Economic Analysis of Greenhouse Policy

A layperson's guide to the perils of economic modelling

Clive Hamilton
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Number 15
December 1997

THE AUSTRALIA INSTITUTE

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A layperson's guide to the perils of economic modelling

Dr Clive Hamilton
Executive Director, The Australia Institute and
Visiting Fellow, Public Policy Program, ANU
Professor John Quiggin
Department of Economics, James Cook University

Sponsored by the Sustainable Energy Development Authority of New South Wales

Discussion Paper Number 15
December 1997

ISSN 1322-5421

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Preface

Economic Analysis of Greenhouse Policy is a report to the Sustainable Energy Development Authority (SEDA) of New South Wales. SEDA was established in 1996 to reduce the level of greenhouse gas emissions in the State by investing in the commercialisation and use of sustainable energy technologies.

Economic modelling has played a major role in the public debate over the cost of reducing greenhouse gas emissions in Australia. Much of the public reporting of economic modelling on this issue has suggested that greenhouse gas emissions can be reduced only at substantial cost to the economy.

By contrast, SEDA has found extensive opportunities to reduce greenhouse gas emissions in Australia through measures that enhance economic performance. SEDA commissioned two of Australia's leading academic commentators, Dr Clive Hamilton and Professor John Quiggin, to report on this apparent contradiction.

SEDA has agreed to the publication of this report as a contribution to the ongoing debate on this very important issue of public policy. SEDA hopes that this report will enhance understanding of the nature and role of economic modelling and provide a wider perspective on the many and various claims in regard to the possible economic impacts of reducing greenhouse gas emissions.

Any opinions expressed in this report are those of the authors and do not necessarily reflect the views of SEDA or the NSW Government.

Cathy Zoi
Executive Director, SEDA

Executive summary

This paper examines the role of economic models in the formulation of climate change policies in Australia. Particular emphasis is given to the MEGABARE model constructed by the Australian Bureau of Agricultural and Resource Economics. The Government has drawn heavily on the results of MEGABARE to support its argument that uniform abatement targets would be too costly for Australia and would impose an unfair burden on this country.

While economic models are often extremely complex in structure, as a rule only a few key relationships are important for explaining their results. Moreover, modellers must make a series of assumptions about how an economy works and which factors are important to include in a model. The choice of assumptions essentially determines the results that emerge from the end of the modelling process. These facts mean that economists who build and use models can effectively determine the outcome by changing the model in sometimes obscure ways. For these reasons transparency in building models and reporting their results is crucial to their credibility.

Economic models are powerful devices for providing analysis of the possible economic implications of measures to reduce greenhouse gas emissions. While there are several economic models that can provide insight into policy choices in Australia, the Government has relied almost exclusively on the MEGABARE model. The evidence provided in this paper shows that the model construction, its use in greenhouse policy analysis and the interpretation of the results have been biased in ways that exaggerate the economic costs of reducing emissions.

The principal characteristics of the MEGABARE model that make it a poor guide to formulating climate change policies are as follows.

- The model fails to account for '*no-regrets' energy saving* measures, i.e. the energy savings that firms and households could obtain at no net cost. Studies indicate that these may amount to as much as 30% of energy used in Australia.

- The model fails to allow for *technological change* in response to policies to cut emissions. Technological developments in energy efficiency and renewable energy will clearly have a major impact on the costs of meeting targets.

- The model operates in a way that produces projections of changes in types of fuels used that are *wholly inconsistent with expert opinion* on likely changes in energy consumption patterns in Australia.

- The model explicitly excludes assessment of the *benefits of reducing emissions* in the form of the avoided costs of climate change. While a legitimate modelling choice, evaluating the costs but not the benefits means that the results of the model can say nothing about the desirability of reducing emissions. Yet MEGABARE results are used to make recommendations against major emission cuts.

- The model *ignores the non-energy sources* of greenhouse gas emissions so that the costs of emissions reduction fall entirely on the energy sector thereby driving up the estimated costs.

- By assuming that emission targets will be confined to developed countries, the model seriously *overstates the degree of carbon leakage* and the likelihood of jobs going off-shore.

- The MEGABARE modellers return the revenue from carbon taxes (the policy instrument used in the model) to tax-payers as *lump-sum payments*. Many studies have shown that this is the *worst option*, and that recycling revenue by reducing payroll taxes or taxes on investment is less costly and may even result in net benefits to employment and economic growth.

- ABARE uses various *presentational devices* which give a grossly misleading picture of the economic costs of reducing emissions. The results of the MEGABARE model indicate that the costs of cutting emissions would be extremely low.

In sum, the MEGABARE model does not provide accurate or reliable estimates of the economic impacts of emission reduction policies and should be disregarded. The Australian Government would be well advised to draw on alternative sources of economic advice, ones that give more comprehensive, considered, transparent and dispassionate assessments. Finally, in order to avoid suspicion of client capture, the Government's economic analysis should be funded solely from the public purse.

1. Background to the issue

The results of economic models have been a vital part of the debate over climate change policies in Australia. The Government has used the results of models to argue that proposed measures to reduce greenhouse gases would impose a very large burden on the Australian economy, much larger than other advanced countries. The Prime Minister has predicted big increases in unemployment and large wage cuts if the European proposal to cut emissions by 15% below 1990 levels by the year 2010 is adopted. He has also declared that his government will only sign an agreement that allows Australia to *increase* its emissions.[1]

The principal source of modelling advice to the Government has been the Australian Bureau of Agricultural and Resource Economics (ABARE), a research agency within the Federal Department of Primary Industries and Energy. ABARE has used an economic model known as MEGABARE to make projections about the economic consequences of policies to reduce greenhouse gas emissions.

These model results have provided the rationale for the Australian Government's advocacy of the 'differentiation' approach to setting emissions reduction targets at the international negotiations due to culminate in Kyoto in December. Under the Australian Government's differentiation approach Australia would be given a less stringent target than other OECD countries.

1 Eg. House of Representatives, Hansard 22 September 1997; *Australian Financial Review*, September 29 1997 and October 13, 1997.

The Australian arguments, and the economic modelling that has been used to support them, have attracted considerable controversy both at home and abroad. Within Australia there are now many critics of the Government's policies and the economic modelling that is used to support it. Recently, 131 professional economists – including 16 professors of economics – signed a statement critical of the Government's position and declaring that policy options are available that would slow climate change without harming employment or living standards in Australia. The statement is reproduced in the Appendix.

The purpose of this paper is to outline the role of economic models in the climate change debate in Australia and to evaluate their conclusions. Most emphasis will be given to the MEGABARE model because the Government has chosen to rely on it almost exclusively to develop and justify its position. The report is written for the interested lay person. Although the basic ideas captured by economic models are straightforward, many lay people (and indeed many economists) feel that the use of complex and arcane models excludes them from the debate. It is hoped that this paper will help to demystify economic models of climate change.

