williamson 2005) at $1,148 in 2000 US dollars. In 2004 it was $36,627, showing a compound annual growth rate of 1.7%. The same growth rate has been achieved by Japan since 1870, Brazil since 1900 and India since 1945 (Easterlin 2000b). The UK and France have grown per capita GDP annually at 1.3% and 0.9%, respectively, since 1820 (Easterlin 2000b).

Table 3 summarises world growth rates in per capita GDP over the period 1950 to 1995.

Table 3: Growth Rate of Real GDP Per Capita, Major Areas of the World, c. 1950–1995, and Share of World Population, 2000

	Annual Growth Rate (%)	**Ratio: Per Capita GDP at End to Beginning**	**Share of World Population (%)**
More developed areas[1]	2.7	3.1	20
Less developed areas[2]	2.5	2.9	80
China	3.8	5.0	21
India	2.2	2.5	17
Rest of Asia	3.7	4.6	21
Latin America	1.6	1.9	9
Northern Africa	2.1	2.4	2
Sub-Saharan Africa	0.5	1.2	11

1. Composed of northern America, Japan, Europe, Australia and New Zealand.

2. All other nations. Caribbean nations are included with Latin America; Melanesia, Micronesia and Polynesia under Rest of Asia (which excludes Japan).

Adapted from Easterlin (2000b) p. 11

What is plain from the table is that the last half century has been an economic watershed for humankind with even Sub-Saharan Africa, the laggard area, achieving growth rates in productivity in excess of those achieved prior to the major turning point in the productivity history of all nations (see Easterlin 2000b).

Easterlin (2000b) reports the even more substantial rates of increase in life expectancy, speedy increases in rates of decline in fertility rates and major qualitative changes in lifestyles that correlate with these changes in productivity. (This is not to argue that productivity drives quality of life – see below.)

'By most measures here, the rates of change in the less developed countries in the last half century have substantially exceeded those in the historical experience of western Europe. If there are limits to growth in the standard of living – an imminent stationary state – it is not evident in the historical record' (Easterlin 2000b, p.23).

Increasing productivity has overrun constraints expected of the resource base, and begun to resolve unacceptable output distribution (i.e. poverty), posed by extraordinary population growth. Through its second-round effects on life expectancy (particularly in infancy), education and social institutions supporting the aged (in some nations), productivity growth has created a social dynamic that will cause world population to stabilise (most likely by 2300 at about 9 billion people (United Nations 2004)). See Galor and Weil (2000).

Easterlin (2000a, p. 3) draws an interesting analogy: 'The current environmental movement bears a strong resemblance to the public health movement of the nineteenth century, which was precipitated by the sanitation and crowding problems of rapid urbanization. These earlier problems were in the course of time successfully solved by advances in technological knowledge and social organization, most notably by the establishment of a public health system (Easterlin 1999). It is perhaps optimistic to suppose that a similarly successful response will be made to environmental degradation, but clearly substantial resources are currently being devoted to the problem, and the outlines are emerging of needed new technologies, institutions, and public policies to deal with it.'

Sustainability advocates seem often to take the view that salient thresholds of sustainability have already been breached or that part of relevant uncertainty is that they may have been. The implication of this is that any proper accounting for capital-stock depletion (erosion of minimal resource levels) would discount the growth rates in real per capita GDP. That is, some of the productivity growth should not have been achieved. This can only be valid to the extent that depletion has been irreversible.

Plainly, both in the last 50 years and in the 1800s, economic growth has occurred in ways that generated unexpected negative externalities. True productivity was overstated to that extent. The obverse is also true. True productivity has been understated to the extent that economic growth has generated unexpected positive externalities. Individual longevity is an outstanding example: the global average life expectancy at birth in the early 1950s was 41 years and, by 2000, 62 years (Easterlin 2000a).

The compounding beneficial effects of global economic growth have, like the deleterious effects on the world's ecology, been profound. One cannot sensibly contemplate either separately.

