

Greenhouse economics: the Australian Government mobilises the numbers in the lead up to Kyoto.

Honours Thesis

By

RONLYN DUNCAN

Submitted in partial fulfilment of the requirements of a B.A. (Honours) degree with the School of Science and Technology Studies, Faculty of Arts & Social Sciences, University of New South Wales, Sydney.

November 1997.

TABLE OF CONTENTS

INTRODUCTION	4
CHAPTER ONE	9
<i>Why is the Australian government refusing to adopt legally binding reduction targets? A survey of its perspective as the world's largest coal exporter and the most to lose from an acceptance of climate change as a serious environmental threat</i>	<i>9</i>
CHAPTER TWO	19
<i>The existence of uncertainty in regulatory science debates means that the 'interpretative gap' is bridged by domains usually thought to be external to science.</i>	<i>19</i>
CHAPTER 3	30
<i>Quantification is a powerful style of rhetoric, but is it also a misplacement of trust?</i>	<i>30</i>
CHAPTER FOUR.....	38
<i>Despite economic models embodying mathematical language and notions of objectivity and authority, their rhetorical value is in their 'interpretative flexibility'.</i>	<i>38</i>
CHAPTER FIVE	45
<i>The 'contextualisation' of MEGABARE and the proliferation of informal rules to create a useful rhetorical device in support of the Australian government's position in climate change negotiations</i>	<i>45</i>

CHAPTER SIX.....	62
<i>The mobilisation of MEGABARE and its role in overshadowing the 'environmental reality' of climate change with an 'economic reality'</i>	<i>62</i>
CHAPTER 7	77
<i>Climate change might be happening elsewhere in the world, but it is not happening in Australia.....</i>	<i>77</i>
CONCLUSIONS.....	97
WORKS CONSULTED	101
APPENDIX 1	109
APPENDIX 2:.....	111
APPENDIX 3.....	112
APPENDIX 5.....	114

INTRODUCTION

The United Nations Framework Convention on Climate Change (FCCC) was signed by 155 countries at Rio de Janeiro in 1992 and it was ratified in 1994. The Convention is based on the belief that to avoid the detrimental effects of climate change, greenhouse gas emission levels need to be significantly reduced¹. In 1995 the Intergovernmental Panel on Climate Change (IPCC)² released its Second Assessment Report (SAR) which states that "the balance of evidence suggests a discernible human influence on global climate" (IPCC 1995, Section 4). The IPCC SAR represents a consensus of 2,500 scientists. The Australian federal government is adamant that it accepts this scientific consensus and declares that Australia will play its part in reducing greenhouse gas emissions³. However, its refusal to commit to legally binding targets and substantially reduce its emissions appears to contradict these assertions. This situation begs the question that if the possible detrimental effects of climate change are so severe, then why is there hesitation to take action? A reasonable conclusion could be that if climate change was *really* a serious threat, then Australia would not be taking the stand that it is. However, the IPCC scientific consensus and concerns expressed by many commentators about the risks of not taking action are difficult to ignore.

¹ References throughout this thesis to "climate change" should be interpreted as meaning human-induced climate change.

² The IPCC was established in 1988 under the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO). It was the first climate change body established. Its role is to provide scientific, technical, economic and policy advice on the issue of climate change (Stuart 1994 pp 211-213).

³ Future reference to "the government" should be interpreted as "the Australian federal government" unless otherwise stated. Future references to "emissions", "reduction emissions", "reduction targets" will relate to carbon dioxide emissions unless otherwise stated. FCCC negotiations relate to other greenhouse gases such as methane, nitrous oxide and perfluorocarbons, however, there is disagreement between countries in relation to which gases should be reduced by a legally binding target, for instance, only carbon dioxide or all gases (DFAT 1997 pp 22 & 61-66).

Australia has not always opposed emission reduction targets. In 1990 both federal and state governments announced their commitment to the 1988 Toronto target:

... to stabilise greenhouse gas emissions (not controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer) based on 1988 levels, by the year 2000 and to reduce these emissions by 20 per cent by the year 2005 ... subject to Australia not implementing response measures that would have net adverse economic impacts nationally or on Australia's trade competitiveness, in the absence of similar action by major greenhouse producing countries (DEST 1992 p 8).

In his dinner speech in November 1991 at The International Conference on Coal, the Environment and Development, the Chief Executive Officer of CRA Limited stated:

I understand that officials around the world have come to recognise that the Toronto target is not achievable. The international negotiators now talk about emissions stabilisation or minimisation. Australia has the dubious distinction of being one of three countries (with New Zealand and Denmark) still arguing for a version of the Toronto target. One might admire the altruism of such a position, but it will certainly do nothing for the ordinary Australian and very little for the environment. In early discussions on the Toronto target our Government clearly spelt out its intention not to "proceed with measures that would have net adverse economic impacts nationally or on Australia's trade competitiveness in the absence of similar action by major greenhouse gas producing countries". It is a disturbing fact that in recent discussions on the issue there is an observable tendency to omit this vital caveat. I understand that other countries have similarly qualified their intentions and it would be quixotic of Australia not to adhere to this sensible policy (Ralph 1992 p 861).

Obviously, there has been a considerable change of heart⁴.

In recent times, Australia has been unashamedly vocal in its opposition to what currently appears to be international agreement to reduce emissions by imposing legally binding targets on Annex 1 countries⁵. The statements and actions of the government, industry and the Australian Bureau of Agricultural & Resource Economics (ABARE) demonstrate that the greatest perceived threat to Australia from

⁴ See Appendix 1 for a sequence of international and domestic events and dates since the Toronto target was proposed in 1988.

⁵ Countries listed in Annex 1 of the FCCC have committed to emission abatement under Article 4.2(a) and (b) of the Convention. In general terms, they are developed countries and countries which have economies in transition. For instance, United States, European Union, Japan, Canada, Former Soviet Union and Australia (ABARE & DFAT 1995 xii).

climate change is not environmental, it is economic⁶. This threat has taken on a firm 'reality' for these actors with the quantification of the impacts of emission reduction targets on the global economy by ABARE using its economic model, MEGABARE. It will be argued that, armed with the findings of MEGABARE, the government, ABARE and industry have been deliberate in their attempt to redefine the climate change debate in Australia and internationally by overshadowing the 'environmental reality' with an 'economic reality' (cf. Wynne 1996 pp 363-365). MEGABARE has provided the means for this transformation. A concern for this thesis is that this 'economic reality' is difficult to deconstruct because of the authority and notions of objectivity attributed to quantification and the ease with which quantified rhetorical statements can be mobilised in the political arena. A further concern is the extent to which this 'economic reality' is constrained by a culture intimately connected to the coal industry and power generation as well as the limitations of economic modelling which, by mathematical necessity, perpetuate the *status quo*.

This thesis will begin with a survey of the government's actions on climate change since the endorsement of the Toronto target, and the various aspects of its current position in an attempt to view the current negotiations from the perspective of the government and the world's largest coal exporter. It should be recognised that the claims supporting the government's current opposition to the FCCC negotiations were being expressed pre-MEGABARE⁷. The important point is that MEGABARE has played a vital role in communicating both domestically and internationally the

⁶ Reference will be made throughout the thesis to the general entities such as "the government", "ABARE", "industry", "sustainable energy supporters". It should be recognised that these classifications are being used merely for convenience and that they are groups of individuals. Comments and behaviour attributed to them should be interpreted as being that of individuals. Reference to "industry" should be interpreted as industry councils or companies that have a vested interest in the continued use of fossil fuels, particularly coal, e.g. BHP Limited, the Business Council of Australia, CRA Limited, the Electricity Supply Association, *etc.* See Appendix 3.

⁷ The change of heart must have occurred during 1992, after the comments of J.T. Ralph of CRA Limited. There has been minimal change in the points being raised in papers published by ABARE researchers in *Australian Commodities* since 1992, although the first article located which indicates the use of MEGABARE and sets out its findings is Hanslow *et al.* (1994 September). See , Haynes, *et al.* (1990); Neck *et al.* (1992); ABARE (1992a); Treadwell (1993); Fisher (1994 March); Stuart (1994 June).