2. What is an economic model?

An economic model is an attempt to represent mathematically the major relationships and processes that govern the behaviour of an economy. Each relationship and process is built from economic theory or observations about actual behaviour. Since these relationships are the subject of more or less intense debate, a model is really a set of assumptions about how an economy works. For example, many economic models contain equations which purport to show what will happen to demand for a commodity, such as coal, when the price of coal changes. They also contain equations that attempt to capture the relationship between interest rates and investment, consumer behaviour and disposable income and growth of the world economy and demand for our exports. The assumptions built into models heavily influence the results that emerge from them.

Models used to analyse climate change policies contain tens of thousands of equations and huge data bases, and therefore require a great deal of computer power to solve. They can be structured in a way that allows modellers to evaluate the impact on the economy of changes in government policies, sometimes referred to as 'shocks'. Even though the models used to analyse climate change are enormously complex, the assumptions that must be made are simplifications of the real relationships they represent. The modeller hopes that the simplifications are valid and will hold good in the future.

> Despite the complexity of economic models, usually only a few key relationships are important for understanding their results.

Obviously, assumptions based on past experience are less likely to remain true the further we go into the future. This is a particular problem in the case of climate change modelling when we need to know the economic impacts of policies at least 20 or 30 years into the future. This is why modellers prefer to talk about 'projections' rather than 'predictions'. While a prediction is a statement about what is likely to happen in the future, a projection is a statement like this: "if the relationships captured in the model remain true then, holding everything else constant, the values of certain variables are expected to be as follows". Most economic modellers recognise that:

- the relationships captured in the model will not continue to hold true, especially over longer time periods; and
- other influences not captured in the model will affect the time paths of variables.

Assumptions are unavoidable in both formal economic models and the informal 'models' of the economy that policy makers, Treasury officials and foreign exchange dealers carry around in their heads. Writing down these models mathematically is a very useful way of exposing their assumptions to scrutiny. Typically, economic models are subject to intense scrutiny from the community of economists and the assumptions have to be defended, modified or discarded. A large part of this paper is devoted to evaluating the assumptions that have been built into economic models of climate change in Australia.

Unfortunately, some modellers fail to heed the distinction between predictions and projections and use their modelling results to make firm policy recommendations.

3. Economic models and their uses

The economic models of most interest are economy-wide models that attempt to capture all of the economic relationships that are judged to be important to the question at hand. Among these are a class of models known as computable general equilibrium (CGE) models. CGE models are structured in such a way that when they are solved through time on the computer the key variables converge on 'equilibrium' values, i.e. those that bring the whole system into balance. These are a class of models known as 'top-down' models; they are described and distinguished from 'bottom-up' or engineering models in Box 1.

The distinction between top-down and bottom-up models is important in the climate change debate as each type of model generally leads to very different conclusions about the economic impacts of measures to reduce greenhouse gas emissions. As a rule, bottom-up models indicate that the costs of reducing emissions would be much less than suggested by top-down models mainly because they allow for the existence of 'no-regrets' energy savings, i.e. measures that will reduce a firm's costs and are therefore worth doing even in the absence of greenhouse benefits.

Modelling results emerge by comparing different 'scenarios', i.e. sets of assumptions about the future that are fed into the model. Usually a number of policy scenarios embodying different policies and policy objectives are compared with the 'business-as-usual' (BAU) scenario. The BAU scenario reflects the modeller's set of assumptions about what is likely to happen over the modelling time frame in the absence of policy changes to reduce emissions.

A strategy to reduce greenhouse gas emissions is likely to involve a range of measures including taxes, mandatory energy standards for appliances and vehicles, abolition of subsidies to fossil fuels, promotion of research into renewable energy, extension of public transport and so on. Top-down economic models have great difficulty capturing most of these policy changes so that a carbon tax alone is generally used in order to achieve the desired change. A carbon tax set at high levels and introduced instantaneously would be a blunt instrument and would cause considerable economic dislocation. As a result, top-down models tend to exaggerate the costs of the transition away from heavy dependence on fossil fuels.

The economic costs of reducing greenhouse gas emissions depend on a comparison of some measure of national well-being (such as GDP or gross national expenditure) without the policy change – the business-as-usual scenario – and with the policy change. If the BAU scenario reflects an exaggerated growth in reliance on fossil fuels then the costs of reducing emissions will appear to be higher. As we will see in Section 5 both of these problems – using a single carbon tax and exaggerated reliance on fossil fuels – are present in the MEGABARE model.

Box 1 Top-down and bottom-up models

Top-down models are attempts to capture all of the key actors and relationships in an economy – the producers and the consumers of all types of goods and services, the behaviour of firms and households, the role of government as revenue raiser and spender, and the interaction of a national economy with the rest of the world through flows of goods and services and financial instruments. They are known as top-down models because the model-builders ‘stand above’ the economy and attempt to capture all of the features and relationships believed to be significant.

Top-down models are of two broad types. *Computable general equilibrium* (CGE) models are designed so that when solved all of the markets represented by supply and demand relationships ‘clear’, i.e. demand is just satisfied by supply at the equilibrium prices. CGE models place more emphasis on the detailed industry structure of the economy and are better suited to examining questions of longer term structural change. The basic building blocks for CGE models are input-output tables. In Australia the main CGE models are the ORANI model (now developed into the MONASH model), MEGABARE, G-Cubed and the IMP model.

Macroeconomic models are developed to capture shorter term aspects of the ‘macro-economy’. They generally do not disaggregate the economy by detailed industry group but place much more emphasis on capturing relationships within financial markets and aggregate behaviour of firms and households. They are based on statistically estimated representations of economic relationships based on data from previous quarters or years. (This type of statistical estimation is known as ‘econometrics’.) The principal macro models in Australia are the Treasury’s NIF model and the Murphy model.

In recent years, modellers have combined features of CGE and macro models to obtain better tools for making short-term and long-term projections of the impacts of policy changes.

When top-down models are used to analyse climate change policies the modellers usually pay extra attention to the structure of the energy-producing and energy-using sectors. However, they are structured in a way that sees policy changes translated into changes in emissions through the price system. Many experts with practical experience of business decision making and the nature of the energy market find this unsatisfactory because factors other than energy price changes can have a big impact on energy use.

Box 1 (continued)

Bottom-up models of greenhouse gas abatement focus on the technological choices that firms and households currently face or could face in the future. They thus begin with cost and performance data on a range of specific technologies in the energy sector. Once information on the various technological options is gathered the model is solved by finding the least-cost means of reducing emissions.

Bottom-up models, also known as 'engineering models', suffer from the disadvantage that they do not have the detailed representation of the rest of the economy that top-down models have. For example, changing energy technologies may over time effect labour demand and thus wage rates which in turn could affect technological choices. Nor do they capture projected changes in the demand for energy services.