6 Policy

Humankind is confronted with an awkward decision problem: environmental impacts of economic growth are becoming clear and, while their long-term implications are uncertain, the opportunity costs for humankind of arresting growth to address the impacts are substantial. As Ben-Ami (2004, p. 1) suggests '[t]he notion that economic growth has to be curtailed is tragic when billions still live in dire poverty.'

However, the notion of critical limits applying to ecological systems invites absolute responses. A clear manifestation of this is the Precautionary Principle. In the Australian context this has been defined as follows.

> *Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*
>
> *In the application of the precautionary principle, public and private decisions should be guided by:*
>
> *(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and*
>
> *(ii) an assessment of the risk-weighted consequences of various options.*
>
> Commonwealth of Australia (1992) para 3.5.1

As Wills points out, this approach is only assured of being rational if the uncertainty with which it is intended to deal is non-existent. Prudent application requires 'information about, first, the magnitude of the present costs of precautionary measures, and, second, the future consequences, costs and benefits of precautionary … policies' (Wills 1997, p. 237). In the example of the global warming issue, there is uncertainty related to the cost of emission control (due to consequent economic and social dislocation) and to future consequences, due to poor understanding of climate change and lack of foresight about future technology and human responses to climate change (Wills 1997).

It is entirely possible that precautionary measures do nothing but incur current costs for the dubious, but politically real, benefit of 'narrowing the perceived range of possible events and outcomes' (Wills 1997, p. 237).

When the Precautionary Principle is applied to technological innovation (the main source of productivity growth), its implications are potentially severe. Strictly applied, it abolishes contemplation of upside risk associated with innovation. The prospect of balancing positive and negative consequences, where the latter may knowingly be entertained, is obnoxious to this principle. Infinite negative utility is being attached to possible negative effects on the ecology. This implies that there is no scope for allowing any further damage to be done to the ecology: if we are not at a cliff's edge, we don't want to find out by perhaps falling over it.

Irreversibility is central to this. Also central is fearfulness or pessimism and conflation.

Irreversibility occurs when current economic activity reduces future options. It can only be defined when desired outputs of the core system are well defined. The notion refers to the incapacity of a resource source to continue to provide the resource. This requires the valued characteristics of the resource to be known, including volumes required. That is, projections of technology (and associated input:output relationships) are critical.

The attention to optimism and pessimism in ecological economics is appropriate. In the face of uncertainty so central to future resource adequacy, more fundamental analysis than speculative attachment of probabilities to quite ambiguous futures is required. The calculus of mainstream decision theory simply runs out of analytical steam in the context of such uncertainty (Wright 1983).

This is not a scientific problem, however. It is a management problem.

Proposing alternative models of reality, as do ecological economists, goes to a number of problems related to the quality and usefulness of research but coping with irreducible uncertainty is not one of them. Arguably, ecological economics offers no solution. In fact, it may reify the problem. This arises from conflation.

The sustainability literature is populated with a good deal of generalised concern about 'the resource base'. This glides easily into an inclination to attribute intrinsic merit to current natural resource systems. This is unlikely to provide an adequate base for rational decision making. Both tendencies arise in a context of considerable ignorance about relevant biophysical systems and their long-term dynamics and about the impacts of economic activity on them. Which bits of the set of resources should we worry about?

The widespread alarm about global warming is a good example. Much of the blossoming popular concern about global warming appears to be grounded in climatic fundamentalism: change is abhorrent, whatever its net affects on humankind. It is thus heretical to seek to know, for example, what 'runaway global warming' means and why it matters.

7 Conflation

Philosophers, as one might expect, have long contemplated the relationship between man and Nature. Only recently, however, has the 'third power', or compounding effect of technology been addressed directly (Ihde 1979):

> *[Francis] Bacon did not anticipate this profound paradox of the power derived from knowledge: that it leads indeed to some sort of domination over nature (that is, her intensified utilization), but at the same time to the most complete subjugation under itself. The power has become self-acting, while its promise has turned into threat, its prospect of salvation into apocalypse.*
>
> Jonas (1976) p. 84

Jonas (1976), said to be the philosophical father of the German environmental movement, argues that man is in some sense responsible to care for Nature:

> *Such narrowness in the name of man, which is ready to sacrifice the rest of nature to his purported needs, can only result in the dehumanization of man, the atrophy of his essence even in the lucky case of [his] biological preservation.*
>
> Jonas (1976) p. 77-8

This claim to ethics prompts Ihde (1979) to focus on what Nature comprises and how extensively this ethical claim can be made. This applies directly to the position adopted by those supporting intergenerational equity. He posits a range with a 'minimal Nature', that which is barely necessary to sustain life, at one extreme and 'total Nature', where 'we owe allegiance to the kindred *total* of [nature's] creations' (Jonas 1976, p. 78), at the other.