'worldview' of coal and power generation held by the government, ABARE and industry. To show how this has been possible, it will be necessary at the outset to introduce an epistemological discussion which contrasts a sociological account of knowledge, 'finitism', with a rationalist account, 'extensional semantics'. A 'finitist' perspective acknowledges the inherent existence of uncertainty and 'interpretative flexibility' in scientific knowledge-claims. These circumstances can be exploited in debates surrounding policy-relevant science to reinforce or change the direction of judgements and consequently, the nature of knowledge. The acceptance or rejection of these judgements can determine whether climate change is understood to be a severe environmental threat or one that is adaptable with perhaps beneficial impacts. It will be argued that rhetoric plays a major role in determining the direction which the construction of knowledge takes. It is on this basis that the thesis will focus on quantification which is characterised as a particularly powerful style of rhetoric. It will be argued that quantification, despite its semblance of authority and objectivity, can be a misplacement of trust because of its capacity to hide assumptions that accomplish political objectives, and its tendency to generate complexity proportional to demands for transparency and standardisation. To elaborate upon these ideas, the discussion will move on to economic models which are viewed as a form of quantitative rhetoric which can generate tractable knowledge-claims for mobilisation in the political arena. It will be argued that the characteristics of quantification are exemplified by economic models and that their rhetorical value is in their 'interpretative flexibility'. Collectively, these theoretical claims have implications for an analysis of the climate change debate in Australia. First, they bring into focus the nexus between the domains of science, politics and economics. This is in contrast to a traditional view whereby the findings of science would be taken as 'truth', a policy response would be structured to accommodate this 'knowledge' and any economic ramifications would be viewed as inevitable. Second, it allows an exploration of the interactions that are played out between these domains.

Having developed a 'finitist' theoretical framework around the issue of quantification, the focus of the thesis will turn directly onto ABARE and MEGABARE. It will be shown that MEGABARE has been constructed to reflect the 'worldview' of ABARE, the government and industry in terms of fuel switching and future power generation. During the mobilisation of MEGABARE's findings, the views of the government and ABARE, and the interpretations of MEGABARE's results have been strongly criticised. It will be necessary to discuss these criticisms in some detail so that the limitations of ABARE's economic modelling are understood and also the extent to which the modelling is constrained by the *status quo*. It will be argued that the mobilisation of the findings of MEGABARE by the government and ABARE has been an attempt to overshadow the 'environmental reality', which the FCCC was founded upon, with an 'economic reality', generated by MEGABARE. Given the policy-relevant nature of the IPCC science, the imperatives and limitations of the domains of politics and economics have acted to contextualise the scientific consensus. Having demonstrated this, it will be argued that judgements in relation to the IPCC science and the severity of climate change have been made contingent upon economic judgements.

CHAPTER ONE

Why is the Australian government refusing to adopt legally binding reduction targets? A survey of its perspective as the world's largest coal exporter and the most to lose from an acceptance of climate change as a serious environmental threat

To set the scene, it should be recognised that carbon dioxide is only one of several greenhouse gases considered to be contributing to climate change, however, its contribution is by far the greatest. The main source of carbon dioxide emissions is the burning of fossil fuels. The fossil fuel that emits the highest amount of carbon dioxide (per joule of energy released) is coal (Hammond *et al.* 1991 p 12). Coal is the cheapest and most abundant energy fuel and is, therefore, the most widely used for the generation of power. The burning of coal to generate power has made industrialisation possible all over the world (Steeg 1992 pp 19-20). The generation of power is a symbol of economic development. Therefore, any policy that imposes a reduction on carbon dioxide emissions will be perceived as a direct threat to the very foundation of industrialisation, economic growth and standards of living.

Australia has the world's largest coal reserves (31% of the total world resource) which will last for at least another 385 years (DPIE 1996b p 13). Australia is the world's largest coal exporter (Melanie *et al.* 1994 pp 475-476). Coal is Australia's largest single export commodity and it generates 80% of Australia's electricity (Stuart 1994 pp 213-214). The abundance of its coal resource gives the country a comparative advantage in international markets for its exported goods (Business Council of Australia 1993 p 28)⁸. An enforced reduction in coal use is equated with a considerable rise in costs to substitute more efficient or non-emitting technology for existing fossil fuel technology. This would require the premature

⁸ It is claimed that this comparative advantage would be significantly reduced if industry and power generation subsidies and cross-subsidies were removed (Diesendorf 1996 pp 33-48).

retirement of existing capital⁹. Also, it is assumed that such reductions will make Australia less competitive in its export markets and reduce its export income. Energy efficient use is dismissed as a trivial contribution to reducing emissions¹⁰. The government claims that the effect of these factors is a substantial welfare loss for every Australian in terms of gross national expenditure (GNE) and massive job losses¹¹.

Australia has vast reserves of coal that have a distinct price advantage over other potentially less emission intensive fuels, such as natural gas and renewables in electricity generation, given existing capital structures. The penalty for emitting carbon dioxide in this region must rise significantly in order to make coal a less attractive input than other fuel sources and thus for substitution to occur (ABARE 1997a p 44).

In 1990 both federal and state levels of government endorsed the Toronto target but that endorsement was made conditional upon abatement measures not having an adverse impact on Australia's economy and other major emitting countries

⁹ A legally binding reduction target is likely to enforce technological change on industry before it is ready to retire its existing fixed capital. In its submission to the Industry Commission (IC), BHP Limited indicated that it would support incremental change with incentives to do so. However, it would not be prepared to incur huge capital costs when, in its view, such action would only result in a minimal reduction in emissions (IC 1991 p F71).

¹⁰ See Dickson & Pakravan (1995 p 11). It has been expressed by ABARE (1992a p 36 & Treadwell 1993 pp 85-93) that encouraging energy efficiency could increase energy use. This view is rejected by the sustainable energy supporters.

¹¹ As far as it can be ascertained, a change in GNE relative to business-as-usual under uniform abatement of approx. -2.5% is made up of a trade related loss of 1.0% and a technology substitution/carbon tax loss of 1.5% (ABARE 1997a p 54 & 79). It should be noted that GNE, as a measure of welfare, is different to GDP (Gross Domestic Product) (ABARE 1997a p 35). GNE specifically captures fluctuations in the trade balance. This is needed for ABARE to show monetary variation between countries. It reflects how much is spent in an economy which would include amounts borrowed offshore. In contrast, GDP, in general terms, is a measure of domestic income. Warwick McKibbin stated in an interview on 4.8.97 that "if a student used GNE in a paper as a measure of welfare, I would fail them". McKibbin is a Professor of Economics at the Australian National University, a member of the US based Brookings Institution and member of G-cubed climate change model team which is being used in formulating the United States position on climate change. In MEGABARE, the high economic cost of the technological change is quantified by modelling the introduction of a carbon tax into the economy. However, the government does not advocate the introduction of a carbon tax and would strongly oppose one. In terms of job losses, the Prime Minister, John Howard claimed that 90,000 jobs would be lost if a reduction target of 15% below 1990 levels was adopted (ABC Triple J radio news 22.9.97). Senator Robert Hill, the federal Minister for the Environment, rejected Japan's proposal of a 5% uniform reduction in emissions below 1990 levels by the year 2012 on the basis that it would result in unacceptable job losses in Australia (ABC television 7.00 pm news 6.10.97). This indicates no reduction level is acceptable.

taking similar measures (Henderson-Sellers 1993 pp 203-209)¹². Consequently, in December 1990 the then Labour government directed the Industry Commission (IC) to evaluate the costs and benefits of adopting the endorsed Toronto target. The IC (1991 p 50) could not quantify or even articulate the benefits of reducing emissions. This would require the quantification of the benefits of avoiding climate change. In relation to the costs, it concluded:

Australia would be affected through the impact of energy prices resulting from whatever domestic mechanisms are put in place to cut emissions. Taxes on energy will raise prices to users and reduce producer returns. This will cause a reorientation of Australian production away from the production of energy and energy intensive products, with a consequent effect on Australia's output and industry structure. ... [B]ecause of the importance of trade to Australia's economic performance, the effects of ... [an international] consensus on Australia's major trading partners' economies will be particularly important. The more severe the effect of a world-wide commitment to reduce emissions on the economies of Japan and the OECD countries, as major markets for Australian exports, the more severe will be the effects of a consensus on this country (IC 1991 p 53).