However, bottom-up models have the advantage of being able to provide a much more realistic picture of how energy is actually produced and used and the energy-efficiency opportunities available to firms and households. These opportunities typically include the identification of inefficiencies in the current use of energy, indicating that investments could be made to save energy at no net cost. In a perfect world, these investments would be undertaken by profit maximising firms (and prudent households) even if there were no greenhouse benefits or inducements offered by the government. Their existence can be explained by 'information failure' – it takes an energy audit to point them out to managers – capital constraints (or very short pay-back periods) and risk aversion.

These costless energy savings are the 'no-regrets' measures that are the subject of hot debate. Top-down models generally assume that markets operate perfectly, so that efficient firms and households have equalised the returns on all of their investments so that there are no 'free lunches' not already devoured.

The principal bottom-up model used in Australia is MENSA, developed by ABARE from the international MARKAL model. MENSA results indicate that substantial costless energy savings are available in Australia (ABARE 1991).

Every economist who has been involved in building and using a model knows how easy it is to make a few innocuous and difficult-to-detect changes to the model that have a major influence on the results that come out at the end. This is why transparency is so important in using the results of economic models, i.e. clearly documenting the model and making it subject to peer review and public debate.

Modellers are faced with many decisions when building and using an economic model. They must make decisions about:

- what to include and what to exclude;
- how best to represent an economy mathematically;
- the data fed into the model;
- the nature of the policy experiments conducted; and
- how to interpret and present their results.

Each of these decisions can have a marked effect on the results that emerge from the model. Box 2 reports on a study by the World Resources Institute that reveals graphically just how important the assumptions of climate change models are in determining the estimated economic costs.

4. Economic models of climate change in Australia

Greenhouse policies in Australia have been analysed by a number of economic models. Among the CGE models, the three main ones are the ORANI model, the G-Cubed model, and MEGABARE. A brief overview of these models follows.[2]

ORANI

The ORANI model is a large CGE model of the Australian economy with more than 100 industry sectors. It does not include representations of other economies in any detail, but it is designed to show the influence of changes in trading patterns on the Australian economy. ORANI was originally developed to analyse changes in trade policies, especially the impact of tariff cuts. It is based on ‘neoclassical’ principles, i.e. it assumes market clearing behaviour. Like all models based on input-output tables it shows the direct and indirect effects of policy changes as they ripple through the economy.

ORANI is a ‘comparative static’ model, i.e. one that solves for all of the impacts of a policy change at once rather than through time. However, the MONASH model, the successor to ORANI, is a dynamic model, i.e. one that simulates the impact of a policy change through time allowing variables to adjust at different rates before reaching a new ‘equilibrium’.

ORANI has often been criticised for assuming that markets clear and for relying too heavily on substitutions between goods in response to changes in prices. If a high degree of substitution is built in to a model, so that the economy adjusts smoothly to a policy change such as a fall in tariffs, then the costs of adjustment will appear to be minimal.

[2] For a more detailed description see Hamilton and Common (1994) or James (1996).

Versions of ORANI have been developed to examine greenhouse policies (see, for example, McDougall and Dixon 1996). These versions have more elaborate representations of the energy sector of the economy allowing substitutions between different types of fuels as well as the substitution of labour and capital resources for energy. They also disaggregate the crucial electricity sector and allow various combinations of technologies for generating electricity – steam turbine, gas turbine, combined cycle, hydroelectricity, other fuel-burning and other non-renewables.

G-Cubed

G-Cubed is a dynamic model of the world economy in which the world is divided into eight regions, each with several industry sectors (five energy sectors and seven non-energy sectors) (McKibbin 1997). The regions are linked by flows of trade and finance. In particular, capital is assumed to be mobile so that rates of return on investments are equalised, at least between OECD countries. Like ORANI, it is a general equilibrium model but, unlike ORANI, it allows for lags in adjustment before the system reaches equilibrium. While the model converges on a market-clearing equilibrium in the long run, unemployment of resources can emerge for extended periods.

G-Cubed combines features of CGE models, which typically do not allow for adjustment problems, and macroeconomic models that have little sectoral detail. It also incorporates a set of assumptions about how households and governments plan their spending and savings behaviour in response to their expectations about how the economy will change in the future. They are said to display 'rational expectations'. The model attempts to integrate 'real' and 'financial' markets and takes into account the effects of changes in stocks of financial assets.

In analysing greenhouse policies the incorporation of wealth effects has led the G-Cubed modellers to conclude that global emissions trading would lead to large wealth transfers between countries and thus 'enormous stress on the world trade system' and exchange rate volatility (McKibbin and Wilcoxen 1997). However, it is not clear whether the instability is an artefact of the model or would be a real effect. In practice, one of the principal problems with emissions trading has been the *lack* of trading (and thus wealth transfer) rather than an excess of it.

MEGABARE

Like G-Cubed, MEGABARE is a global general equilibrium model. It was developed specifically to analyse greenhouse issues. It is a dynamic multi-country, multi-commodity model that can provide numerical estimates of the impacts of policies on the structure of trade and industry (Hanslow *et al.* 1996; ABARE 1997). Like G-Cubed it can also estimate the impact of Australian policies on our trading partners and the impact of their polices on us. Being a dynamic model means that sectoral rates of investment are determined within the model, and as such rates of return are equalised across countries. This is very important in explaining the emphasis that MEGABARE places on 'carbon leakage' (a phenomenon discussed below).

Box 2 How a model's assumptions determine its results

An important study by the World Resources Institute provides a powerful demonstration of the influence of the choice of assumptions on the results of climate change models (Repetto and Austin 1997). The authors assembled 162 different projections from 16 of the 'most reputable and widely used economic models'. They then carried out a statistical analysis (using regression techniques) in order to relate projections of changes in GDP due to emissions abatement policies to the most important assumptions made by the modellers.

Expressing them in the forms that give the worst case results (that is, the highest economic costs from policies to reduce emissions), the assumptions are as follows:

1. There are no non-carbon alternative fuels built in to the model, or these fuels become more expensive as demand for them rises.

2. There is no scope for improving energy efficiency because markets are assumed to operate efficiently.

3. Minimal inter-fuel and product substitution can occur.

4. No joint implementation is available, i.e. there are no opportunities to claim credits for reducing emissions in countries where the abatement costs are lower.

5. Carbon tax revenues are returned as lump-sum payments rather than recycled by cutting taxes elsewhere.

6. No account is taken of the avoided costs of air pollution from lower emissions.

7. No account is taken of the avoided damage from climate change.

The authors found that these seven assumptions – along with the type of model used and the assumed size of the emissions reduction – explain 80% of the variation in projected economic impacts.

The authors use the statistical relationship between the cost projections and the assumptions to plot several cost curves, reproduced in the figure below. Each cost curve reflects a different combination of assumptions. The lowest curve shows the costs when all seven worst-case assumptions apply, while the top-most curve shows the costs when all seven best-case assumptions apply. The curves are arranged so that the assumptions are progressively relaxed or changed according to the order of the list above. The upper curves show that under some assumptions there may be net economic benefits from cutting emissions.

