2 POLICY CHOICE ABOUT CLIMATE CHANGE MITIGATION

Key points

The central policy issue facing the Review can be stated simply: what extent of global mitigation, with Australia playing its proportionate part, provides the greatest excess of gains from reduced risks of climate change over costs of mitigation?

Answering the question draws on our capacity to model conventional economic effects, to measure and to value uncertain outcomes, to value effects that are not felt through markets for goods, services or factors of production, and to value costs and benefits incurred and received by different people at different times.

This chapter puts forward a framework for looking at these issues. It favours transparent reporting of the premises of subsequent discussion, and the introduction of analysis of the sensitivity of outcomes to variables.

The reserves and resources of fossil fuels are finite, which means that their costs are likely to rise over time. This reduces the costs of mitigation, which brings forward an inevitable eventual adjustment away from fossil fuels.

How do we assess whether Australian mitigation action is justified? Would the substantial costs of mitigation be exceeded by avoided costs of climate change? What degree of mitigation would lead to the largest net benefits?

These turn out to be immensely complex questions. The answers are affected by judgments about the prospects for effective international mitigation. They depend on the efficiency of the means chosen to achieve reductions in greenhouse gas emissions, including supporting measures that affect the market response to the mitigation regime, and therefore on the costs of achieving various levels of abatement. They depend on the efficiency of supporting measures that determine how equitably the costs of mitigation are distributed across the Australian community, and on the international distribution of the mitigation burden. They depend on the options for and costs of adaptation. And the decisions need to be taken under uncertainty and risk.

The answers are also affected by our ability to measure accurately the conventional economic effects of climate change, and the likely reduction in those effects due to mitigation. Not all of the effects on output and consumption through market processes are amenable to precise quantification, so our conclusions depend on our ability to form sound judgments about the magnitude of changes that are excluded from attempts at formal measurement simply because adequate information is not available at this time. The answers are affected fundamentally by the approach that is taken to decision-making under conditions of risk and uncertainty, and in particular, on the insurance value that is placed on avoiding the possibility of large negative outcomes independently of the effect of those possibilities on expectations of average outcomes.

The answers depend also on the value that is placed on outcomes that are not related to consumption of goods and services, relating to Australians' valuation of environmental amenity in many dimensions. These assessments are affected by how we see the inter-relationship between these and other non-material values with conventional consumption in determining welfare.

The answers are affected by the relative value that is placed on the welfare of people living in the future relative to the welfare of those living at present.

This chapter introduces an approach to decision-making that deals with these immensely complex and difficult issues. The Review seeks to form and to present judgments relating to the key mitigation choices for Australia in a transparent way. This allows people who are uneasy or unhappy about the conclusions to understand and take issue with the premises and the logic that led to them.

This chapter seeks to address the methodological issues in a simple way. We are seeking to assist community choice on the extent of mitigation that provides the greatest excess of gains from reduced climate change over costs of mitigation. The complexity of the influences on that choice make simplicity especially challenging as well as particularly important. Here, even more than in other areas of public policy choice, focus on the central issues is essential if we are to reach conclusions through a transparent process that is open to challenge, and which can lay a basis for long-term community support and policy continuity and stability.

Climate change mitigation decisions in 2008, and for the foreseeable future, are made under conditions of great uncertainty. There is large uncertainty about the climatic outcomes of varying concentrations of greenhouse gases, about the impact of various climate outcomes, and about the costs and effectiveness of adapting to climate change (chapters 3, 6, 8 and 10 in particular). There is uncertainty about the costs of various degrees of mitigation in Australia (chapters 10, 15 and 16). There is large uncertainty about the extent to which the international community will make effective commitments to mitigation, and about the relationship of global to Australian mitigation efforts (chapters 12, 13 and 14).

Under such uncertainty, it is always sensible to ask whether it would be better to delay decisions, while information relevant to the decision is gathered and analysed. However, it is as much a decision to do nothing, or to delay action, as it is to decide to take early action. The issue is whether delay would be a good decision.

When human-induced global warming first became a major international public policy issue nearly two decades ago, it may well have been good policy to take only modest and low-cost steps on mitigation, and to invest heavily in improving the information base for later decisions.

In 2008, the costs of delay—in the probabilistic terms that frame a good decision under conditions of uncertainty—are high. Work for the Review, reported in Chapter 4, has already changed international perceptions of the rate at which emissions will grow over the next several decades under business as usual, which is running Australia and the world towards high risks of dangerous climate change at a more rapid rate than is generally understood. The opportunity costs of delaying decisions are high.

Australia and its partners in the international community will, for good reasons, make historic and fateful decisions about their approaches to climate change mitigation in the three years ahead. They will do this on the basis of currently available information and analysis, however sound or weak that may be.

The sceptical economist—and the Review counts itself within this tradition—insists on equally rigorous evaluation for a decision to delay as for a decision to take action now.

The Review's approach to the important questions about mitigation policy starts with scientific assessment of the costs of climate change to Australia and Australians. We have to be able to compare the costs of climate change without mitigation, and with varying degrees of effective mitigation and adaptation effort. These costs include indirect costs through effects on other countries, to the extent that these feed back into impacts on Australia, or are felt by Australians in themselves. The scientific assessments are highly uncertain, and their impacts on human activity and welfare even more so. We have no alternative to making decisions on complex issues of valuation under great uncertainty.

2.1 Risk and uncertainty

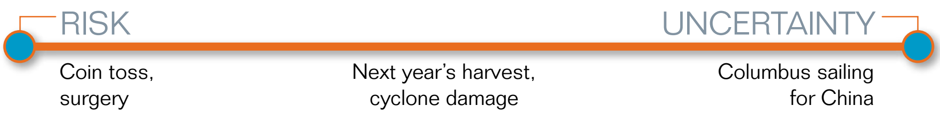
Climate change policy requires us to come to grips with both risk and uncertainty. Keynes (1921), and Knight (1921) drew a distinction between the two that is still useful today.

Risk relates to an event that can be placed on a known probability distribution. When we toss a coin, we do not know whether or not we will see a head. If we toss the coin enough times, it will fall as head about half of the time.

In many spheres of human life, an activity has many similarities with others that have been repeated many times, so that participants have a reasonable idea of the odds. A piece of surgery with some risk of death, and short-term investments in financial markets, have these same properties. No new piece of surgery, and no new investment, is exactly the same as any other. But there have been enough similar events for players to feel that they can form judgments with some confidence about the probabilities.