Therefore, the implementation of the Toronto target would not be in Australia's economic interest (domestically or in terms of trade). Furthermore, the negative impact on Australia's trade would be inversely proportional to the number of its trading partners that committed themselves to reduce their emissions.

The FCCC, signed in 1992, incorporates qualifications regarding the economic impact of abatement measures and provides that the reduction in emission levels by Convention signatories should take into account:

.... the differences in Parties' starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties to the global effort regarding that objective. (Part Item 2(a) Article 4: Commitments).

¹² The Toronto target only required the reduction of carbon dioxide emissions (DFAT & ABARE 1995 p xviii) however Australia committed to reducing other greenhouse emissions as quoted in the Introduction. It is noted that DEST (1992 p 8) makes reference to the 1990 commitment as an interim planning target and characterises it is a "yardstick" by which future action could be measured. However, there is no reference to the 1990 commitment in DEST (1997).

The Parties shall ... take into consideration in the implementation of the commitments of the Convention the situation of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of measures to respond to climate change ... notably countries that are highly dependent on income generated from the production, processing, export and/or consumption of fossil fuels and associated energy intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives. (Item 10, Article 4: Commitments) (United Nations 1992).

Australia relies heavily on the above sections of the Convention when defending its position (e.g. Stuart 1994).

After signing the FCCC, the government launched its National Greenhouse Response Strategy (NGRS) in 1992 to demonstrate its commitment to reducing greenhouse gas emissions. In March 1995 Greenhouse 21C expanded the NGRS to include the Greenhouse Challenge Program which established co-operative agreements between industry and government to encourage the implementation of 'no regrets' measures by industry in their production processes (Dickson & Pakravan 1995 p 3). A 'no regrets' measure is the introduction of policy or technology that reduces greenhouse emissions which has net economic benefit (ABARE & DFAT 1995 p xvi).

In 1995 the first Conference of the Parties to the FCCC was held in Berlin when Australia argued unsuccessfully that developing countries should be brought into an emissions reduction agreement. In Geneva in July 1996 it was agreed that Annex 1 countries should adopt legally binding targets to reduce emissions beyond the year 2000, although there was no agreement on a specific level. Australia opposed this provision (DFAT 1997 pp 33-34)¹³. Senator Hill is quoted as saying:

¹³ The government also proposed a comprehensive approach whereby any reduction target should include other major greenhouse gases as well as all sinks and sources in line with its interpretation of the general principle of the Berlin Mandate (DFAT 1997 p 62). However, there is considerable disagreement over the measuring of the gases and their conversion to a carbon dioxide equivalent by a Global Warming Potential index number (Hammond *et al.* 1991 pp 10-35). Also, the proposal would be difficult to establish and monitor. Japan proposes that an agreement should relate only to carbon dioxide emissions. A comprehensive approach is important to Australia because, for instance,

"For Australia to agree to this part of the statement would be tantamount to signing a blank cheque" (Willis 1996 p 196). Since Geneva, proposals for legally binding reduction targets below 1990 levels have been made by the European Union (EU) (i.e. 15% by the year 2010) and by Japan (i.e. 5% by the year 2012). Australia continues to oppose legally binding targets at any level.

A fundamental objection the government has to the current round of FCCC negotiations is that a legally binding uniform reduction target is not fair or equitable, despite its appearance as such and its simplicity. The government claims that it would impose vastly different costs on different economies. The marginal emission abatement cost¹⁴ in Australia is said to be much higher than in other countries. This claim is based on assumptions about the high cost of technological change to bring about a reduction in emissions. It is also claimed that Australia's heavy reliance upon fossil fuels for domestic use, export income and exports production will result in a higher cost burden for Australia if a uniform target is adopted¹⁵. The government proposes a 'differentiated' approach whereby each country would be given a non-legally binding target determined in accordance with its economic circumstances. The government proposes that certain factors should be used to determine the initial 'differentiated' target for each country (e.g. population growth rate, growth in GDP per capita, emissions per unit of GDP) (DFAT 1997 pp 94-97). Differentiation is designed to ensure that each country shares equally in the cost burden of reducing global emissions.

companies like BHP Ltd (1996) and CRA Ltd (1996) participating in the Greenhouse Challenge Program currently use the GWP to convert their emission reductions of methane to a carbon dioxide equivalent. If a comprehensive approach is not agreed at Kyoto, methane emission reductions would not count towards a reduction target for Australia.

¹⁴ The cost of reducing emissions by one further unit (i.e. a tonne) (ABARE & DFAT 1995 p xv). "Marginal costs are derived on the assumption that the cheapest option for abatement would be explored first followed by the more expensive ones. This results in the marginal cost rising as the level of greenhouse gas abatement increases" (IPCC Fact Sheet 227).

¹⁵ The fossil fuel intensive nature of Australia's economy is illustrated by the Australian energy sector per capita emissions being 36% above the International Energy Agency average in 1993 (DPIE 1996b p 22).

Australia is the only Annex 1 signatory to the FCCC that opposes a legally binding reduction target. The implementation of a tradable quotas scheme would depend upon reductions being made legally binding. Therefore, the government does not at this stage support a tradable quotas system, and would only do so if it was satisfactorily 'differentiated' and issues of monitoring and enforcement were resolved (DFAT 1997 pp 61-69 & 103-110). ABARE claims that a 'differentiated' tradable quotas scheme is the optimal 'least-cost' solution (Fisher, 1994, pp 50-54). Such a scheme could be implemented amongst Annex 1 countries but the optimal outcome is if developing countries are also included¹⁶.

The government and ABARE claim that any actions taken by Annex 1 countries to reduce emissions will be ineffective if the developing countries are not also required to reduce their emissions (DFAT 1997 p 31 & pp 139-142; ABARE 1997b pp 1-8). This is despite the FCCC and the Berlin Mandate stating that such a requirement of developing countries would be unfair; that they have the right to increase their emissions to develop their economies; that the majority of the emissions in the atmosphere are largely the responsibility of the Annex 1 countries and that the

¹⁶ Under a scheme of "grandfathered tradable quotas", whereby countries can trade emission quotas but each country is given the same initial quota, Australia suffers a welfare loss in terms of GNE of approx. 1% which is similar to the outcome of a uniform reduction target. A 'differentiated' tradable quotas scheme, whereby different initial allocations are made to each country taking into account their particular circumstances, would result in the same losses in GNE for all Annex 1 countries of approx. 0.1% (ABARE 1997a pp 79-81). ABARE's findings are dependent upon virtually all abatement taking place in the Former Soviet Union (FSU) because their energy production is considered to be inefficient. Therefore, they have a much lower marginal abatement cost. ABARE's proposal would result in vast amounts of income being transferred to the FSU. It is noted by ABARE (1997b p 81), however, that: "Without the participation of the Former Soviet Union, global gains resulting from the move to tradable quotas would be significantly lower than those estimated in this study". A question was put to Stuart regarding reduced demand for Australian coal if developing countries were required to reduce their emissions, as advocated by ABARE and the government. Stuart indicated that the FSU and developing countries have similar economies and that in this case the demand from Annex 1 countries would increase as the abatement regime would include all countries. Roger Stuart <rstuart@abare.gov.au>. 'Economic Impact'. Private e-mail message to Ronlyn Duncan. 29 July 1997. On this basis, if developing countries were included in an agreement, both the FSU and developing countries would become 'abatement sinks' for the rest of the world. McKibbin & Wilcoxon (1997 pp 6-8) consider that such a scheme would involve the transfer of such large sums of money, it could destabilise the world trade system. For instance, permits for the US could add \$24-48 billion to the US trade deficit per year which would never be agreed to by the US government. It would also create many problems for these countries (even if they were willing to become 'abatement sinks', which is unlikely) in terms of technology transfer, traditional export markets and exchange rates.