MEGABARE allows for substitution among fuel sources in the electricity sector, although the model can only 'select' combinations of inputs that are consistent with existing technologies. Substitution can also occur between electric arc and blast furnace technologies in the iron and steel industry. The model assumes 'optimising behaviour in competitive economies' (Hanslow *et al.* 1996: 642) which, in the greenhouse context, means that it is assumed that maximum efficiency of energy use always prevails at given prices, i.e. there are no 'no-regrets' options available to firms and households to reduce energy consumption.

The MEGABARE model allows for some technological change by incorporating a rate of autonomous fossil fuel energy efficiency improvement of 0.8% per annum. However, the modellers assume that there is no stimulus to technological change induced by the introduction of greenhouse gas abatement measures. In other words, firms cannot respond to measures such as a large carbon tax by enhancing energy-saving or renewable energy technological innovation, even in the long term.

5. The MEGABARE model in the climate change debate

The Australian Government has based its international climate change position on the results of the MEGABARE model. Yet the model has been the subject of intense criticism from many quarters at home and abroad. In particular, many argue that the model is constructed and used in a way that seriously exaggerates the costs of reducing Australia's greenhouse gas emissions. As we have seen, the choice of assumptions made by economic modellers has a major influence on the results generated by their models. Here we examine the assumptions of the MEGABARE model and the way in which its results have been interpreted.

5.1 Benefits of emissions reductions measures

The principal benefits of reducing greenhouse gas emissions are the impacts of climate change that will be avoided as a result of international action. The potential physical impacts on Australia are summarised in Box 3; these are the costs of doing nothing. Most of them will give rise to direct, and possibly very large, economic costs. In other cases, such as the impact on species and ecosystems, the main concern is with the ecological and ethical values rather than economic values.

There is considerable uncertainty about the extent and severity of these impacts, and the further they occur into the future the greater the uncertainty. There is even more uncertainty about the economic values involved, although some economists have made estimates of the economic costs of doing nothing (IPCC 1996; Sorensen 1997; Frankhauser and Tol 1996). These studies indicate that climate change associated with a doubling of CO_2 concentration in the atmosphere will involve substantial net economic costs. Most climate scientists now believe that a doubling of CO_2 is unavoidable and research effort should be focussed on the climatic implications of a trebling of CO_2 concentrations in which case damages may increase more than proportionately (Whetton *et al.* 1996).

MEGABARE makes no attempt to assess the benefits of reducing greenhouse gas emissions. As a modelling strategy this is defensible; the purpose of the model is simply to measure the economic impacts of meeting emission abatement targets (although it does assume that climate change will have no effect on the baseline or business-as-usual projections). However, ***if this modelling strategy is adopted then it is impossible to make any judgements about the desirability or otherwise of reducing greenhouse gas emissions*.**

Basing climate change policies on MEGABARE is like arguing that Australia should not build the Olympic Stadium at Homebush because it will cost $1.5 billion. If the benefits are ignored then *every* action is too expensive.

Despite the obvious logic of this, the Government has used MEGABARE results to argue that Australia can afford to do very little to reduce our emissions. The Government has effectively assumed that the economic costs of climate change will be zero, or at least very low. The available evidence suggests that the economic costs – in agriculture, forestry, human health, infrastructure, tourism and insurance – are likely to be very high. The study by the World Resources Institute outlined in Box 2 showed that when economic models do take account of the benefits of averting climate change (and other forms of pollution associated with burning fossil fuels), there are indeed economic benefits from cutting emissions.

If only the costs of a policy change are assessed, and the benefits are excluded, then it is impossible to say whether the policy is desirable or not.

5.2 Treatment of technology

Most people would expect that if restrictions were imposed on consumption of fossil fuels, such as a large carbon tax, the natural reaction of businesses would be to seek out alternative energy sources. This new market would stimulate technological change leading to greater energy efficiency and cheaper alternatives to fossil fuels. It comes as a surprise therefore to find that the MEGABARE model assumes that there will be no additional technological change in response to greenhouse gas policies. How does MEGABARE justify this?

Firstly, the model does assume that the overall rate of energy efficiency in the economy improves by 0.8% per year (the so-called rate of autonomous end-use energy-intensity improvement or AEEI). Secondly, the model allows for technological choice in response to a policy change but it does so in a very unrealistic way, one which excludes new technologies and cost-reductions in existing alternatives.

ABARE decided not to use the standard method of modelling energy because it ‘can imply the use of technically unknown production processes ...[and] once a decision is made to use a particular technology, there is extremely limited scope to substitute other inputs for that form of energy’ (ABARE 1997).

Box 3 Impacts of climate change on Australia

CSIRO scientists have identified the following possible impacts of climate change on Australia (DFAT 1997).

- Mean temperature rises of up to 3.4 degrees C in capital cities by 2070.
- Increased winter rainfall.
- Sea level rise leading to higher storm surges, more frequent coastal flooding and damage to coastal ecosystems.
- Increased flooding in many areas.
- A substantial reduction in winter snow cover.
- More days of high and extreme fire danger over much of the continent.
- Major impacts on Australian flora.
- Increased productivity of some types of crops due to increased concentrations of carbon dioxide.
- Increased weed problems.
- Southward expansion of insect pests such as the cattle tick and Queensland fruit fly.
- Increased pressure on threatened species.
- Increased intensities of tropical cyclones.
- Higher incidence of diseases such as malaria, encephalitis, Ross River fever and dengue.

MEGABARE's 'fixed technologies' approach implies that there are no existing possibilities for improvements in the fuel-efficiency of electricity generation, including reductions in transmission losses and so on. It further implies that a large increase in the price of fuel will not result in any research and development effort aimed at discovering technological improvements.

A further difficulty arises with the way in which electricity produced using different technologies is treated. Most modelling is based on the assumption that the cheapest available technology will be used to produce any given good or service. For a capital-intensive technology like electricity generation, the rate of adoption of cheaper technologies will depend on the rate at which existing investments in power stations depreciate. If the price of coal rises relative to that of, say, gas, to the point where gas-fired generation is cheaper, new power stations will be gas-fired. Hence, if such a price increase is sustained over a long period, gas will displace coal as existing coal-fired stations are decommissioned and replaced by gas-fired stations.

In MEGABARE, however, electricity generated by different processes is combined in a way so that no input can be eliminated from the production mix. That means that coal-fired electricity is an indispensable input to the production of the final electricity product. With the MEGABARE modelling assumptions, an all-gas or all-hydro system of electricity generation is simply not feasible.

Moreover, the scope for expansion of an energy source is tightly constrained by its share in the base period. In particular, because Australia currently has very little gas-fired energy generation capacity, the structure of the model implies that there is very little capacity for future expansion of gas-fired generation. In reality, the replacement of coal by natural gas is expected by all experts to be the major factor dominating the electricity industry in Australia over the next 20 years (Anderson 1997).