There is uncertainty when an event is of a kind that has no close precedents, or too few for a probability distribution of outcomes to be defined, or where an event is too far from understood events for related experience to be helpful in foreseeing possible outcomes. Humans are often required to form judgments about events that are unique, or so unusual that analysis based on secure knowledge and experience is an absent or weak guide. Columbus sailing west in search of China is a historically important example.

Figure 2.1 The risk–uncertainty spectrum

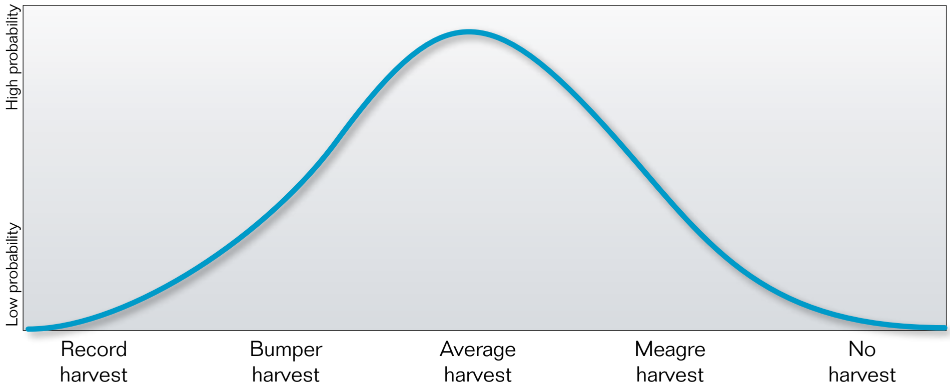


The 18th century British philosopher Bayes has given his name to what is now a well-developed approach to decisions under uncertainty. Bayesian decision theory encourages us to treat decisions under uncertainty as if we were taking a risk (Raiffa 1968; Raiffa & Schlaifer 1961). Bayesian decision theory advises us that we will make the best possible decisions under uncertainty if we force those who are best placed to know to define subjective probabilities that they would place on various outcomes, and work through the implications of those assessments as if they were probability distributions based on experience. These subjective probability distributions can then be updated on the basis of emerging experience.

While the distinction between risk and uncertainty is analytically helpful, it does not distinguish discrete and separate phenomena. Rather, risk and uncertainty are the extreme ends of a single spectrum. Next year's harvest can be assessed as a risk on the basis of past experience but carries an element of uncertainty, because it is affected by various climatic parameters that are not at all predictable from experience or with current knowledge. The risk of a cyclone hitting a tropical city can be assessed using data on past occurrence of cyclones, but many aspects of the potential damage are uncertain.

If it is correct to treat a subjectively formed assessment of a probability distribution as if it were drawn from a distribution based on repeated experience, what is the difference between risk and uncertainty? Perceptions of the probability distribution formed under conditions of uncertainty are more likely to change materially with a small number of new observations or amount of experience or further analysis.

Figure 2.2 A probability distribution



The Review's work on climate change over the past year has made some contact with risk, more with uncertainty, and most of all with the wide territory between them. The mainstream science, embodied in the work of the Intergovernmental Panel on Climate Change (IPCC), sometimes discusses possible outcomes in terms of fairly precise probability distributions (see chapters 3 and 6), yet describes its assessments in terms of 'uncertainties'. This suggests that they are applying Bayesian approaches to decisions under uncertainty.

The decision framework is rarely made explicit, and sometimes is not clear.

The climate models on which the assessments are based are themselves diverse. The climate models provide numerous observations on possibilities out of their diversity, as well as from each generating numerous results from repeated experiments. These are the senses in which the IPCC science draws from probability distributions. There are many points at which judgment rather than experience informs the model relationships. The resulting conclusions are therefore located somewhere on the uncertainty side of the middle of the risk–uncertainty spectrum.

2.2 The costs of mitigation

The increase in greenhouse gas emissions is a product of the advances in science, technology and economic organisation that have transformed humanity as well as its natural context over the last two centuries. In the history of life on earth, and even of human life, we are talking about an almost infinitesimally short period of extraordinary dynamism.

A modern acceleration in rates of human-induced greenhouse gas emissions is the source of contemporary concerns about climate change.

Economic development over the past two centuries has taken most of humanity—but certainly not all—from lives that were insecure, ignorant and short, to personal health and security, material comfort and knowledge that were unknown to the elites of the wealthiest and most powerful societies in earlier times.

In the first millennium after the life of Jesus Christ, global economic output increased hardly at all—by only one sixth. All of the small increase was contributed by population growth, and none by increased production per person. By contrast, output increased 300-fold in the second millennium, with population increasing 22 times and per capita production 13 times. Most of the extraordinary expansion took place towards the end of the period. From 1820 until the end of the 20th century, per capita output increased more than eight times and population more than fivefold (Maddison 2001).

In most of its first two centuries, the cornucopia of modern economic growth was located in a small number of countries, in Western Europe and its overseas offshoots in North America and Oceania, and in Japan. In the third quarter of the 20th century it extended into a number of relatively small economies in East Asia.

A new era began in the fourth quarter of the last century, with the rapid extension of the beneficent processes of modern economic development into the heartland of the populous countries of Asia, including China, India and Indonesia. From this has emerged what can be described as the Platinum Age of global economic growth in the early 21st century (Garnaut 2007). Incomes are growing rapidly in a large proportion of the developing world. In the absence of a major dislocation of established trends, this is likely to continue for a considerable period. Analysis presented in the draft report points to the Platinum Age contributing a greater absolute increase in annual human output and consumption in the first two decades of the 21st century than was generated in the whole previous history of our species, and then adding almost that much again in the next following decade to 2030 (chapters 4 and 9).

Increasingly through the 21st century, the expansion of production will be associated with rising output per person, rather than increase in population. In all of the economically successful countries, higher incomes, together with the increased expectation of survival of children and the expansion of education and choice for women with which it is associated, are leading to marked falls in fertility and declining rates of population increase. Before the end of the 21st century, a continuation of these processes is expected to have led to stabilisation (by about 2080), and then, at least for a while, gradual decline in global human population (Chapter 4). But by that time, nearly three billion will have been added to the global population.