What distinguishes each point in the range beyond the minimal end-point is the amount of aesthetic, man-enriching elements of Nature. Human enrichment, he argues, has merit but it does not constitute an ethical requirement: it 'lack[s] the "bite" of the lower level of necessity. It is an appeal to relative richness or variety' (Ihde 1979, p. 136); arguably the 'normal good' referred to previously.

Jonas argues that technology, in essence, has got out of hand and that 'we need today an imaginative-anticipatory heuristics of fear to lead us to the discovery of the duties, even the principles, with which to meet the challenge of coming events' (Jonas 1976, p. 87). Ihde (1979, p. 139) detects significant parallels with the Fall of man and the need for recovery 'either by Law and fear or Faith and Grace': a new ethics. (The reader will detect significant parallels with Costanza's alternative futures, above.)

'It is an ethics which is not only based upon an ethics of fear, but is a fearful ethics. It is an ethics which in response to what Jonas perceives as the heightened ambiguity of the contemporary situation, the heightened complexity of the human situation, and the heightened uncertainty of more and more long term projections, reverts to what I shall call a strategy of conservatism which essentially advises: if we cannot make long-term projections in the light of uncertainty, it is doubtful that we ought to undertake the actions beyond a certain magnitude at all.

'Jonas states this as: "Never must the existence of the essence of man as a whole be made a stake in the hazards of action. It follows directly that bare possibilities of the designated order are to be regarded as unacceptable risks which no opposing possibilities can render more acceptable" [Jonas 1976, p. 87]. But here we return to the previous confusion of conflated levels. What decision could possible risk the whole essence of man? If we mean the bare existence of man in minimal Nature, then such technologies which might threaten the entire biosphere (nuclear warfare and destruction of oxygen producants (sic) in the ocean) might well fall under the question of the strategy of conservation. But if we mean the unstunted, enriched essence of man with respect to the totality of Nature, then we mean any technology at all! This is because any technology raises a question with respect to man's essence. It is here that the near absolutism of this new, old ethic begins to come clear. Ultimately, it is an apocalyptic ethic which as with all apocalypses poses a clear either/or.' (Ihde 1979, p. 139.)

This is, in effect, a discussion about the Precautionary Principle and about the selection of goals which ecological economists have proposed as simply more appropriate and informed. The former is more transparent: it is a decision strategy. Ecological economists, though, are proposing a radical ethical position as 'pragmatic' science.

8 Uncertainty

The appeal to intergenerational equity with respect to distant generations is arguably the weakest basis for seeking to address sustainability. As we move to contemplate very distant generations relevant uncertainty explodes. Even the notion of 'minimal Nature' loses practical meaning. As well, and it is possible that proponents are not unaware of this rhetorical effect, the appeal to intergenerational equity sweeps *total* Nature into the frame. The reference to undefined future generations forbids specification of which parts of the environment, and to what extent, actually matter. The logical flaw, of course, is that 'no parts' becomes a possible valid member of the set.

This reinforces the naiveté of seeking risk averse policies, and aspiring to make optimal choices, relying on formal analysis under substantial ignorance.

In the long run the distinction between renewable and non-renewable resources blurs. Species disappear and ecosystems change. One part of the static perspective that underlies sustainability is ignorance of the randomness and change that characterises the ecology. There would seem to be no case, on the grounds of sustainability, for interference with such evolutionary ecological processes.

Since the identity of valued inputs cannot be projected into the future very far, the aspiration to care about the impacts of current activity on future generations begs a question: impacts on what? What should we sustain? This question has immediate relevance for intra-generational equity as well: equity with respect to what?