Some of the non-standard features in MEGABARE would be justified if simulations were undertaken for a time horizon of ten years or less. But the claim that, over a period of 20 years or more, there is 'extremely limited scope' for substitution between fuel sources is nonsense. Over this time scale, most items of machinery, and even entire plants, can be written off. There are numerous examples of shifts in fuel mixes over considerably shorter periods, such as Japan's move away from reliance on oil after 1973.

The gap between the MEGABARE cost estimates and the true costs will increase over time as the factors deliberately excluded from consideration – such as the potential for endogenous technological change and the replacement of existing capital investments in coal-fired electricity generation with new plants using alternative technologies – become more important.

5.3 Business-as-usual assumptions

One of the largest opportunities to reduce Australia's greenhouse gas emissions lies in energy efficiency. There are now many studies in Australia demonstrating that large reductions in energy consumption are possible at no net cost. In other words, the investments required to save energy – such as through better lighting, electronic timing devices, insulation and changes in industrial processes – will be repaid in lower energy bills over a short period. Wilkenfeld (1996) lists nine Australian studies that show cost-effective energy measures resulting in energy savings of between 20% and 48%. Savings of this magnitude would allow Australia to meet emission reduction targets likely to be agreed at Kyoto at no economic cost.

MEGABARE assumes that these energy efficiencies do not exist. The modellers decided to impose on the model the theoretical assumption that markets operate perfectly, so that if there were any costless energy savings to be had then cost-minimising firms and households would already have exploited them. Clearly, by making this assumption, one that is contradicted by all of the evidence, MEGABARE seriously overstates the costs of reducing Australia's emissions.

Box 4 ABARE and the Club of Rome

In 1974, the Club of Rome released the results of a large scale modelling exercise under the title *Limits to Growth*. The central conclusion was that continued economic growth was feasible only through unsustainably rapid rates of exploitation of energy and mineral resources. Most economists who reviewed the *Limits to Growth* model argued that it was fatally flawed because it failed to take account of the possibility of technological progress or of substitution between factors of production. Economists argued that as particular resources became scarce their prices would rise. This would lead first to the substitution of more plentiful resources using existing technologies and then to research expenditure that would permit the development of less resource-intensive technologies.

The MEGABARE model is similar to the *Limits to Growth* model, except that the policy conclusion is reversed. Like the *Limits to Growth* model, MEGABARE yields the conclusion that continued economic growth, at least in Australia, requires unsustainably rapid rates of exploitation of energy and mineral resources. Unlike the Club of Rome, however, ABARE draws the conclusion that unsustainably rapid rates of exploitation must be allowed to proceed. As with *Limits to Growth*, the conclusions of MEGABARE are based on a modelling decision to exclude from consideration the possibilities of technological progress or of substitution between factors of production.

ABARE makes an equally serious mistake in defining the 'business-as-usual' scenario. The costs of reducing emissions will be influenced by the gap between the expected growth in emissions in the absence of any policy measures (business as usual) and the level to which emissions must be reduced to meet targets. If the growth of emissions under business as usual is exaggerated then the costs of attaining the target levels will appear to be higher. The MEGABARE modellers seriously exaggerate this growth in the crucial electricity sector (Pears 1997). How do they do this?

For the period 1992-2020, the model projects a 60% increase in the amount of electricity generated from coal under business as usual (ABARE 1997: 98). Electricity from natural gas is expected to increase from a small base by 137%. Experts in the industry expect the amount of gas-powered electricity to increase by 300% or more, mostly at the expense of coal (Anderson 1997; Pears 1997). Thus the business-as-usual scenario seriously exaggerates the growth of coal-fired electricity.

What happens in response to policies to meet emissions targets? In practice, the most important effect of such policies in the electricity sector would be to hasten the transition from coal to natural gas. Yet the MEGABARE model shows gas taking a *smaller* share of the market than under business as usual! At the same time the share of coal collapses and there is a massive growth in renewable energy sources which take 66% of the market by 2020. Even the most ardent advocates of renewable energy would not dare to hope for such rapid growth.

In addition to these problems, the MEGABARE model imposes all of the costs of adjustment to lower emissions on the energy sector. In fact only 60% of Australia's greenhouse gas emissions in 1995 came from the combustion of fossil fuels; the rest came mainly from land-clearing, forestry, landfills and agriculture (the latter two mainly in the form of methane) (NGGIC 1997). Indeed, it is a little-known fact that the official inventory of Australia's greenhouse gas emissions shows that our emissions actually *declined* between 1990 and 1995 (see Box 5). This was due to the influence of land-use changes and suggests that Australia may be one of the few countries in the world to achieve the Rio target of stabilising emissions by the year 2000. By analysing emissions reductions from combustion of fossil fuels only, the economic costs are unduly inflated because cheap opportunities for cutting emissions in the non-energy sectors are ignored.

The effect of these modelling errors is to force the economy to make a dramatic switch away from coal, requiring the early retirement of large investments in coal-fired generating capacity. But instead of switching to the obvious medium-term alternatives – natural gas and energy efficiency – the economy is forced by the model to adopt currently expensive renewables. In this way, the economic burden of greenhouse policies appear to be much higher than they would be in reality.

Box 5 Australia's falling emissions

Australia's latest official inventory of greenhouse gases shows that Australia's total greenhouse gas emissions actually *fell* by 3.1% between 1990 and 1995. Compiled by Australia's foremost experts, the new inventory revises earlier work on the contribution of land clearing to Australia's emissions.

	1990 Mt	1995 Mt
Net emissions excluding land-use change	379.6	402.4
Net emissions from land-use change	116.2	78.1
Total net emissions	**495.8**	**480.5**

(Source: NGGIC, *National Greenhouse Gas Inventory 1995* (1997))

The fall in emissions arises from a slow down in the rate of land clearing in the 1970s and 1980s. While estimates of emissions from land-use change are subject to considerable uncertainty, it is remarkable that no attention has been given to the policy implications of the role of land clearing. Much of this land clearing is economically marginal and causes environmental problems other than greenhouse gas emissions and therefore should not proceed anyway.

5.4 The types of costs of emissions reductions

Australia will potentially experience two types of economic cost as a result of mandatory reductions in greenhouse gas emissions. The failure to distinguish between the two has led to much confusion in the debate.

The first is the cost of reducing Australia's own emissions to the agreed level over the agreed period. Many people – including the 131 economists who signed the statement in the Appendix – believe that Australia could reduce its greenhouse gas emissions below 1990 levels by 2010 without any cost at all to the Australian economy.

The second is the cost to Australia of activities by other countries in fulfilling their obligations under the Climate Change Convention. As other countries reduce their emissions they will shift away from coal and towards natural gas, energy efficiency and renewables.[3] As worldwide demand for coal slows and then declines Australia's terms of trade with the rest of the world will deteriorate (unless, of course, Australia can sell other types of energy services and technologies to compensate for the decline in coal). In the MEGABARE results, the terms of trade effect accounts for 40% of the total estimated costs. The costs associated with declining terms of trade are unavoidable because they come about as a result of actions by other countries. Even if Australia withdraws from the Climate Change Convention – a prospect explored in Box 6 – these costs cannot be evaded.