The era of modern economic growth has been intimately linked to rapid expansion in the use of fossil fuels. This is returning to the atmosphere a part of the carbon that was sequestered naturally over billions of years, through a process that created the conditions that were necessary for the emergence of human life on earth. The share of carbon returned to the atmosphere is small relative to the stock, but large enough to throw the equilibrium of heat trapping in the atmosphere out of balance.

The amount of fossil fuel in the earth's crust, in the forms of petroleum, natural gas, coal, tar sands and shale, is obviously finite. However, the amount is so large that its limits are of no practical importance for climate change policies.

However, there is a much tighter engineering limit to the availability for human use of fossil fuels: the point at which the energy used to extract the resources would be greater than their energy content.

Tighter still is the economic limit: the availability of fossil fuels in forms and locations that can be extracted for human use at costs below the prices of oil, gas and coal in global markets. There is debate about whether the economic limits will constrain global economic growth in the period immediately ahead or in the foreseeable future. The limit will be reached much earlier for liquid petroleum than for natural gas, and for gas much earlier than for coal (Chapter 4).

It was once common for eminent economists to see constraints on the availability of natural resources and in particular fossil fuels as placing limits on modern economic growth (Malthus 1798; Jevons 1865). The success of technological improvement and economic processes in easing supposed constraints in the first centuries of modern economic growth established confidence that these constraints would be overcome in ways that allowed global economic growth to continue.

The sustained rapid growth through much of the world from the early nineteen fifties to the early seventies, and the contribution of extraordinary Japanese growth to pressure on global resources at the end of that period, rekindled old concerns about resource constraints on growth.

Concerns about the availability of fossil fuel resources was one element in the analysis and cautions of the Club of Rome, and their ill-fated prophecy about limits to growth in the early 1970s (Club of Rome 1972). The cautions turned out to be ill-judged because the Club of Rome failed to give sufficient credit to human ingenuity applied to discovery, extraction, refining, transport and utilisation of fossil fuels. The extraordinary growth in demand for fossil fuels in the early years of the Platinum Age—and the immense and unexpected increases in prices which have accompanied it—have rekindled interest in resource limits to growth. Will the supply conditions of fossil fuels slow down the growth in greenhouse gas emissions enough to do the mitigation task for humanity?

It is clear from the present state of knowledge—as it was not to earlier generations—that it would be possible for the world economy to adjust to the approach of economically relevant limits to fossil fuel availability, without bringing the increase in human consumption of goods and services to an end.

For the time being, the pervasive and rapidly growing use of fossil hydrocarbons in economic activity is a matter of economic optimisation and not of technological necessity. If the human species avoids some catastrophic truncation of the triumphs of modern economic development, it will need to make a transition out of reliance on fossil fuels, and it will succeed in doing so.

The constraints on the economic availability of fossil fuels will aid the climate change mitigation process. But the Review's analysis suggests that in the time available, the reduction in use of fossil fuels, associated with scarcity and high prices, will be nowhere near enough to avoid high risks of dangerous climate change.

To the extent that mitigation is effective, reduced demand for petroleum and other fossil fuels associated with effective mitigation would reduce the global price of these resources, improve the terms of trade of importing countries, and probably have favourable effects on global economic growth. This would be an offset for some countries against the cost of mitigation.

The beneficiaries of lower fossil fuel prices would not necessarily include Australia, whose terms of trade rise with high global energy prices. However, lower global prices would benefit many groups within Australia. Lower export prices for resources hurt producers in these industries, and the beneficiaries of government revenue generated from the resource industries. But they also tend to lower interest rates and the exchange rate, and so reduce pressures on rural and much of the manufacturing and service industries, and many households.

Adjusting to limits on the use of fossil fuels required to mitigate climate change would be less costly than naturally imposed economic constraints on the availability of fossil fuels. This is because sequestration through physical processes (geosequestration) or biological processes (biosequestration) can ease the mitigation task but cannot ease natural constraints on fossil fuel supply. But mitigation needs to be imposed through political processes. Decisions of this kind in single countries are hard enough. The necessity to achieve mitigation outcomes through cooperation of many sovereign entities, each with an incentive to shift as much of the cost of adjustment as possible to other countries, increases the challenge.

A revolution in humanity's use of fossil fuel-based energy would be necessary sooner or later to sustain and to extend modern standards of living. It will be required sooner if the world is to hold the risks of climate change to acceptable levels. The costs incurred in making an early adjustment will bring forward, and reduce for future times, the costs of the inevitable eventual adjustment away from fossil fuels. How much sooner and at what extra cost is the central question before the Review.

Later chapters will discuss approaches to mitigation (8 to 18). Costs of mitigation depend on the extent to which, and the time over which, reductions in emissions are achieved. Costs depend on the efficiency of the instruments chosen to implement policy. There are cost advantages in having a single price on emissions as the main instrument of policy, supported by measures to correct market failures in utilisation of the commercial opportunities created by the price on emissions.

If mitigation is approached through an efficient set of policies, its costs are determined by the extent and the rate of emissions reductions to be achieved. These, in turn, are determined by the ambitions of a global effort to which Australia has subscribed, and by what Australia is prepared to do in the context of global action.

The cost of mitigation can be calculated for various levels and rates of reductions in emissions. Each level and rate of Australian mitigation can be related to a global mitigation outcome. The global mitigation outcome will define a benefit to Australia in terms of reduced risks of climate change. The benefits of reduced risks of climate change to Australia can be (roughly) estimated. The costs and benefits of mitigation can then be compared. The policy task in setting Australian mitigation objectives, therefore, begins with identification of the costs and benefits (in reduced risks of loss from climate change) for various mitigation ambitions.

The higher the market prices of petroleum, coal and natural gas, the lower the costs of mitigation will be. This is because the costs of business as usual, compared with the costs of using alternative, low-emissions technologies, will be higher. This is a matter of high current interest at this time of historically high fossil fuel prices.

The more ambitious the extent and speed of reductions in emissions, the higher the costs of mitigation will be. It will be lower the more efficient the instruments chosen to give effect to policy.

An economically efficient approach to mitigation would generate a rising carbon price over time, and therefore impose increasingly strong pressure for adjustment out of high-emissions technologies, and increasingly strong incentives for sequestration. For a given abatement task, emissions costs will be lowest if the emissions price rises at the interest rate, which will lead to optimal timing in investment in the mitigation effort.