Annex 1 countries need to lead by example (United Nations 1992). The concern is that between 1990-2020 non-Annex 1 countries are expected to increase their emissions at the rate of 3.96% p.a. whereas the rate of increase for Annex 1 countries is projected to be 1.34% p.a. By 2016, non-Annex 1 emissions are expected to overtake Annex 1 emissions and by 2020 non-Annex 1 emissions are predicted to be 52% (ABARE 1997a p 20)¹⁷. The future increase in emissions predicted from China was a particular concern expressed at the National Academies Forum on climate change in April this year. ABARE and the government also argue that if all countries are not involved in reducing emissions, Australian industries (e.g. steel and aluminium production) could move offshore where energy production is cheaper - this is known as 'carbon leakage' (ABARE 1997b pp 1-8). Consequently, it is assumed that the costs of reducing emissions will adversely affect Australia's trade competitiveness and its economy if the developing countries are not also required to stabilise or reduce their emissions at the same time as Annex 1 countries.

The government and ABARE assert that 'carbon leakage' would actually increase global emissions. For instance, if aluminium production moved off-shore, the product would still be produced but the emissions generated in its production would be higher than if it was processed in Australia. The assumption is that Australian production is more efficient than in developing countries¹⁸ (DFAT 1997 p 55). Going a step further, in June this year ABARE (1997a pp 56-64) produced a report which concluded that if only Annex 1 countries adopt emission reduction targets, the economies of non-Annex 1 countries would be adversely affected because, *inter alia*, the increase in costs brought about by higher costs in Annex 1 countries

¹⁷ The emissions projections for non-Annex 1 countries are determined by business-as-usual output which is calculated by using economic and population growth rates. Population growth rates are determined by the model itself and are linked to assumptions about the extent to which people of non-Annex 1 countries are expected to possess increasing amounts of disposable income over time which is expected to increase their demand for energy.

¹⁸ This view was expressed by Senator Robert Hill in his address to the National Academies Forum in Canberra on 29 April 1997.

would make the imports for non-Annex 1 countries more expensive which would adversely affect their terms of trade.

A conclusion that can be drawn (and has been drawn by various Australian industry groups, such as the Business Council of Australia) from the apparent non-uniform result of a uniform target is that countries agreeing to the uniform target, which are insisting Australia should follow suit, are only doing so for their own benefit to undermine Australia's established export markets (Willis 1996 p 196). On the basis that the uniform abatement target of 15% was originated by the European Union, which currently has high rates of unemployment and low GDP, this accusation cannot be dismissed out of hand¹⁹.

On the basis of the assumption that energy consumption is proportional to economic growth (IC 1991 p G22), all industry organisations expect production growth. For instance, in the Greenhouse Challenge Progress Report 1996²⁰, it is stated that the emissions of the initial 1995 signatories were 73 Mt (a 3% increase on 1990 emissions at 71 Mt). This small increase is explained by "flat" economic growth. The forecast for the year 2000 is 93 Mt (a 27% increase on 1995 emissions at 73 Mt). The report states:

The relatively large notional increase has been explained by the companies as coming from an expectation of large scale production increases and development of new production facilities (Commonwealth of Australia 1997 p 11)²¹.

¹⁹ Australia is critical of the EU because it is differentiating targets between its countries so that, for instance, Portugal increases whilst the UK reduces emissions. Australia's concern is that the EU is receiving the benefit of a differentiated system yet it will not support Australia's proposal for a global differentiated system (DFAT 1997 p 70).

²⁰ The Greenhouse Challenge program is a joint venture between the Department of Primary Industries & Energy (DPIE), the Department of Sports & Territories (DEST) and the Department of Industry, Science & Tourism (DIST).

²¹ A DFAT survey (using ABARE's industry surveys as corroborating evidence) indicates that "investment of around \$68 billion is currently under consideration in the energy and energy-intensive sector in Australia". These funds will be spent over the next five years and will be concentrated in the minerals processing sector e.g. oil and gas refining and iron, steel and aluminium industries (DFAT 1997 pp 82-83).

It is difficult to imagine a company director publicly predicting a future reduction in production. Of course, if emission estimates are high, there is more scope to continue emitting at high levels. The government projects Australia's emissions will rise by 40% *above* 1990 levels by 2010 (DFAT 1997 p 6). Consequently, the prospect of a legally enforced emission reduction *below* 1990 levels is a cause for its concern and protest. Also, a high emissions projection makes emission reductions by 'no regrets' measures look insignificant (DFAT 1997 p 79). The conclusion is, therefore, that Australia has to go beyond 'no regrets' measures (Dickson & Pakravan 1995, pp 11-12) which will involve a disproportionate capital cost which means that Australia cannot become a party to an agreement on legally binding uniform reduction targets if it does not make concessions for Australia's circumstances. However, it is difficult to see how 'differentiation' could accommodate a 40% rise in emissions above 1990 levels.

In light of the discussion so far, one is almost sympathetic to the government's position and the explanations for its stand. However, virtually every aspect of it has been comprehensively challenged by commentators such as Clive Hamilton of The Australia Institute (Hamilton 1997a & 1997b) and Mark Diesendorf of the Institute for Sustainable Futures²². Hence, it is difficult to understand how there can be such divergent views on the same issue. To bring the debate into clearer focus, it needs to be understood that the climate change debate is about a clash of paradigms. The sustainable energy supporters are questioning the legitimacy of a fossil fuel intensive

²² For example, see Hamilton (1997a & 1997b); Diesendorf (1996, 1997b & 1997c); Diesendorf & Hamilton (1997) and Garraro, C. & Galeotti, M. (1997). When referring to these commentators collectively, they will be referred to as "sustainable energy supporters". Clive Hamilton is the Executive Director of the Australia Institute Limited which is an independent non-profit public policy research centre based in Canberra. It participates in public debates on economic, social and environmental issues. Mark Diesendorf is the Director of the Institute of Sustainable Futures which is affiliated with the University of Technology, Sydney. Australia's capacity to reduce its emissions *because* of its high reliance on coal is a particular claim made by these commentators which has been recognised in a study conducted by the International Energy Agency (cited by Hamilton 1997b). The sustainable energy supporters are adamant that Australia can significantly reduce its emissions by efficient use to make one joule of energy go further, without the introduction of renewable energy generation systems at this stage. It is claimed that a barrier to these gains are market failures which could be rectified with government intervention and sound policy responses.

economy and the institutional policies and structures that are connected to it. In effect, they are attempting to displace the existing paradigm. It should not be a surprise that there is strong resistance. A particular theme of this thesis is the way in which the existing paradigm is resisting the threat of change.

CHAPTER TWO

The existence of uncertainty in regulatory science debates means that the 'interpretative gap' is bridged by domains usually thought to be external to science

So, why is there hesitation and how can the government justify its stand on refusing to adopt a legally binding reduction target? It will be argued that a fundamental motivation is the uncertainty inherent in the IPCC science and the further uncertainty created by different climate projections made by the IPCC in its 1990 report compared with its 1995 report. Despite the scientific consensus of over 2,500 scientists established by the IPCC SAR (1995), significant changes were made to the initial projections of the 1990 report. For instance, the "best estimate" projection of an increase in global mean surface temperature of approx. 2 degrees Celsius by the year 2100 is said to be one-third lower than that projected in its 1990 report; its sea level rise projection of 50 cm by the year 2100 is 25% lower than in the 1990 report. The reasons for these changes are attributed to improvements in the climate models. For instance, they now include the cooling effect of sulphate aerosols (DPIE 1996a pp 1-3).

Scientific consensus exists in varying degrees and it can mean different things to different people (Gilbert & Mulkey 1984 p 140). This is not a situation peculiar to this issue or science itself. It has to do with the construction of knowledge. Uncertainty can be exploited by interests deliberately attempting to influence the direction of debate and its conclusions, or it can simply be interpreted differently depending upon the philosophical or political commitments of an individual, group or discipline (Barnes 1981 pp 303-333). The exploitation of scientific uncertainty is particularly acute in this issue because climate change science, and knowledge in relation to it, is still in the process of being constructed. Accordingly, there is considerable scope for uncertainty and disagreement about climate change - if it will

occur, when it will occur, where it will occur and to what degree? This is at odds with the traditional view of the authority of science. It does, however, go some way in explaining why there is often so much disagreement between experts and groups in controversies surrounding scientific issues, particularly those in policy-relevant science.