".. it is clear that stabilisation of CO_2 at about twice pre-industrial levels would require eventual reduction of CO_2 emissions to less than 30% of current emissions" (Manning *et al.* 1996:22)

If, as many believe, Australia could reduce its own emissions to the required level at no economic cost, then the terms of trade effect is the only cost, and the total cost would be only 40% of that estimated by MEGABARE (assuming that the terms of trade effect is modelled properly). How big are the costs estimated by ABARE? We will see in Section 5.6 that they are in fact very small.

5.5 Carbon leakage and loss of industry

It is repeatedly claimed by the Government that if Australia is required to reduce its emissions then energy-intensive industries will shift off-shore with the loss of Australian jobs. Moreover, it is argued, since Australia's export industries are efficient energy users shifting industry to Third World countries would result not only in lost jobs but in an overall increase in global emissions, thus defeating the purpose of the international agreement. This process is known as carbon leakage.

It is argued that if Australia is given a more lenient target than other Annex 1 (OECD) countries then it will be able to specialise in production of metals in which it is more fossil-fuel efficient so that carbon leakage will be reduced. But there are several serious flaws in this argument.

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[3] Major new nuclear power programs are out of the question in Japan, the USA and Europe.

Firstly, how significant is carbon leakage likely to be? Different modelling exercises show differing levels of likely leakage, including some that show it to be very low, a few percentage points of reductions only (BIE 1995; McKibbin 1997). The MEGABARE model estimates a rate of carbon leakage of 13.9% for its more stringent scenario, i.e. for every million tonnes of CO_2 reduction in Annex 1 countries, an additional 139,000 tonnes will be emitted by non-Annex 1 countries (ABARE 1997:30-31).

Box 6 The costs of withdrawal from the Convention

Since all developed countries will reduce their consumption of fossil fuels in order to meet targets, the reduction in Australia's coal exports would occur even if Australia were simply exempted from any role in emission mitigation. Under this outcome, the reduction in exports would be partially offset by an expansion in exports of energy-intensive commodities such as aluminium, for which the cost of production in other developed countries would be increased by carbon taxes and other measures requiring reductions in emissions. Australia would be a beneficiary of 'carbon leakage'.

However, there is little likelihood that the rest of the world would allow Australia to gain an unfair trade advantage by avoiding its global pollution responsibilities. The minimum step that signatory countries could take in response to Australian withdrawal from the Convention is the imposition of a tax on the CO_2 emissions embodied in Australian exports of metal products. Such a step may be consistent with GATT, since Australia's failure to tax embodied CO_2 emissions would be equivalent to an export subsidy. A compensating import duty would be necessary to provide a 'level playing field' in world markets for aluminium and steel.

This scenario would have the same effects on Australian exports as compliance with the Convention's emission targets, except that the revenue from taxes on Australian emissions would go to foreign countries rather than accruing to Australia. This loss would offset any benefits arising from a failure to reduce growing emissions embodied in goods and services consumed domestically. Thus, even assuming a minimal response from other developed countries, Australia would gain little or nothing by pulling out of an international agreement. There is, of course, no guarantee of a minimal response by other countries.

The ABARE number is almost certainly a major exaggeration for Australia. Energy-intensive industries that are exposed to foreign trade account for around 17% of Australia's total greenhouse gas emissions (Hamilton 1997). To obtain the ABARE degree of carbon leakage would require nearly all of this industry to move out of Australia and into countries with much lower levels of energy efficiency.

Around 83% of Australia's greenhouse gas emissions derive from activities that are not subject to foreign competition (Hamilton 1997, Table 1). For these sectors, emission targets that increase energy prices would pose no threat to 'international competitiveness' or domestic employment.

There are several reasons why this is extremely unlikely. The main one is the assumption made by the MEGABARE modellers that an agreement on emission targets by Annex 1 countries will have no effect on non-Annex 1 (Third World) countries. In fact the Framework Convention itself, and all of the major parties, acknowledge that developing countries will be brought into the target-setting process once Annex 1 countries have shown the way. ABARE's analysis gives little credit to corporate decision makers who are assumed to relocate billion-dollar plants with 20-30 year life-times to countries that will also have to begin cutting emissions in a decade or so. The aluminium industry is discussed in more detail in Box 7.

Kyoto is recognised as only the first step in achieving the 70% cut in global emissions that scientists say is needed to avoid a doubling of CO_2 concentrations and potentially catastrophic climate change.

In addition, many experts (and industry analysts) believe that changes in energy prices have almost no impact on the decision to locate major raw-materials processing activities. Dr Lee Schipper of the International Energy Agency, and perhaps the world's foremost expert on energy policy, observes that big industries tend to be guided not by low energy costs but by the location of mineral resources, transportation and know-how. [4]

Box 7 Carbon leakage in practice

When we examine particular industries the Government's claims about carbon leakage become even less persuasive. Alan Pears has made the following observations concerning the future of the Australian aluminium industry (Pears 1997). A number of factors will allow continuing output growth at the same time as reductions in greenhouse gas emissions. These include:

- emissions per tonne of aluminium will fall by around 25% due to the fall in the greenhouse emissions intensity of Australian electricity;
- improvements in smelting technology by Comalco are expected to reduce energy per tonne by 15%; and
- sharp reductions in perfluorocarbon (PFC) emissions are reducing greenhouse gas emissions by 10% per tonne of aluminium.

Overall, emissions per tonne of aluminium could be reduced by more than 40%. A similar story can be told for the steel industry.

[4] *Australian Energy News*, Department of Primary Industry and Energy, September 1997.

5.6 Presentational tricks

It comes as a surprise to most people to discover that the economic costs of emissions reductions estimated by MEGABARE are extremely small. This is despite the fact that the MEGABARE model is constructed in a way that tends to exaggerate the costs of greenhouse gas reduction measures. This is surprising because the Government has persistently claimed, on the basis of ABARE's advice, that the proposed emissions reductions would be very damaging to the Australian economy. For example, it has claimed that:

- Australian wages would be cut by 20% below business-as -usual levels by the year 2020;
- GDP would be cut by 2% by 2020;
- each Australian would lose $9,000 from their savings accounts;
- tens of thousands of jobs would be lost; and
- the economic cost for each Australian would be 22 times higher than for each European.[5]

How can we explain the contradiction between the actual MEGABARE results and the predictions of economic ruin? The answer is through the use by ABARE of a number of statistical tricks in the presentation of its modelling results.

Welfare changes in the MEGABARE model are measured by changes in annual per person real gross national expenditure (GNE). The model results in 1995 indicate that real GNE falls below the 'business-as-usual' path by amounts ranging from -0.27% in the year 2000 to -0.49% in 2020 (DFAT & ABARE 1995). It is most important to recognise that this does *not* mean that the *growth rate* of GNE is lower by these amounts, but that the absolute levels of real GNE are lower by these amounts. This is a very small change by any standard. Clearly a projected fall in GNE by half a per cent over a 25 year period will be swamped by many other changes in the economy.