We are seeking to allocate efficiently over time access to a limited global capacity to absorb additional greenhouse gases without unacceptably high risks of dangerous climate change. The allocation problem is familiar as one of optimal depletion of a finite resource. This frames the economics of the timing of the mitigation effort, and suggests the relevance of the 'Hotelling curve' to the price curve for the right to emit (Hotelling 1931).

The annual costs of mitigation are likely to rise for some time, as a rising emissions price forces deeper abatement. While the price of emissions would be expected to continue to rise over time at the interest rate, the cost to the economy would not rise at that rate. At some time, the tendency for costs to rise would be moderated and eventually reversed by improvements in the technologies that emerge to replace fossil fuels and other sources of emissions.

At some time in the future—perhaps around the time when economic constraints on the use of fossil fuels would in any case be forcing structural change comparable with what had been achieved for mitigation purposes—the incremental costs of mitigation will become negative. The sunk costs of technological improvement and structural change associated with mitigation will avoid the need for some investments to accommodate the constraints on availability of fossil fuels.

Past mitigation will become a positive contributor to current annual economic output at the point where the global economy would have been forced to use substitute technologies whose emergence had been facilitated by the greenhouse gas abatement effort.

Above all else, the cost of mitigation in Australia, and not only the benefits in avoided climate change, will be affected by the nature of the global mitigation effort. An effective global effort would make available a wider range of opportunities for trade in mitigation responsibilities, assigning higher effort to countries in which it can be achieved at lowest cost. A global effort would increase and distribute more efficiently and equitably the world's investment in new technologies to develop lower emissions paths to consumption and production. And it would obviate the need for special policy measures to avoid carbon leakage, or the shift of emissions-intensive industries from high-mitigation to low-mitigation countries—a policy requirement that is likely to be profoundly distorting of domestic economic efficiency and political integrity.

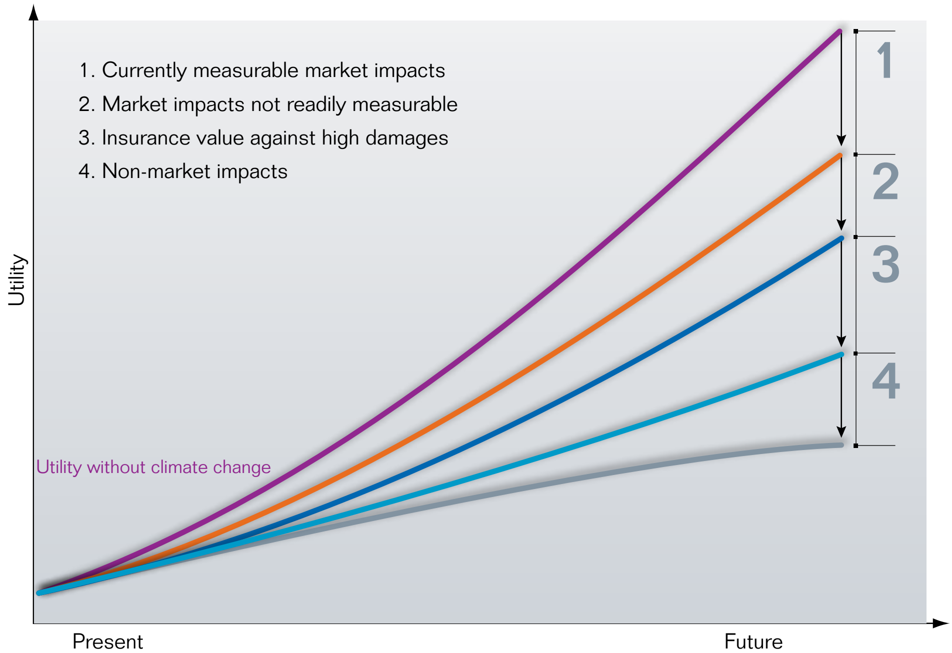
2.3 Four kinds of benefits from mitigation or avoided climate change

Three kinds of benefit from avoided climate change—that is, mitigation—can be measured in monetary values, as a change in the value of output or consumption. The fourth kind of benefit of mitigation requires a different measurement unit. Let us evoke an old tradition in economics, and talk about units of utility. (We could just as well call it welfare, if we removed ourselves from a modern interpretation in terms of social security for disadvantaged people.) That unit, 'utility', is used in economics to represent welfare in a demonetised fashion.

The four kinds of climate change impacts, which in part can be mitigated, are illustrated in Figure 2.3.

The first kind of benefit from mitigation comprises currently measureable market impacts of climate change, which are avoided by mitigation (Chapter 9). The measurement can be brought together through a computable general equilibrium economic model. The starting point for assessment is the estimation of climate impacts based on the means of the relevant probability distributions for these outcomes. These effects are typically measured as an impact on GDP or consumption, with monetary values as the unit of measurement.

Figure 2.3 The four kinds of climate change impacts



The second kind of benefit of mitigation comprises market impacts that are similar in nature to the first, but which are not amenable to measurement in the current state of knowledge. For the Review, these comprise impacts that were not defined precisely enough in time for the modelling, but which are, in principle, amenable to quantitative analysis. We seek to use what we know of these effects roughly to compare their possible size with the impacts that have been subject to formal modelling. As with the effects that are subject to modelling, we focus on the means of the probability distributions of possible outcomes. We are drawing these judgments from views of the impacts that are closer to the uncertainty than the risk end of the risk-uncertainty spectrum. There is no reason to expect our estimates of these impacts to be too low rather than too high, but they are more likely than the estimates of the first kind of benefits to be subject to large adjustments, in one direction or another, with the advance of knowledge. Examples from the Review include the impact of climate change on the tourism industry. As with the first type of benefits, the estimation of these effects would be in monetary values of GDP or consumption (chapters 7 and 10).

The third kind of benefit of mitigation is the insurance value that it provides. On many impacts, there is large asymmetry between human evaluation of outcomes that are much more benign and much more damaging than the mean. Humans tend to be risk averse when the outcomes include the possibility of large loss. Some of the possible outcomes near the more damaging end of the probability distribution would be thought by many people to be catastrophic. In such cases, mitigation has additional insurance value. What would we be prepared to pay to avoid a small probability of a highly damaging or possibly catastrophic outcome? It is probably more than we would be prepared to pay to avoid the certain prospect of the catastrophic event's contribution to the mean outcome. Like the first and second kinds of benefit from mitigation, insurance value of mitigation could also be measured in monetary value—though in most instances it is not obvious how to value them, and they are not estimated quantitatively in the draft report. Uncertainty strongly plays into this category of benefits, as the probability of extreme or catastrophic climate impacts is not known from experience, and must instead be deduced from expert judgment.