A traditional view of science is that articulated by Robert Merton (1973 pp 270-277), who asserts that science should be granted unqualified autonomy so that scientists can be engaged in the extension and validation of scientific knowledge without external influence. Merton claims that scientists should apply to their work, and the work of others, the institutional norms of universalism, communism, disinterestedness and organised scepticism, collectively referred to as the "scientific ethos". Merton assumes, *inter alia*, that the world external to us is the only determinant of our knowledge. The scientific knowledge sought by scientists exists in that world independent of the intellectual and social commitments of the scientist (Mulkay 1979 pp 1-21). Science is the means by which this 'pre-existing' knowledge is accessed. Hence, scientists can make observations, develop hypotheses and contribute to the extension of knowledge with objectivity. On this basis, science is to be accorded an autonomous and authoritative institutional status in society.

The epistemic foundation of "the scientific ethos" is 'extensional semantics' which is discussed (and criticised) by Barnes (1982 pp 29-31). A demarcation between true/rational and false/irrational is fundamental to extensional semantics²³. Also, terms, concepts and facts, the foundation of knowledge, are narrowly defined as

²³ Bloor (1992 pp 1-21), a proponent of the sociology of knowledge, initiated the rejection of this demarcation in originating the Strong Programme which has four tenets: *causality*: a belief is not understood just on the basis that it is merely rational but because there are causes for it to be held; *impartiality*: rationality is not only assigned to assumed-to-be-true beliefs; *symmetry*: the same cause can apply to both true and false beliefs; *reflexivity*: judgements should not undermine the discipline. For instance, to claim that scientific judgements are socially constructed means that the judgements of the discipline (e.g. sociology) making the claim are equally socially constructed and equally matters of judgement.

being either true or false. Their correct usage is considered to have been determined in advance of any judgement about usage. This assumes that the conceptualisation of what is being observed, and usage applied to, is immutable, unrevisable and perceivable unhindered. Consequently, it is possible for scientists to perceive the natural world objectively. Judgement as to what is true/rational or false/irrational is conveyed by the terms or concepts themselves or ascertained by an individual's rational behaviour - observation and reason. Incorrect usage or erroneous judgements, however, are equated with irrationality, such as the influence of subjectivity or social influences²⁴.

It will be argued that the above account of knowledge is untenable, particularly in a post-Kuhnian world in which it has been shown that judgements as to the "correct" usage of concepts and scientific theories have been revised (sometimes several times) by the rational means of observation and reason. These changes in proper usage²⁵, documented by Kuhn in *The Structure of Scientific Revolutions* (1970), verify that the objective observation of the natural world does not, in the end, determine what becomes accepted as currently instantiated knowledge. This is not to deny the existence of the 'real' world or its influence on us, but it does indicate that there is an 'interpretative gap' between what we observe and what we come to agree, at a particular point in time, is in existence (Barnes 1982 pp 64-70).

In contrast to Merton, Barnes (1982 pp 29-40) seeks to show that proper usage and knowledge is contingent and that it is, ultimately, determined by us, not by what we observe. Any application of usage (past, present or future) requires our judgement anew on each application because terms or concepts do not have "inherent properties"

²⁴ For instance, in documenting a history of science, science can be seen as directional and progressive. Concepts, beliefs and theories that are considered to contribute to the state of scientific knowledge at that time will be seen as incremental steps towards the current accepted theory. They will require no further explanation. However, concepts, *etc.* that do not contribute to the current accepted theory will be either discarded or explained by irrationality and not included as part of the progressive process (Kuhn 1970).

²⁵ For instance, the change in the concept of speed (Barnes 1982 pp 36-40).

and cannot by themselves determine "future correct applications". Usage and knowledge is, therefore, revisable and even inventible, depending on the commitments or the changing circumstances of a community making the contingent judgements. It is possible for judgements to be deemed inappropriate, correct, inadequate or wrong at different times. Under these circumstances, the true/rational and false/irrational demarcation is irrelevant. This account of knowledge is referred to as 'finitism'.

If an individual subordinates his inclinations to the routinely accepted mode of use of a term, it is to the practice of his fellow men that he defers, not to any set of rules or instructions for use which, as it were, come with the term. Proper usage is simply that usage communally judged to be proper. ... nature itself sets no constraints on the form of the routine which is produced (Barnes 1982 p 29).

If concept applications are contingent, then judgements as to "correct" usage can, according to Barnes, differ depending on the goals and interests of the different communities or groups with an interest in determining the application and usage of the concept. Indeed, the most persistent and consistent goals and interests are expected to determine the accepted concept application at a particular time. This explains the "relationship between old knowledge and new" (Barnes 1982 pp 101-120). It is possible for goals and interests to influence concept application judgements because of the existence of the 'gap' between observation and what becomes accepted as knowledge. In abstract terms, this 'gap' is a zone of uncertainty which is amenable to several interpretations. This indicates how there can be several plausible theories from one set of observations (Brown 1984 p 12). Moreover, this 'gap' can be used as a resource by different groups or communities in pursuing their goals and interests to change judgements and, as a result, what eventually becomes accepted as knowledge. The use of rhetoric plays an important role in the outcome. Therefore, in the realm of policy-relevant science, where knowledge is still in the process of being constructed, there will often be several interpretations about what actually exists in the 'real' world.

The utilisation of this zone of uncertainty is particularly evident in the domain of 'regulatory science' (or 'trans-science' as originated by Weinberg). Weinberg (1972 p 209) draws the distinction between science proper and 'trans-science' in an attempt to draw a boundary between which questions science could, with confidence, answer and those that it could not²⁶. Policy makers involved in setting standards or regulating polluting industries often ask questions of science that cannot be answered due to, for instance, the physical impossibility of carrying out the necessary experiments²⁷. For science to retain its autonomy and authority, it has to protect its credibility. This is threatened by the requirements of 'regulatory science' which is characterised by uncertainty and influenced by factors other than science, for instance, politics and economics (Jasanoff 1987 p 197). Hence, Weinberg proposes that such impossible questions should be moved out of the domain of science and a boundary drawn between it and 'trans-science' (Shackley & Wynne 1995a p 219).

Scientists have been articulating a "rhetorical style" of drawing boundaries between, for instance, science and pseudo-science since the late 19th Century (Gieryn 1983 pp 781-784). Its purpose is to protect the authority and autonomy of science from intervention by governments or vested interests. A key point is that a boundary is a resource because it is flexible, ambiguous and contingent. Scientists can relocate or dissolve it depending on the interests of the discipline or institution at a particular time, or the context in which it is relevant. A boundary can be used to exonerate science from responsibility for consequences it considers it cannot control by contrasting its authority with the lack of authority of other actors (Gieryn 1983 pp 790-792). Many sociological studies have concluded that science does not operate in accordance with Merton's "scientific ethos". Instead, the norms are to be seen as

²⁶ From a sociology of science perspective, scientific uncertainty extends much further into scientific knowledge than would be acknowledged by scientists (and Weinberg for that matter).

²⁷ For instance, in an example given by Weinberg (1972 p 210), it would take an experiment requiring 8,000,000,000 mice to determine, to a 95% confidence level, whether or not the mutation rate increased by a certain level when subjected to a given level of radiation.

"flexible vocabularies"; they are a resource for utilisation by scientists in their 'boundary-work' to uphold the authority of science and to make credible their claims in different contexts and to different audiences (Mulkay 1979 pp 71-72; Salter 1988 pp 6-8).

Despite the extent of scientific uncertainty in making regulatory decisions, policy makers do make decisions with the scientific knowledge that is available. This appears straightforward. The scientists provide what science they can, the policy makers make their decisions and the regulated entities abide by the decisions so made. However, it is not at all that simple. The zone of uncertainty inherent in 'regulatory science' becomes a resource for all stakeholders - the regulatory agency, scientists, industry, environmental groups, politicians and affected communities - to utilise in pursuing their different interests. An agency's science is often met with an industry's counter-science which is met with environmentalists' counter-counter-science (not necessarily in support of an agency), which could be met with a community's counter-science. All of the different findings can be a description of the same situation and be based on the same or similar observations (Salter 1988 pp 5-6). The existence of the 'interpretative gap' makes this possible.