This question is central for two reasons. One is the point just made: how should one frame the target of sustenance when the preferences, technology and inputs needed in the future are unknown? This predictable ignorance of the future implies that there may be considerable ecological fundamentalism or fearful conservatism, rather than equity concerns, driving the wish for sustainability.

The other reason relates to opportunity cost. Sustainable resource use means reduced resource consumption relative to the level that would otherwise obtain. Current levels we can assume are near-optimal given prevailing technology and prices; there is no incentive to squander resources. If there is to be a preferred different level of resource use it must be less, logically. This implies reduced aggregate economic output.

Many advocates of sustainability approach sustainability as though it were a stylistic choice with no costs. This is naïve and not consistent with the closed-system, rival-good basis for the concern in the first place. The whole issue is characterised by zero-sum-game characteristics. As well, the temporal dimension introduces compounding. Reasonable people may differ as to appropriate discount rates to apply to choices involving more than one generation; there is *no* scope for debate about the direction of the compounding effect of reduced economic output.

This, alone, creates a need for sustainability advocates to examine closely the costs of reduced current resource use.

Ecological economists confront this directly: they acknowledge that sustainability requires restrictions on long-run economic growth (Costanza et al. 1997). To the anticipated observation that this implies reduced circumstances for humankind ecological economists argue that maximising economic growth is an inappropriate social objective. Instead, total welfare has to be calculated with proper accounting for resource depletion or, for some writers, modification of human aspirations to better reflect the demands arising from ecosystem maintenance. That is, our valuation of current wealth is wrong so we are not well placed to value reductions in it or changes to it in its context. This is casuistry.

The basis for this approach is that economic growth is a construct that has evolved in an environment where resources were not seen as rival goods. That is, further adaptation by humankind is required to achieve a long-term feasible economy. The notion of a 'growth fetish' (Hamilton 2003) is introduced into the debate.

In the context of this review, suggestions that people have been seduced by marketers into defining happiness by material possessions (see Hamilton 2003) or, more insightfully, that the intrinsic valuation of money, rather than valuation for its instrumental use, with increasing wealth will come to be seen as a 'disgusting morbidity' (Keynes 1931), are propositions that co-exist happily with less growth and greater valuation of Nature per se. However, it is a considerable leap from here to seeking mandated reductions in growth, even among those in the front of the Spaceship.

This is a radical assertion in that it implies a totalitarian response: some institution moderating economic behaviour because, in its unfettered form, it will collapse the global common. The extremeness of this posture arguably arises from the need to eliminate, or at least reduce, opportunity cost from advocacy of sustainability since benefits cannot be valued.

9 Summary

There is clear, widespread concern in developed economies that the natural resource base is under pressure. Deterioration arising from human economic activity seems to be visible. To most people this seems to be intrinsically undesirable and indicative, therefore, of flaws in private and public resource allocation. 'Sustainability' is a policy target that matches perfectly the concern. There is a delightful symmetry in the vagueness of both concern and solution.

The intellectual explanation for the concern is that it challenges intergenerational equity and analysis clearly reveals that there is endemic market failure associated with resource allocation across generations. The intellectual explanation may not be the real trigger for concern. It is possible that the concern is intrinsic conservatism amongst people with high standards of living who, now, feel less dependent on resource-exploitative economic activity.

Whatever the case, there *is* an intergenerational equity problem, there *is* market failure and there *is* a need for intervention in markets to achieve excludability in resource consumption which subsequent generations cannot possibly effect, themselves, on their predecessors.

The closed system character of Earth and its Sun signals limits and readily triggers considerable fear of irretrievable loss of essential resources. When it does, relevant uncertainty can lead to a generalised negative response to consumption of the resource base. The spectre of infinite negative utility haunts observation of economic activity. Practically, in its extreme form, this translates into infinite utility attaching to total resource preservation. (The difference between this (deep green) position and weaker forms is that the former is logically consistent.)

Rational accommodation of the reality of possible irreversibility of damage to resource bases requires appropriate valuation of resources. With this, mainstream economic analysis is perfectly capable of overcoming market failure. Such valuation is impossible. All valuation is current-generation bound.