It is not a new idea for governments to make large financial commitments for insurance against low-probability, high-impact events. Defence absorbs several percentage points of GDP per annum, most of it on insurance against genuinely low-probability developments.

The possibility of outcomes that most people would consider to be catastrophic makes this a particularly important element of the assessment. Weitzman (2008) sees it as the main element:

> …the burden of proof in the economics of climate change is presumptively upon whoever wants to model or conceptualize the expected present discounted utility of feasible trajectories under greenhouse warming without considering that structural uncertainty might matter more than discounting or pure risk per se. Such a middle-of-the-distribution modeler should be prepared to explain why the bad fat tail of the … distribution is not empirically relevant and does not play a very significant role in the analysis.

The focus of Australian policy making is on maximising the welfare—or utility—of Australians. We can think of a utility function as rising with Australian consumption of goods and services, and also with a number of non-monetary services, such as environmental amenity (which itself may have a number of components), longevity, health, and welfare of people in other countries. If the comparisons of costs and benefits of the first three categories of gains from mitigation suggest a particular outcome, and it is clear from inspection that inclusion of the fourth might lead elsewhere, it is necessary explicitly to compare the monetary with the non-monetary effects on welfare of a particular position. This could in principle be done by forcing a monetary value onto particular non-monetary outcomes. An alternative is to leave the comparison of the monetary and non-monetary outcomes until after the two outcomes and the possible conflict between them is known.

Examples of such non-market impacts include Australians' valuation of environmental amenity. They include the value that Australians place on the integrity of the Great Barrier Reef and other features of the Australian and international landscapes, on inherited shorelines, on genetic diversity and on the survival of species (biodiversity). They include the value that Australians place on long-established communities and social structures built around particular patterns of climate, or the use of green urban gardens and playing fields for recreation. To include such elements in an Australian utility function is not to place intrinsic value on environmental conservation, as some people argue that we should. It is only necessary to accept that many Australians value such things, including as options for their offspring and future generations more generally, and would be prepared to sacrifice some consumption of goods and services to have more of them. Another example of a non-market impact that Australians value would be the avoidance of poverty and trauma in other countries (again, as valued by the sum of individual Australians). The proof of the importance of such matters lies in the continued support by Australians of public and private international development assistance and disaster relief.

Non-market elements in a utility function, and the level of utility when the function includes market and non-market elements, are in their natures difficult to measure. Any politically derived mitigation policy decision will implicitly value them alongside changes that can be measured more easily.

Traditional welfare economics contains a few important insights into the roles that non-market factors, such as environmental amenity and concern for the welfare of others, might play in determining utility in a world of climate change and of possibilities of mitigation.

The non-market values are likely to be 'superior goods', in that the relative value that people assign to them rises with incomes. In the late 21st century, when the average purchasing power of incomes over material goods and services is likely to be several times the present level (Chapter 4), much higher relative value will be placed on any truncation of the natural estate that has occurred in the intervening years.

It is likely that at higher incomes, the price elasticity of substitution between conventional consumption and access to such non-market values as environmental amenity and concern for others' welfare will be low, and much lower than today. Near subsistence levels of consumption, few people would willingly sacrifice much access to material goods and services for greater environmental amenity, or for improved development prospects of others at home or abroad. But in the likely material affluence of the late 21st century, many more people are likely to want to trade substantial amounts of access to material consumption for small amounts of improved values of services that are not available through market processes.

An extremely low rate of substitution between non-market services and conventional consumption of goods and services at high incomes, in the presence of large impacts from climate change, would challenge the proposition that continuing economic growth would necessarily lead to higher average utility in the distant future.

One implication of these insights is that the utility of Australians under policies that allocate high priority to such non-market values as the services provided by the natural environment, and provision of a favourable environment for development in poor countries, is likely to be much higher than the application of today's preference systems at today's material consumption levels would suggest.

2.4 How effective adaptation reduces the cost of climate change and the benefits of mitigation

Some of the costs of climate change can be diminished by the adaptive behaviour of individuals and firms, and by policies that support productive adaptation.

As we will discuss in the final report, effective adaptation requires a strong applied science base, good markets for reallocation of resources, goods and services, and capital for investment in defensive structures and new productive capacity that is more suitable to the new environment.

All of these capacities are more abundant in developed than low-income developing countries. For the latter, the impact of climate change is likely to be undiluted and more severe. Australia's location in an immediate region of vulnerable developing countries will make some of its neighbours' challenges its own. Investment in adaptive responses in the arc of island countries and regions from Timor-Leste through eastern Indonesia, Papua New Guinea and the South Pacific is likely to become an important component of Australia's own cost-reducing adaptation to climate change.

The modifying impact of adaptation is exemplified by Australian agriculture. Better and earlier knowledge will allow farmers to make timely decisions on whether new money should continue to be invested in locations that seem to be severely damaged by climate change, or whether it is better to find new livelihoods in less challenging locations. Investment in plant and animal genetics may be able to diminish the loss of productivity associated with higher temperatures and changing rainfall patterns. Investment in water retention or storage will sometimes be an economically sensible response to more variable rainfall.

Hardest of all, the most effective adaptive responses in agriculture to climate change will sometimes require fundamental changes in attitudes, policies and institutions. For example, as we will see in Chapter 7, the loss in irrigated agricultural value under moderate warming and drying scenarios could be greatly reduced by shifting from established to free market allocation patterns of water allocation, so that limited water resources are directed without qualification to their most productive uses. Livestock industries in these same circumstances would suffer less, if established patterns of quarantine on feed imports were to be relaxed. We can presume that change of such a fundamental kind would not be achieved without rancour and disputation over policy, and would require public policy management of exceptional dexterity and quality.

In assessing the costs and benefits of mitigation, the costs of adaptation need to be subtracted from business as usual and mitigated output and consumption. The benefits of adaptation through reduced climate change damage need to be subtracted from the gains from mitigation. In Chapter 7, the Review takes this partly into account by presuming substantial adaptive response in assessing the costs of climate change at various levels of mitigation. For example, the presumed wheat yields are based on expectation that planting times and new seed varieties will be developed rapidly for changing conditions. These effects are carried forward from Chapter 7 to the modelling reported in Chapter 9.