These circumstances make 'regulatory science' decisions complex, particularly because of the political environment in which they have to be made. For instance, the banning of chemicals determined to be carcinogenic can have significant economic ramifications for a chemical company and the economy of a region. A regulatory agency attempting to enforce its decision would be met with resistance from the regulated industry and possibly political representatives of a region faced with economic downturn. Therefore, regulatory agencies have to ensure that their decisions are justifiable so that they will be accepted by the regulated industries and communities which their decisions affect (Jasanoff 1990). This becomes difficult

when such decisions are matters of judgement. This is where the notion of the authority of science is crucial to the rhetoric of political actors.

In the United States, various institutions (e.g. the Environment Protection Agency) have formulated standardised methods and procedures to extrapolate scientific findings to facilitate making decisions in the absence of scientific certainty and to generate an agency's own scientific credibility (Jasanoff 1990). These procedures have been found to be necessary to ensure that agency decisions are recognised as legitimate and that they are implemented by regulated industries. Regulatory agencies are vulnerable to accusations of bias, particularly if, when faced with uncertainty, they justify their decisions as fulfilling the obligations of their Charter, which is usually not in accord with the needs of industry (e.g. the EPA applying the precautionary principle in banning a chemical that is a major revenue generator for a chemical company). Jasanoff (1987 pp 195-198) states that industry often attempts to move decisions out of the hands of regulatory agencies (by instigating judicial review of their decisions or exercising their power in the political arena to have them reviewed) and into the domain of science because it considers 'scientific' decisions will be more in line with its interests. For instance, scientific experiments and findings can be challenged by experts on the grounds of most aspects of their methodology and technical procedures (Chalmers 1976 pp 63-64). This generates protracted technical arguments and effectively delays decisions. Conversely, environmentalists will claim that a decision should remain with an agency on the basis the agency's Charter is more in line with the interests of the public in general (and their interests). Hence, the boundary between science and policy is not at all fixed and there are high stakes involved in controlling it (Jasanoff 1987 p 198).

Shackley & Wynne (1995a) extend the above conception of regulatory science to the idea of "mutual construction" whereby scientific methodology is effectively,

although implicitly, influenced by the needs of policy makers and these needs are, themselves, restricted by the perceived limitations of science²⁸. The idea of 'mutual construction' conceptualises 'regulatory science' not just in terms of its function in cordoning off a domain in which uncertainties can be dealt with away from 'pure science' or 'pure politics', but as "a material institutional and cultural enterprise" (Shackley & Wynne 1995a p 221). The boundaries between science, politics and economics still exist as scientific rhetoric, but in reality they are virtually indistinguishable because the three domains are interdependent - their development is akin to a positive feedback system - each is mutually determined and enhanced by the other.

The concept of 'mutual construction' clarifies, and to some extent supplements, the concept of goals and interests advocated by Barnes (Miller 1997 p 26). Criticisms of analyses that reify²⁹ "interests", as expressed by, for instance, Woolgar (1981) and Wynne (1996) are acknowledged as valid. Woolgar (1981 p 387) draws attention to the tendency for interests to be haphazardly designated as causal explanations for the success of knowledge-claims. As is the case with natural science, one set of empirical observations can elicit several interpretations. As a result, the theories of the social scientist can be constructed in the same way as those of the natural scientist, and the reification of interests does not dissolve this reflexivity. It is not possible to elaborate the issue of interests here, however, it is acknowledged that the identification of an "interest" in a controversy is itself a matter of judgement. Indeed, it could serve to

²⁸ Shackley & Wynne (1995a pp 226-229) document several examples of 'mutual construction' in relation to climate change and make the point that their conception of regulatory science is different to that of Jasanoff and Salter. In fact, Shackley & Wynne consider their conception should be referred to as "fiducial science" because of the high levels of trust between scientists and policymakers they found to be crucial to a 'mutual construction' situation. This would exist because of the uncertain nature of climate change science and policy. In 'normal regulatory science', trust is embodied in well-established procedures such as toxicological extrapolations which have previously been agreed to be "good science" amongst the stakeholders. "Fiducial science" exists when direct policy actions are being developed and the relationship between science and policy is therefore much closer. In this case, policy imperatives actually encroach upon core science and become a determinant of knowledge itself.

²⁹ To reify something is to attribute causal power to something that is actually an abstraction - the "fallacy of misplaced concreteness" (Marshall 1994 p 445).

obscure a more complex and insightful explanation. The concept of 'mutual construction' addresses this insufficiency by recognising that knowledge construction is a process involving the "cultural dimensions" of the interaction of institutional commitments and constraints existing in both scientific and policy communities, rather than decisive interests defined as such by the person conducting the critique (Wynne 1996 pp 357-359). An analysis in terms of the concept of 'mutual construction' within the framework of 'regulatory science' brings currently instantiated judgements in the domains of science, economics and politics into focus and allows judgements of new knowledge-claims to be viewed in light of these past contingent judgements that have previously become institutionalised or accepted in a community. This gives a more realistic conception of the process involved in the construction of knowledge and the relationship between old and new knowledge³⁰. This relationship is not as decisive as the concept of 'goals and interests' encourages us to believe. It is much more subtle and is determined by a much wider field of scientific, economic and political judgements that are interconnected and interdependent.

To illustrate the 'mutual construction' of a knowledge-claim, Shackley & Wynne (1995a pp 226-227) discuss, *inter alia*, their view that the IPCC scientists' understanding of the political imperatives for "sensible planning" instead of a "fear of global catastrophe or collapse" has influenced their "best estimate" findings. Consequently, this commitment has established a trajectory of climate change science which dismisses the possibility of abrupt climate change, and which authorises future policy actions to deal with a climate change scenario within the limits predicted by the science. Furthermore, the science that predicts this future scenario is also the means for generating certainty in the future, which is needed to implement the future

³⁰ The notion of 'mutual construction' can be conceptualised in terms of a scientific paradigm (Kuhn 1970). For example, a judgement and the subsequent adoption or rejection of a knowledge-claim is influenced by the commitments and beliefs already existing in a particular community. Any new knowledge-claim will be judged in terms of its expected or predicted ramifications on existing commitments and beliefs. Hence, currently instantiated knowledge can have considerable influence on the direction of future knowledge-claims. This indicates that the stakes in one set of knowledge-claims prevailing over another will be very high.

policy actions. For instance, it is claimed that policy makers need more certainty at both a global and a regional level. Global circulation models (GCMs) are considered the best means available for simulating global climate change (based on research funding and their use). At a global level their reliability is considered to be good but not so at a regional level. Therefore, GCMs are being developed to improve their resolution and to include regional factors such as biological carbon dioxide exchange, vegetation feedbacks and atmospheric chemistry. The science and the policy mutually reinforce each other and the science is the means of providing the future certainty required by policy. The capacity for future certainty legitimates the present scientific and policy commitments. These commitments "act as closure mechanisms" and cut off the possibility for alternative scientific investigation or policy directions. The belief that answers will be forthcoming entrenches both the science and the policy direction. This belief limits policy options to minimal actions and delays planning (Shackley & Wynne 1995a pp 221-227). Such a strategy can be justified on economic grounds. Regulated industries are, not surprisingly, unwilling to forego revenue or outlay funds without a good reason. The prospect of future certainty, and the existence of current uncertainty, is a sufficient justification for delaying action³¹. The problem is, who can say when certainty is sufficient? A judgement in this respect will vary depending on the commitments of those involved and it will not occur at the same time. Therefore, delay will be perpetuated.