Ecological economics is a discipline developed explicitly to overcome this barrier. It emphasises the merit of explicitly and thoroughly contextualising economic activity in its social and ecological milieu. Unfortunately, this solves the wrong problem and forces ecological economics towards a religious position, and away from science, whereby desired policy outcomes are a component of the discipline. There is no reduction in relevant uncertainty. There is only an argument in support of intrinsic values.

The defining characteristic of populist, and physical scientists', discourse on sustainability is lack of attention to the opportunity cost of resource preservation. This is particularly helpful to these proponents when a great deal about economy-environment interaction is unknown, partly known or wrongly known. Opportunity cost is the denial of intrinsic value. Strident virtuous positions struggle for air when opportunity costs are understood to exist.

The challenge for economists, on the other hand, is dealing with irreversibility.

The political response inevitably tends to reflect the populist view in domains as intensely debated as this. Thus, the Precautionary Principle and commitments to undefined sustainability have blossomed in government responses. Both are vague or silent on costs. It cannot be otherwise because relevant uncertainty persists.

Both are strategic decision making responses to uncertainty. The Precautionary Principle is so conservative a strategy as to be pre-Enlightenment. Sustainability is so inadequately defined as to be meaningless as a guide to action. As Pannell and Schilizzi (1999, Section 5) suggest '"[s]ustainability" is at once extremely important and practically useless'.

As political public relations responses to public alarm both work well: government is seen to be alert to the issues and to be doing something.

Of concern, however, is that, to the extent that they may be operationalised, their rationality as decision strategies is not apparent. It would be of concern if the possible consequence of irrationality were simply excessive resource preservation. Unfortunately, the issue is not an intrinsic value issue; there are opportunity costs. A possible consequence is perverse outcomes, including the imposition of substantial costs on members of current generations who live in absolute poverty.

10 References

von Amsberg, Joachim (1995), 'Excessive environmental risks: an intergenerational market failure', *European Economic Review* 39, pp. 1447-64.

Arrow, Kenneth, et al. (2004), 'Are we consuming too much?', *Journal of Economic Perspectives* 18(3), pp. 147-72.

Asheim, Geir B., Buchholz, Wolfgang and Withagen, Cees (2002), 'The Hartwick Rule: myths and facts', Discussion Paper 52, Tilburg University, Center for Economic Research. Retrieved on 12 December, 2005 from http://greywww.kub.nl:2080/greyfiles/center/2002/doc/52.pdf

Ashraf, Nava, Camerer, Colin F. and Loewenstein, George (2005), 'Adam Smith, behavioural economist', *Journal of Economic Perspectives* 19(3), pp. 131-45.

Ben-Ami, Daniel (2004), 'The dismal quackery of eco-economics', *spiked essays*. Retrieved on 16 August, 2005 from http://www.spiked-online.com/Articles/0000000CA750.htm

Bennett, Jeff (2005), 'Australasian environmental economics: contributions, conflicts and "cop-outs"', *Australian Journal of Agricultural and Resource Economics* 49(3), pp. 243-61.

Berkes F. and Folke C. (1994), 'Investing in cultural capital for a sustainable use of natural capital' in Jansson A.M., Hammer M., Folke C. and Costanza R, eds. *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, Island Press, Washington (DC), 128–49.

Boulding, Kenneth E. (1958), *Principles of Economic Policy*, Prentice-Hall, New Jersey.

Boulding, Kenneth E. (1970), Beyond Economics: Essays on Society, Religion, and Ethics, Ann Arbor Paperback.

Brätland, John (2005), 'On method and ethics in Rawlsian investment rules designed to achieve "intergenerational equity"', Working Paper. Retrieved on 12 September, 2005 from http://www.mises.org/journals/scholar/Bratland4.pdf

Commonwealth of Australia (1992), *Intergovernmental Agreement on the Environment*, AGPS, Canberra.

Costanza, Robert (2001), 'Visions, values, valuation, and the need for an ecological economics', *BioScience* 51(6), pp. 459-68.