The costs of adaptive responses will generally come early, and the benefits from reduced costs of climate change later. On the whole, the Review has only been partially able to to take account of the costs of adaptation; and the assessment of reduced costs of climate change on output and consumption is incomplete.

Some of the most important adaptive responses to climate change, and the most difficult to bring to account in analysis of optimal levels of mitigation, involve changes in attitudes and values. The city dwellers of densely populated regions of Northeast Asia have long been accustomed to life that is almost entirely separated from the natural environment. If climate change separates more and more humans from natural environmental conditions, will they simply change in their values and preferences, and learn to accept without a feeling of loss what they have never known, or knew only in distant memory? Will it matter to Australians of the future if their children do not enjoy the grassed playing fields that were once formative in what we imagined as our community culture? Could Australians learn to love living in a country and a world shorn of many of the natural features that are now enjoyed with comfortable familiarity?

Humans adapt to changed and difficult environments when they must. There will still be joys of learning and life even in the most unhappy scenarios of future climate change. But it must be doubted that humans will have changed so much that they fail to regret what they still had in the Australian natural environment in the early 21st century. For want of reason to do otherwise, the Review will assess the value that Australians place on environmental amenity in terms of today's perspectives and preferences, manifested in a future world of greatly increased consumption of conventional goods and services.

2.5 Measuring the benefits of mitigation against the costs

To a sceptical economist, the case for action is not made simply by comparing the cost of unmitigated climate change with the cost of mitigation. Chapter 9 makes this comparison, but cannot go on to an assessment of whether mitigation is worthwhile until more of the modelling is completed.

The relevant comparator is the reduction in the cost of climate change that is achieved as a result of the mitigation action. If we are evaluating Australian mitigation action, the reduction in costs of climate change that is relevant is that associated with the total global mitigation action that it enables—either by Australia, or by the set of countries which are undertaking joint action.

The benefit from mitigation is the costs of climate change avoided, after the costs and ameliorating effects of adaptation had been taken into account. Do the benefits of mitigation exceed the costs for Australians?

The costs of mitigation come earlier and are more certain. The benefits come later and are less certain. How do we compare later with earlier benefits? How do we compare more with less certain outcomes? Here we must come to grips with challenging issues about discounting for time.

The costs and benefits of mitigation, in Australia and in other countries, fall on and accrue to different groups in the community. They are also felt and valued in various ways by different people. How do we weigh the relative effects on welfare of different people? In particular, what relative weight do we give to costs and benefits to the rich and to the poor? It may be that an overall assessment of whether mitigation is worthwhile will depend on the distribution of costs and benefits across the community.

The landmark Stern Review (2007) addressed the question of whether mitigation action was justified for the world as a whole. This turns out to be an easier question than whether mitigation action is justified from the point of view of an individual country. An assessment of whether mitigation action is justified for an individual country must deal with all of the complexities that Stern addressed for the world as a whole, plus one. And the additional source of complexity is perhaps the most difficult of all.

The relevant mitigation is global. A single country's action is relevant only in its direct and indirect contribution to global mitigation. The costs of various levels of mitigation for a single country depend mainly on the extent of its own mitigation—although these costs are substantially reduced for any given level of mitigation by its embodiment in a global agreement within which at least major economies apply similar emissions pricing regimes. The benefits depend overwhelmingly on what other countries are doing. Each country's evaluation of whether some mitigation action of its own is justified depends on its assessment of the interaction between its own decisions and those of others. Thus its own decision framework must depend on its assessment of the dynamics of complex games, among many countries. The games are framed within an awful reality, that each country has a narrow national interest in doing as little as it can, whatever others do, so long as its own action does not diminish the mitigation action that others actually take.

The global mitigation effort is the sum of the separate but inter-related mitigation decisions of individual sovereign countries. It is the sum of implicit or explicit decision processes in all countries, of the kind that we are attempting for Australia. The sum of the decision processes in many countries—democratic and authoritarian, soft and hard states, rich and poor—will determine the global mitigation effort.

The Review's terms of reference require it to analyse the degree of Australian mitigation effort that would be necessary to support a global agreement to hold greenhouse gas concentrations to 550 ppm, and separately to 450 ppm. The final report, with the support of the modelling reported in detail in the draft supplementary report, will examine the choice of Australian mitigation ambitions comprehensively.

2.6 A graphical representation of the benefits and costs

Let us plot our expectations of the level of national utility or welfare over time in the absence of national mitigation, national or global (Figure 2.4). National utility will generally rise over time, in line with the Australian experience through its history. On the same graph, now plot expectations of welfare over time at a given level of national mitigation, which is associated with a defined degree of global mitigation.