It has been shown that a focus on the domain of 'regulatory science' can facilitate an understanding of the dynamics between science, politics and economics and the positions taken by groups with a stake in the outcome of such decisions. This focus also highlights the complexity of the issues involved. The idea of 'mutual construction' shows that the relationship between these domains is mutually constitutive and perpetuating. An examination of the dynamics of Australia's position on emission reduction targets will demonstrate that a change in the circumstances

³¹ This, of course, denies the application of the precautionary principle.

affecting one of these domains will change the judgements and commitments determining the nature of the others. Furthermore, the knowledge-claims of different groups will recognise and emphasise different parts of an issue which will be connected to science in various ways. The question is, how are these knowledge-claims mobilised so that they can have an impact on our judgements and consequently on what we come to agree is in existence?

CHAPTER 3

Quantification is a powerful style of rhetoric, but is it also a misplacement of trust?

If it is agreed that judgements on what we come to accept as knowledge are contingent, and that currently instantiated knowledge is ultimately determined by us and not the 'real' world, then it can be seen that knowledge-claims in one direction can be contested by actors expressing opposing views. Knowledge-claims can be contested on the grounds of, *inter alia*, their assumptions, their future implications or the influence of political commitments. This begs the question: how are the judgements that contribute to the construction of knowledge mobilised? It will be argued that quantification is a powerful rhetorical style of communication for this purpose. It can be utilised by actors in the contest that determines which knowledge-claims prevail. The stakes can be high, particularly when one set of knowledge-claims supports, for instance, the phasing out of the use of fossil fuels and another set supports their continued use.

The role of rhetoric in determining the outcome of scientific controversies needs some explanation before discussing quantification specifically. It was argued in Chapter 2 that there is an 'interpretative gap' between what we observe and what we come to agree, at a particular point in time, is in existence. Metaphorically, the 'interpretative gap' is bridged by rhetoric. The path that the bridge follows is contingent upon judgements which are influenced by this rhetoric. The study by Collins (1985 pp 79-111) of the controversy surrounding high flux gravity waves illustrates the role of rhetoric in determining the acceptance or rejection of judgements and the influence that existing or past judgements can have on the acceptance of new knowledge-claims. Rhetorical statements highlight the implications that new judgements could have on currently instantiated knowledge and

the adjustments that would have to be made to the knowledge base to accommodate them³².

Quantification is a powerful rhetorical style of communication (Porter 1992a p 644)³³. It is rhetorical because it plays an active role in the construction of knowledge. This is possible for two reasons. First, quantification is conventional. Numbers pervade all societies all over the world and we are extremely familiar with quantification in both absolute and relative terms. Second, quantification is generally attributed a high level of objectivity and authority. This is because it is so thoroughly conventional but also because it is supported by considerable institutional authority and power (Porter 1995 pp 3-8 & p 33).

Apart from the institutional authority vested in quantification, it is granted legitimacy because its language is mathematical. Mathematics requires the application of rules - it is a "highly structured language" (Porter 1992a p 644). Hence, answers deduced quantitatively are thought to be fair because they are assumed to be derived from the application of impersonal mathematical rules which are understood to eliminate the exercise of judgement (Porter 1995 pp 8 & 32). The mathematical language of quantification has facilitated the standardisation of many aspects of our lives. Porter (1992a p 640) refers to the rhetoric of quantification as a "technolog[y] of trust" and a "technology of distance". The act of quantification encourages confidence when one cannot be present to check all details or be sure how answers have been derived. It provides a means for this notion of trust to be extended over long distances (Porter 1995 pp 15 & 90).

³² This point was clarified by David Miller of UNSW on 16.9.97.

³³ Porter (1995 pp 3-4) makes a distinction between disciplinary objectivity whereby a claim of objectivity would be accepted on a personal basis and mechanical objectivity when rules are required to be applied to eliminate accusations or the possibility of subjectivity and to substantiate claims of objectivity. The discussion of quantification will focus on mechanical objectivity.

Quantification is the preferred language of governments (Porter 1992b pp 26). Politically, objectivity (or the semblance of it) is crucial for bureaucracies attempting to reconcile opposing interests in making decisions. In an environment of public and stakeholder distrust regulatory agencies, for instance, rely upon quantification (and the notions of rules and objectivity it embodies) to warrant that their decisions have been made objectively and without bias (Jasanoff 1990). Hence, there is an incentive to quantify and standardise anything that can possibly be described in these terms (Porter 1992b pp 26-28)³⁴. The notion of objectivity is pivotal to the effectiveness of quantification in communicating plausible knowledge-claims (Porter 1992a pp 634-643)³⁵. Claims of objectivity are a rhetorical resource. They can be used by actors to legitimate their views and generate credibility for their knowledge-claims, to draw boundaries around such claims to make them immune to deconstruction, and to discredit opposing knowledge-claims.

The present-day globalisation of economies, corporations, communication, culture, and institutions is a long way from the days when each region in France, for instance, took pride in its sovereign right to have its own bushel vessel, which did not necessarily hold the same amount as a vessel from another region (Porter 1995 pp 24-25). This lack of standardisation limited central bureaucratic control over local areas. Judgements were guided by qualitative, rather than quantitative, goals. The quality of a bushel of wheat varied both within and between regions and its price was negotiated on the basis of quality, not by a standardised measurement. Reliance on the judgement of quality imposed the need for personal negotiation and trust at the local level. However, noble seigneurs had the power to dishonestly manipulate the size of the bushel vessel to their advantage. This encouraged peasants to call for and support

³⁴ This will continue and expand as the computational and storage capacity of computers increases.

³⁵ As alluded to in Chapter 2, the authority of science rests, in large part, upon the expectation of objectivity. On the basis that quantification is such an integral part of scientific experimentation and communication, to some extent the level of objectivity attributed to quantification would be derived from the authority of science. However, the universal, conventional and rule-like nature of quantification also contributes to its notion of objectivity.

the introduction of a standard bushel vessel for France after the French Revolution (Kula 1986 cited by Porter 1995 p 25). Porter (1992b p 25) claims, however, that standardised measurement was still problematic - "quantitative measures were always subject to qualitative modification, and the metric system could never hope to take account of this."

In the United States the centralisation of markets required bureaucratic intervention to establish and enforce standard categories of wheat quality, quantified measurements and price (Cronon 1991 cited by Porter 1995 p 47-48) so that wheat could be sold collectively to larger markets. Therefore, judgements had to be made to facilitate the collection, storage and sale of the wheat. The assignment of qualitative categories were limited to the fewest number possible and acceptable to farmers. Until then, quality was continuous (Porter 1995 p 48). The standardisation of measurement ensured that each farmer got his fair share of the proceeds of the sale of the wheat. The judgements which defined the categorisation, standardisation and quantification had little to do with the characteristics of the wheat and were made, to a large extent, arbitrarily. The judgements were made by people and were contingent upon the administrative and political imperatives of the bureaucracy (e.g. the Chicago Board of Trade) that was responsible for administering the markets. The Board needed to impose uniformity in order to facilitate the large-scale sale of wheat received from several sources and grown under various conditions. The categorisation of quality defined discrete entities and the standardised quantification measured these entities (Porter 1995 pp 37-41). In the end, what was 'real' could be measured by the Board because the Board had actually created what the 'real' entity was - continuous quality no longer existed. A category, knowledge-claim or phenomenon, once defined, measured and institutionalised, is perpetuated and enhanced by its quantification and *vice versa*. This circularity is a feature of quantification. It creates the perception that the categories defined actually exist in the 'real' world, when in fact they are reifications.

A major criticism of quantification is that it is very difficult (impossible in many cases) to quantify, *inter alia*, social values, environmental externalities or the psychological value of job security. Therefore, knowledge-claims based solely on findings generated by methods of quantification are likely to exclude qualitative aspects of an issue.

Quantification is a powerful agency of standardization because it imposes some order on hazy thinking, but this depends on the licence it provides to leave out much of what is difficult or obscure (Porter 1992a p 645).