The statistical error normally made by the Australian Bureau of Statistics in measuring GNE is greater than ABARE's estimate of the economic cost of emissions reduction policies.

One way of understanding the size of the costs predicted by MEGABARE is to compare them to income levels in the future. If the Australian economy grows on average by 3.5% then per capita incomes will reach double their current levels around 1st January 2025. If Australia adheres to its international commitments and reduces its emissions then, according to the MEGABARE estimates, the doubling of per capita incomes will have to wait until around 1st March 2025, a delay of two months.

5 Eg. *Australian Financial Review*, October 13 1997; ABARE 1997; Department of Foreign Affairs and Trade, 'Climate Change: Australia's Approach', Briefing Paper July 1997.

The US Environmental Protection Agency recently commissioned three US modelling groups to estimate the costs of reducing emissions to 1990 levels by the year 2010 by increasing the prices of fossil fuels. Based on these modelling results, the Interagency Analytical Team concluded that 'the losses of economic output resulting from such a policy are real, but relatively small and transient'(Interagency Analytical Team 1997).

These MEGABARE results are embarrassing for the Government. On advice from ABARE, the Government has therefore presented the results in ways that appear to support its case. The Minister for Resources, Senator Parer, has declared in the Senate that stabilisation of greenhouse gas emissions at 1990 levels by the year 2000 would

> have a cumulative effect upon our economy equivalent to a loss of some six per cent of our 1996 gross national expenditure ... [and that this] would be equivalent to a loss in the savings of every Australian of $1,900 in 1996 dollars or a reduction in the savings of a family of four of about $7,600 (*Senate Hansard*, 26 November 1996).

This statement is misleading. The only way to make the numbers 'look big' is to take a series of very small numbers over a very long period (25 years from 1996-2020) and aggregate them. Thus ABARE aggregates projected short-falls in GNE for each year over the period 1996-2020 to arrive at a total figure (after discounting at 5%) of $1,900 per person or $7,600 'for a family of four'. Senator Parer and ABARE say that this is 'equivalent to' taking $1,900 from every person's savings account or $7,600 from the savings of a family of four.

ABARE has used the device of using present value lump sums rather than annual flows, thus multiplying the estimated impact by a factor of between 15 and 20. Then it estimates the impact on a family of four rather than per person. Both of these deviate from normal practice in reporting modelling results. In effect, ABARE takes the number and multiplies it by 60 before putting it into a media release. The $7,600 per average family should in truth be compared to the accumulated expenditure over the same period which, in present value terms, would be around $1.86 million for 'a family of four'.

ABARE's presentational tricks could be used in reverse. We could use MEGABARE results to claim that it would cost us only one middy glass of beer each week to save the world from climate catastrophe.

More recently, ABARE has revised its model. The new results multiply the costs to Australia around fivefold so that estimated costs amount to 2.5% of GNE by 2010 and 3.3% by 2020 (ABARE 1997). Now ABARE claims that the expected emissions targets would cost each Australian $9,000. If true, this means that Australians would need to wait until the 1st December 2025 before their incomes double. The principal reason for this is a change in the model which limited the options to switch to hydroelectricity. If making a small change to the assumed response by the economy to abatement measures can quadruple the estimated economic costs, the whole structure of the model must be questioned.

Some commentators argue that we should not attach much credence to the projections of climate change by the IPCC because its second assessment report reduced the amount of warming projected to occur over the next century by one third (eg. O'Brien 1997). (This is despite the fact that a major reason for the adjustment was a better understanding of the role of aerosols which appear to be *masking* the level of warming due to the enhanced greenhouse effect.) However, many of these same commentators uncritically accept the results of the MEGABARE model despite the fact that minor changes to the model have resulted in a *fourfold* increase in projected economic costs over a 14 year period. The variability in the MEGABARE results is vastly greater than that of the IPCC assessments, so consistency would require the 'sceptics' to reject MEGABARE results even more categorically.

5.7 Revenue recycling

Most economic models of climate change, including MEGABARE, employ a carbon tax as the 'policy instrument' used to reduce emissions. A carbon tax set at an effective level would raise large amounts of revenue. Even a relatively low-level carbon tax of around \$28 per tonne of CO_2 would raise around \$8 billion, enough to eliminate payroll tax. In its more recent work, ABARE has estimated that a massive carbon tax of \$246 per tonne of CO_2 would be needed to cut emissions to the required level.

Economic modellers of climate change must decide what to assume about how this revenue is used by the government. Traditionally modellers assumed that the revenue would be returned to taxpayers in the form of a lump-sum payment. In practice, governments will be faced with a choice: they can spend the revenue, reduce budget deficits or cut other taxes. Many modelling studies have shown that this choice has a major impact on the projected economic costs of emission reduction measures. In particular, if the carbon tax revenue is used to reduce taxes on labour and capital then the costs of reducing emissions are much lower, and there may be a net economic benefit of the tax swap. [6] This is known as the 'double dividend' that may arise from revenue recycling.

In Australia, a number of modelling studies have shown that recycling carbon tax revenue through payroll tax cuts may increase economic growth and reduce unemployment (Common and Hamilton 1996; McDougall and Dixon 1996). Such a tax swap increases fossil-fuel energy prices and reduces the cost of employing labour, and through this means tackles two problems at once.

Although there is some variation across countries according to economic and tax structures, in general modelling studies show that the best option is to cut taxes on investment and payrolls, the next best is to cut corporate taxes, and the worst options are to cut income taxes and to make lump-sum transfers. Some of the modelling evidence for the US economy is summarised in Table 1. The MEGABARE modellers have chosen to return the carbon tax revenue by way of lump-sum transfers. In other words, they have selected the option that generates the highest costs of meeting emissions targets. *The Government has therefore not been advised on the best policies to meet the objective of reducing emissions.*

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6 Some of the Australian and overseas studies are reviewed in Hamilton, Hundloe and Quiggin 1997.

Many studies have shown that the economic impact of a carbon tax depends critically on how the tax revenue is spent. The worst use of the revenue is a lump-sum transfer to consumers. Yet this is precisely what MEGABARE assumes.