Figure 2.4 Utility with and without mitigation

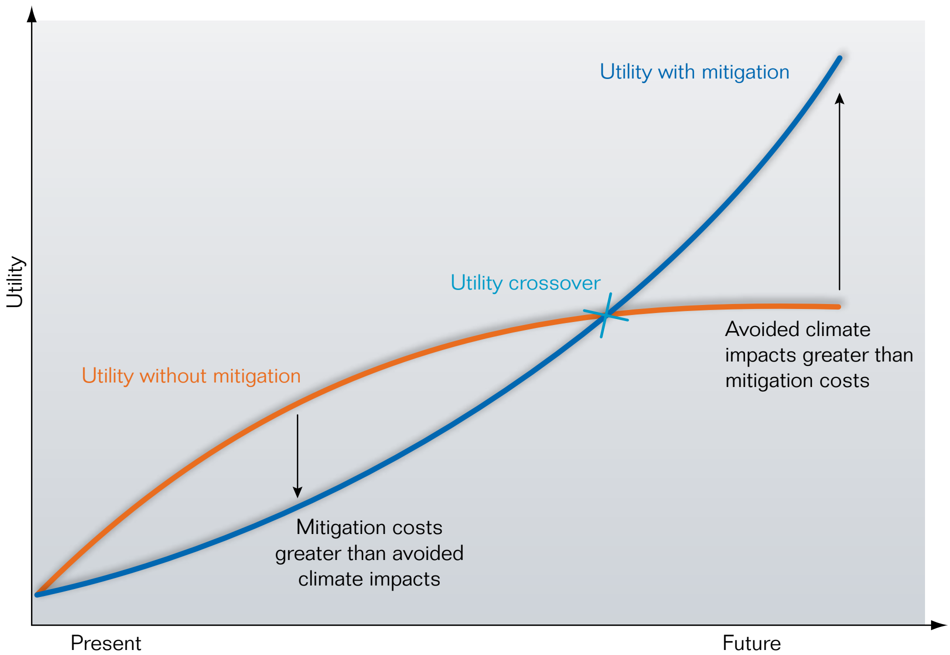


Figure 2.5 Utility under a more ambitious level of mitigation

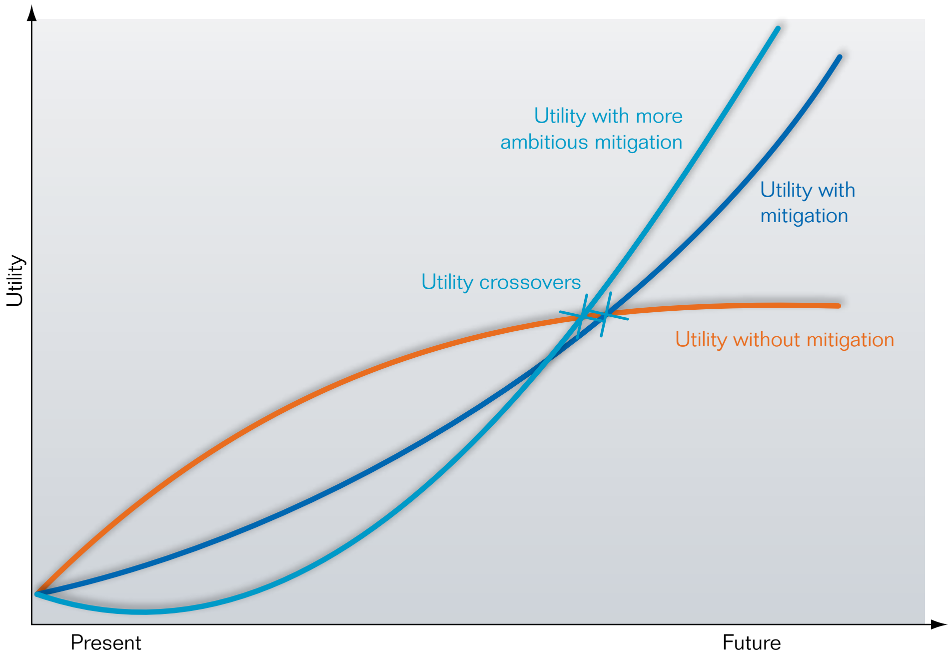
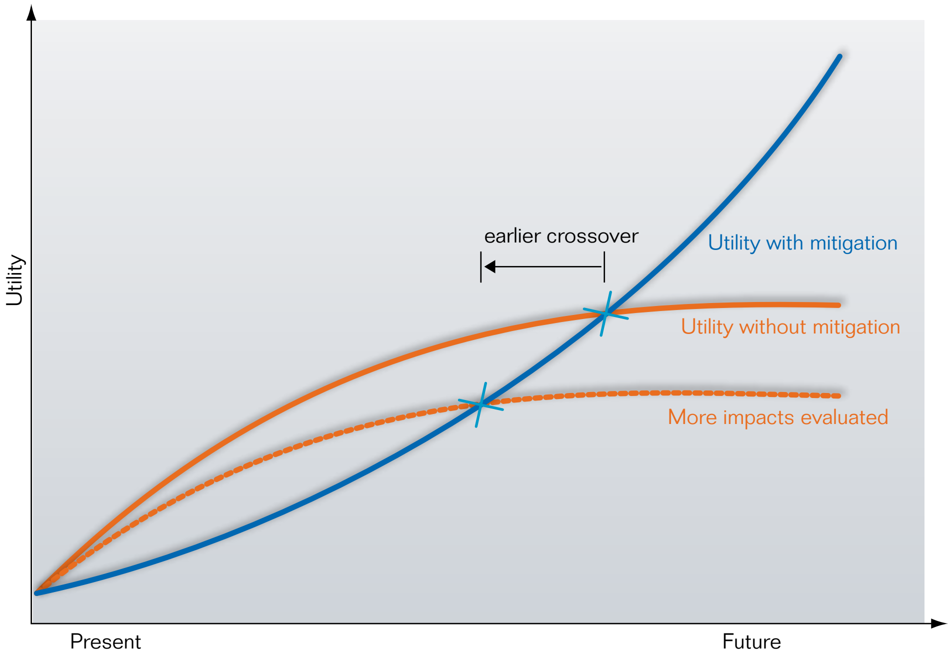


Figure 2.6 Utility with more climate change impacts taken into account



As shown in Figure 2.4, the utility curve in the absence of mitigation is above the utility curve with mitigation in the early years. This follows simply from the reality that mitigation has a cost. However, in cases in which national mitigation is associated with substantial global mitigation, at some point the mitigation utility curve may rise above the utility curve in the absence of mitigation. Let us call the point at which utility associated with mitigation exceeds utility in the absence of mitigation for the first time, the utility crossover point.

The two curves together describe the shape of a fish. The body of the fish covers years in which the net benefits of mitigation are negative. The area of the body of the fish represents the excess costs of mitigation in the years to the crossover point. The tail of the fish covers years in which the net benefits of mitigation are positive. The tail of the fish grows in depth and total area with time.

Figure 2.5 shows the utility curves with and without mitigation for a more ambitious level of mitigation. The fish will tend to have a fatter body and tail, as both the costs of mitigation and the benefits are increased. The relative sizes of body and tail, and locus of the crossover point, are an empirical issue.

Figure 2.6 shows the utility curves with a greater degree of climate change impacts being taken into account. As more costs of climate change are quantified, the utility curve for the unmitigated case shifts downward.[1] The crossover point comes earlier and the tail becomes larger relative to the body of the fish—implying higher net benefits from mitigation. These are also matters for empirical analysis and judgment.

The policy question is whether the area of the body of the fish exceeds that of the tail of the fish. Future utility has to be valued at present values, so the difference in the annual levels of utility between the two curves defining the fish have to be discounted to the present at an appropriate rate. The choice of discount rate will have a major influence on the size of the body relative to the size of the tail. We turn to the discount rate after looking more closely at other influences on the sizes of the body and tail of the fish.