Cutler, David M. and Sheiner, Louise (2000), 'Generational aspects of Medicare', *American Economic Association Papers and Proceedings*, May, pp. 303-7.

Daly, Herman E. (1992), 'Allocation, distribution, and scale: Towards an economics that is efficient, just and sustainable,' *Ecological Economics* 6, pp. 185-93.

Department of Environment and Heritage (1992), *National Strategy for Ecologically Sustainable Development*. Retrieved on 15 November, 2005 from http://www.deh.gov.au/esd/national/nsesd/strategy/index.html

Easterlin, Richard A. (1999), 'How beneficent is the market? A look at the modern history of mortality,' *European Review of Economic History*, December 3:3, pp. 257-294.

Easterlin, Richard A. (2000a), 'Where is economic growth taking us?', Paper presented at the Mount Holyoke conference on The World Economy in the 21st Century: Challenges and Opportunities, 18-19 February.

Easterlin, Richard A. (2000b), 'The worldwide standard of living since 1800', *Journal of Economic Perspectives* 14(1), pp. 7-26.

Evensky, Jerry (2005), 'Adam Smith's *Theory of Moral Sentiments*: on morals and why they matter to a liberal society of free people and free markets', *Journal of Economic Perspectives* 19(3), pp. 109-30.

Galor, Oded and Weil, David N. (2000), 'Population, technology and growth: from Malthusian stagnation to the demographic transition and beyond', *American Economic Review* 90(4), pp. 806-28.

Hamilton, Clive (2003), *Growth Fetish*, Allen and Unwin, Sydney.

Hicks, John (1980), *Causality in Economics*, Australian National University Press, Canberra.

Ihde, Don (1979), *Technics and Praxis*, D. Reidel, Dordrecht.

Johnston, Louis D. and Williamson, Samuel H. (2005), 'The Annual Real and Nominal GDP for the United States, 1790 - Present.' Economic History Services, October. Retrieved on 16 November 2005 from http://www.eh.net/hmit/gdp/

Jonas, Hans (1976), 'Responsibility today: the ethics of an endangered future', *Social Research* 43(1).

Keynes, John Maynard (1931), *Essays in Persuasion, part V*. Reprinted in Keynes, John Maynard (1972), *The Collected Writings, vol. IX*. Macmillan, London.

Kotlikoff, Laurence J. and Raffelhüschen, Bernd (1999), 'Generational accounting around the globe', *American Economic Association Papers and Proceedings*, May, pp. 161-6.

Landsburg, Steven (1997), 'Tax the knickers off your grandchildren; if income distribution is such a good idea, let's make those rich future generations pay', *Slate Magazine*, 7 March. Retrieved on 13 December, 2005 from http://www.slate.com/id/2036/

Mattessich, Richard (1978), *Instrumental Reasoning and Systems Methodology: An Epistemology of the Applied and Social Sciences*, D. Reidel, Dordrecht.

Meadows, Donella H., Meadows, Dennis L., Randers, Jørgen and Behrens III, William W. (1972), *The Limits to Growth: A Report for The Club of Rome's Project on the Predicament of Mankind*, Earth Island, London.

O'Neill, R. V. (1996), 'Perspectives on economics and ecology', *Ecological Applications* 6(4), pp. 1031-3.

Pannell, David J. and Schilizzi, Steven (1999), Sustainable agriculture: a question of ecology, ethics, economic efficiency or expedience? *SEA Working Paper 97/01*, Agricultural and Resource Economics, University of Western Australia. Retrieved on 13 December, 2005 from http://www1.crcsalinity.com/newsletter/SeaNews/spap971f.htm

The State of Victoria Department of Sustainability and Environment (2005), *Our Environment; Our Future: Victoria's Environmental Sustainability Framework*, Victorian Government, Melbourne.

United Nations (2004), *World Population in 2300*, Department of Economic and Social Affairs, New York.

Wills, Ian (1997), *Economics and the Environment: A Signalling and Incentives Approach*, Allen and Unwin, Sydney

Wright, Vic (1983), 'Some bounds to the relevance of decision theory', *Australian Journal of Agricultural Economics* 27(3), pp. 221.