Table 1 GDP Loss (1990-2010) in the USA Under Various Revenue Recycling Options (percentage change in discounted real GDP)

		Model		
Recycling option	**DRI**	**LINK**	**DGEM**	**Goulder**
Lump-sum tax cuts	-0.58	-0.46	-0.62	-0.24
Personal income tax cuts	-0.56	-0.53	-0.16	-0.16
Corporate tax cuts	0.40	-0.11	0.60	-0.17
Payroll tax cuts				
employee only	-0.58	-0.53		
employer only	0.19	-0.25		
Investment tax credit	1.55	1.67		0.00

Source: Shackleton *et al.* 1992

5.8 Model credibility and industry funding

The position the Australian Government will present at Kyoto is one that appears to be driven by the interests of the Australian coal and energy-intensive industries, with little concern for the environmental and economic damage that is expected from global climate change. This interpretation is denied by the Government which claims that it is seeking an effective international agreement that will slow the growth of emissions and ultimately reduce them. It is important for Australia's national interests that our country should not be perceived as self-interested and obstructionist on an issue of critical importance to the future of humanity as a whole, and particularly to many of our Pacific neighbours which face the threat of inundation by rising sea levels. In this context, if the government is to rely on results from the MEGABARE model, it is crucial that the model should be regarded as a credible basis for the assessment of the costs of mitigation policies.

However, the history of the model and the way it has been used greatly reduce its credibility. The fact that the MEGABARE model has been funded largely by companies and industry organisations associated with the fossil fuel industries redoubles doubts about the independence of the modelling work. Details of the funding of MEGABARE by fossil fuel-based corporations are reported in the Appendix.

It must be asked whether fossil fuel based corporations would continue to fund the MEGABARE model if it generated results that were contrary to their commercial interests.

It is well known that models used by consultants can be 'tweaked' to produce the results desired by their clients. A model constructed by an agency of a Government already on record as opposing an agreement requiring mandatory emission reductions, and funded primarily by the industry that sees itself as the main loser from such an agreement, has a credibility problem irrespective of the professionalism of its designers. Such a credibility problem may be overcome in the long term through a clear demonstration that modelling decisions will be driven by independent economic analysis and that results will be published and reported in an unbiased fashion, regardless of whether they are consistent with the policy position and commercial interests of those who have funded the model.

This has not happened with MEGABARE. Misleading descriptions of model results have been used by the Government to justify its policy stance to the Australian public. In the short term, this has provided the Government with highly effective debating points against its domestic critics. However, the effect has been to further undermine the credibility of the model.

The Australian Government has not yet exposed its economic modelling to thorough professional scrutiny and is therefore asking others to accept the results largely on faith. Few people are willing to do so.

6. What Does It All Mean?

Economic models are powerful devices for providing analysis of the possible economic implications of measures to reduce greenhouse gas emissions. But their value is diminished when they are misused to support a particular point of view. While there are several economic models that can provide insight into policy choices in Australia, the Government has relied almost exclusively on the MEGABARE model. The evidence provided in this paper shows that the model construction, its use in greenhouse policy analysis and the interpretation of the results have been biased in a way that exaggerates the economic costs of reducing emissions.

The principal objections to the construction and use of the MEGABARE model may be summarised as follows.

- The model fails to account for 'no-regrets' energy saving measures which may be as high as 30% of energy used in Australia.

- The model fails to allow for technological change in response to policies to cut emissions. Its rigid representation of the process of technological choice and technological change severely constrains the ability of the economy to adapt to the new circumstances.

- The model operates in a way that produces projections of changes in types of fuels used that are wholly inconsistent with expert opinion on likely changes in energy consumption patterns in Australia.

- The model is used to make recommendations against major emission cuts even though no account is taken of the economic or environmental benefits of reducing emissions.

- The model ignores the non-energy sources of greenhouse gas emissions (which account for 40% of the total) so that the costs of emissions reduction fall entirely on the energy sector thereby driving up the estimated costs.

- By assuming that emission targets will be confined to developed countries, the model seriously overstates the likely degree of carbon leakage and the likelihood of jobs going off-shore.

- The MEGABARE modellers return the revenue from carbon taxes (the policy instrument used in the model) to tax-payers as lump-sum payments. Many studies have shown that this is the worst option, and that recycling revenue by reducing payroll taxes or taxes on investment is less costly and may even result in net benefits to employment and economic growth.

- Estimates of the economic costs of emissions cuts are presented in ways that are highly misleading, ways that make small costs appear to be large.

In sum, the results of the MEGABARE model do not provide accurate or reliable estimates of the impacts of emission reduction policies and should be disregarded. Mistakenly, the Government appears to have relied on these model results to entrench its belief that emission reduction policies would be too costly. Economic models could play a very useful role in helping the Government to reach a proper assessment of the implications of climate change policies. However, the models need to be constructed and used in ways that give unbiased and transparent results.

Appendix

A Statement by Australian Professional Economists on Climate Change

1. A report by over 2000 distinguished international scientists under the auspices of the Intergovernmental Panel on Climate Change has determined that 'the balance of evidence suggests a discernible human influence on global climate'. As economists we believe that global climate change carries with it significant environmental, economic, social and geopolitical risks and that preventive steps are justified.

2. Economic studies have found that there are many potential policies to reduce greenhouse gas emissions for which the benefits outweigh the costs. Policy options are available that would slow climate change without harming employment or living standards in Australia, and these may in fact improve Australian productivity in the long term.

3. The economic modelling studies on which the Government is relying to assess the impacts of reducing Australia's greenhouse gas emissions overestimate the costs and underestimate the benefits of reducing emissions.

4. Economic instruments – such as carbon taxes and trading of emission permits within and between countries – will be an important part of a comprehensive climate change policy. 'Joint implementation' policies, in which Australian firms carry out emission-reduction investments in developing countries, can also play a significant role. Revenues raised from taxes or the sale of permits can be used to reduce the budget deficit or to lower existing taxes.

5. Developing countries will need to take measures to reduce significantly their greenhouse gas emissions in due course. But since OECD countries are responsible for over 80% of increased greenhouse gases in the atmosphere, and are in a stronger economic position to reduce their emissions, they should take the lead in cutting emissions.

6. An appropriate equity and efficiency principle for the distribution of the emissions reductions is one where countries which are responsible for high per capita emissions and which are more wealthy should do more to reduce their emissions.

7. Withdrawal from the Framework Convention on Climate Change could seriously harm Australia's long-term economic and diplomatic interests. It would be damaging to our longer-term economic interests if Australia became locked into a fossil-fuel based economic structure while the rest of the world shifts to low-emission energy sources over the next decades.

Signed by 131 professional economists

Funding of MEGABARE climate change modelling

Company/Organisation	*Contributions*	*Share of total contributions*
1993-94		
Australian Coal Association	$50,000	
Total	***$50,000***	***28%***
1994-95		
Australian Coal Association	$50,000	
Business Council of Australia	$60,000	
Total	***$110,000***	***52%***
1995-96		
Figures not supplied		
1996-97		
Australian Aluminium Council	$25,000	
BHP	$50,000	
Business Council of Australia	$50,000	
CRA Ltd	$25,000	
Den Norske Stats Olijeselskap (Statoil)	$50,000	
Electricity Supply Association	$50,000	
Exxon Corporation	$50,000	
Mobil Oil Australia Ltd	$50,000	
Texaco Corporation	$50,000	
Total	***$400,000***	***80%***

Source: Senate Hansard, Questions on Notice No. 565, 2 May 1997

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