The cost of mitigation (augmented somewhat, and more in the low-mitigation cases, by the greater cost of investment in adaptation in the low-mitigation scenarios) will determine the depth of the fish's body.

For any chosen mitigation outcome, there will be an optimum distribution of the mitigation effort over time. For purposes of presentation, we assume that ideal mitigation policies, including ideal allocation of emissions reduction over time are chosen for implementation of the policy.

The length of the body is the time it takes to get to the crossover point.

Beyond the crossover point, the length of the tail is determined only be any limit that society may place on the future time over which it remains concerned for the utility of Australians.

2.7 Valuing the future relative to the present

Should society place any limit on the future time over which it remains concerned for the utility of Australians? It is not obvious why it should do so.

The value of avoided irreversible effects of climate change extends forward to the point at which the life of the human species would have been extinguished by some separate influence. There is some chance of extinction at any time, at least in the contemporary human state of knowledge about weapons of mass destruction and certain capacity to control their use, and the low level of knowledge and capacity relevant to avoidance of the ever-present risks of the earth colliding with extra-terrestial bodies. The probability of extinction is not high in any year and perhaps in any century, but it is above zero.

So if we are to include the welfare of all future generations in our assessment of utility, how should we value the future relative to the present?

In comparing utility across generations, we need to determine the discount rate. There are two key variables: the pure rate of time preference; and the elasticity of the marginal utility of consumption.

The rate of pure time preference is the rate at which future utility is discounted simply because it is in the future.

Many of the philosopher kings of economics, from Ramsey (1928) to Sen (1961), have argued for a pure rate of time preference that is close to zero. This approach was followed by Stern, who placed it at 0.1 per cent, corresponding to a view on the probability in any year of human extinction. Some have commented that if the probability of extinction were as high as that, it is unlikely that the human species would still be here. Stern might respond that the human capacity to construct truly fateful weapons of mass destruction has not been with us long.

There is another view, that market discount rates reflect the time preferences that are revealed in actual decisions on savings and investment, which are the vehicles for arbitrage between future and current economic activity. This was the main criticism of Stern's approach.

The issue is whether the pure rate of time preference is a normative or a positive issue.

The second determinant of the discount rate is the marginal elasticity of utility with respect to consumption. This is a measure of society's concern for equity in income distribution. We accept that a dollar of incremental income means less to the utility of the rich than of the poor. How much less? Higher and lower values have been suggested, but no-one contests that income has diminishing marginal utility with increased income.

In the expected circumstances of continually rising incomes, this argues for placing higher value on current than future income.

This argument for being careful about the sacrifice of current utility through expenditure on mitigation in pursuit of future utility from avoided climate change is a powerful one. It would be the more powerful if a substantial part of the burden of current mitigation were to be placed on people in low-income countries, to the extent that their prospects for economic development were to be significantly diminished.

There is one qualification of this case for caution about strong mitigation on inter-generational income distribution grounds. To the extent that there is a low rate of substitution between conventional consumption and non-market services when incomes are high, and to the extent that climate change introduces a possibility that the availability of non-market services may be greatly diminished for future generations, one cannot be sure that, despite much higher material consumption, the average utility of people in future will be greater than the average utility today.

If anything like a market discount rate is used, later benefits arising over the time periods that are necessary for mitigation policy to have substantial effects have relatively low value. At a real discount rate of 4 per cent—the rate judged to be appropriate for modelling the future price curve for emissions permits (the Hotelling curve)—a dollar in 50 years' time is worth just 13 cents today.[2] The real annual rate of return on long-term US Treasury bonds trading in commercial markets is around 2 per cent. At a real discount rate of 2 per cent, a dollar in 50 years' time is worth just 36 cents today.

Are we comfortable about living for the moment to the extent suggested by the use of market discount rates?

Is there tension between our normative (what should be done) and positive (what seems to happen in markets) view of discounting for the future? Should we treat the interest rates generated in financial markets as market failures?

The application of a social discount rate, lower than market rates, is recommended as best practice in one highly practical area of applied, policy-oriented economics: cost-benefit analysis. Little and Mirrlees (1968) recommend the application of lower rate of discount for future income than is generated in financial markets.

Any case for using social discount rates that are lower than market rates could be seen has having two elements. These work in opposite directions in the conventional case where average incomes and utility rise over time. The market's myopia might be expected to price in a higher rate of time preference than consciously expressed human preferences might suggest. On the other hand, the preferences of the poor are under-represented in financial markets, where a dollar of savings and investment is the basis of the franchise. The non-enfranchisement of the poor tends to reduce the discount rate below what it otherwise would be. The enfranchisement of the poor in financial markets would argue for higher weight being given to current incomes, and therefore for the application of a higher discount rate.

Of course, if considerable weight is given to the bad end of the probability distribution of outcomes from climate change, there is a possibility that utility may be lower for many people in future than at present. The future poor get no votes anywhere, and least of all on Wall Street and in the City of London.

The Review's inclination is towards the use of a low pure rate of time preference, alongside recognition that in dealing with the means of the probability distributions, future incomes should be valued at substantially less per dollar on intergenerational equity grounds. The final report will show the sensitivity of the policy conclusions to variations in the discount rate.

A different calculus becomes necessary for consideration of the future values of the worst possibilities.

2.8 The Review's recommendations in a world of uncertainty and important immeasureable impacts

The draft report can go no further than explain the methodology that it is applying to evaluation of the optimum level of mitigation for Australia. It sets out in Chapter 9 the approach that is being taken to the modelling that will seek to define the cost of mitigation and the first of the four categories of mitigation described in this chapter. Chapter 10 explains how the other three categories will be taken into account.

Doing all of these things in a transparent way will, it is hoped, reveal to the governments to which the Review will be reporting, and to the Australian community, the implications of the climate change policy choices that must be made over the period ahead.

Notes

1 For ease of exposition, Figure 2.6 assumes that utility with mitigation already accounts for the lesser economic consequences of the additional impacts. If this were not the case, the utility-with-mitigation curve would shift downwards but the downward shift would be less than the downward shift of the utility-without-mitigation curve. The crossover point would still be earlier.

2 Four per cent is higher than the rate at which price rises over time in the gold market with its characteristic contango. Gold provides the nearest commercial market to the permit market that would be created by the emissions trading scheme once the market's credibility had been established. The higher premium is used in the modelling because of the presumption that market participants will perceive greater risk in the permit market.

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