Quantification and standardisation eliminate contextual values and attempt to impose impersonal uniform rules to control the direction of future applications - it is because of this that they are assumed to be objective (Porter 1992b p 49). However, rules are the same as concepts - their meaning is inherently ambiguous and their application is contingent (Collins 1985 pp 12-23). Wynne (1988 pp 148-156) argues that the implementation of standardisation to overcome concerns of bias, dispel public distrust or promote credibility and objectivity is often ill-founded. Official rules can promote public confidence, but they can be unrealistic. This encourages the establishment of various sets of informal rules to suit local circumstances. This reinterpretation of the official rules is often important in establishing feasible work practices, and at times crucial to the viability of organisations. However, it can create a situation much more complex than that which the rules were designed to clarify. Hence, the conviction that standardisation makes procedures more transparent and it is an answer to problems of distrust, appears to be misleading.

Rhetorically, however, explicit rules can be used by actors to give a public impression that institutional actions are competent, mechanical and in accordance with officially sanctioned rules. Rules are imposed to standardise the elements of a situation in the optimistic belief (or the rhetorical assertion) that their application to

all situations under any circumstances by any person will elicit the same objective answer. However, as standardisation becomes more refined, the possibilities for reinterpretation are increased (Wynne 1988 p 156). As a result, an increase in public or political demands for objectivity and standardisation can only lead to the creation of more informal rules and thus greater complexity when the aim was to generate transparency.

... a formal public image of technology [or quantification] as mechanical, rule-following behaviour belies a far less clearly rule-bound and determined world of real technological [or quantification] practices. The relationship between these apparently contradictory images of technology [or quantification] seems to parallel ... that between 'rational' and 'contingent' discourses of science [i.e. 'extensional semantics' and 'finitism'] (Wynne 1988 p 148).

On this basis, the general notion of objectivity generated by the application of rules and modes of quantification is actually a "positivistic rhetoric" (Porter 1992a p 638).

... there is considerable premium in science on the objective and the mechanical, on replacing personal judgement and private wisdom with public standards and formal knowledge (Swijtink 1987 cited by Porter 1992a p 646). That is, science enshrines objectivity, meaning (here) not truth to nature, but impersonality, standardization - reducing subjectivity to a minimum (Porter 1992a p 646).

This notion of objectivity gives the impression of "realism". A knowledge-claim that is assumed to be objective is also assumed to be a true representation of the 'real' world when in fact, it merely represents attempts to eliminate personal judgement by resorting to explicit rules (Porter 1992a pp 637-638).

The use of a mechanical methodology to facilitate the application of public policy is central to the work of Shrader-Frechette who has written several works on the philosophical foundations and issues relating to risk assessment. Shrader-Frechette (1991 pp 43-47) originates a process of 'scientific proceduralism' which, in general terms, allows a 'rational' and 'objective' choice to be made between opposing risk evaluations or knowledge-claims³⁶. The essential criterion for a determination of

³⁶ Shrader-Frechette (1991 pp 68-72) argues that constitutive values, which are expressed in the collection of data and the determination of facts guided by a paradigm, cannot be removed from

one risk evaluation over another is the methodological goal of "explanatory power as tested by prediction". Despite Shrader-Frechette (1991 pp 51 & 241) denying an advocacy of universal rules, 'scientific proceduralism' is about comparison and the imposition of a standard that needs to apply in all cases - it is a rule. Hence, it is beset by the limitations inherent in any methodology based on or aspiring to the application of rules. Shrader-Frechette (1985 p 95) is of the view that "correct method" can be substituted in the absence of "correct facts" given the scientific uncertainty and constitutive values inherent in scientific findings. This indicates a belief that the 'interpretative gap' can be brought under control and made 'rational' by the application of explicit rules. However, if rules are just as ambiguous and contingent as concepts, then 'scientific proceduralism' is untenable.

Indeed, on this basis, 'scientific proceduralism' would be more aligned with a radical relativist epistemology of "anything goes" (advocated by Feyerabend 1975 pp 156-167) than a rationalist one because it would generate knowledge-claims based on expedients instead of our interaction with the natural world. Returning to the ideas of Merton, the epistemology of this 'world of expedients', based on rules and which enshrines objectivity, is 'extensional semantics' which promotes the idea that the elimination or rather the prevention of judgements will expose the 'real' world. This allows the 'real' world to be objectively perceived by empirical study. However, as argued in Chapter 2, this account of knowledge is untenable. The current analysis of quantification indicates that the dogmatic pursuit of objectivity, based on this implausible epistemology, cannot expose the 'real' world. Indeed, it is suggested that an adherence to the tenets of 'extensional semantics' would construct a world even further removed from 'reality' than that envisaged from a 'finitist' epistemological

scientific findings. However, contextual values, which are social, personal, cultural, philosophical emphases which "often fill the gap left by limited knowledge", should be avoided. On this basis Shrader-Frechette (1991 p 47) argues that "hazard assessment can be objective and testable, but not wholly value free". Shrader-Frechette (1991 pp 36-48) further argues that the idea of a fact-value dichotomy should not be characterised as objectivity but instead as neutrality. Her definition of objectivity accepts the involvement of constitutive (not contextual) values and denies the existence of the fact-value dichotomy.

perspective. It should be understood that the 'finitist' epistemology is often criticised by advocates of 'extensional semantics' for ignoring the 'real' world. It seems that the reverse is the case.

It has been argued that the dogmatic pursuit of objectivity and refinement of standardisation using methods of quantification will sustain a system of rules at the expense of much detail - a hollow triumph of objectivity over subjectivity. Knowledge-claims constructed in this manner will not adequately represent the important relationships which need to be understood to improve our well-being or create a sustainable future. Our 'real' world will consist of 'expedients' instead of meaningful instrumental entities or relationships. An important point for this thesis is that such 'expedients' can embody rules designed to perpetuate an exercise of power which usually serves interests dedicated to retaining the *status quo*. This is a feature of economic models and an example of how a reliance on rules can obstruct our ability to interact with the 'real' world.

CHAPTER FOUR

Despite economic models embodying mathematical language and notions of objectivity and authority, their rhetorical value is in their 'interpretative flexibility'

Quantification has made possible the standardisation, categorisation, collection and storage of vast amounts of data which can be drawn from all over the world and used by economists to simulate the global economy in macroeconomic models. The magnitude of these simulations means that they have to be carried out by computers. The models attempt to describe economies from which forecasts and projections are made, particularly for use by government and business (Andersen 1995 p 328)³⁷.

Computerised economic models are useful because they allow the interrelationships of complex systems to be simulated and tested from which meaningful and sometimes unexpected conclusions can be derived. A particular point of concern expressed in discussions about economic models, however, is that they are often developed on the assumption that relationships are simple (Diesendorf 1997a p 3). This is because economic models require phenomena or objects to be described quantitatively. This makes the representation of complex relationships difficult. Also, it gives the impression that the defined phenomena are *ipso facto* mathematical when in fact, their properties have been created or distorted for the purpose of representing the desired category quantitatively (Lynch 1988 p 225).

³⁷ In very general terms, a macroeconomic model identifies important sectors in an economy and "represents" them as mathematical equations (Evans 1996 p 398). These equations use the collected data and incorporate several variables which can be either endogenous or exogenous. An independent variable is exogenous if its value is determined by an analyst. A dependent variable might be independent in one equation yet dependent in another, hence, its value will be determined by the model and is, therefore, endogenous. A simulation of a model is followed by an econometric multiple regression analysis which determines the extent or importance of the relationships between the various sectors.

Just as natural scientists make *ad hoc* modifications to their scientific theories when faced with irregularities or unusual phenomena, so do economists. Evans (1997 pp 396-421) found that it is not possible for one model to be determined better or worse than another because there are no clear criteria for determining a "good" or a "bad" economic model. This is largely due to their "interpretative flexibility" and thus, the high levels of uncertainty inherent in the modelling and econometric analysis methods. A model that fails to forecast a significant change in an economy can be retained as legitimate by attributing the failure to, *inter alia*, exogenous variables, external political influences, incorrect sample period or by simply redefining the character of the failure (e.g. different types of economic recession). Conversely, a correct forecast can be attributed to a 'lucky guess'.

No one model, theory or specification is unambiguously superior to the rest. Econometric testing [e.g. multiple regression analysis] is chronically ambiguous. Forecast mistakes are similarly ambiguous and, even when acknowledged, do not force any particular course of action on the modelling team (Evans 1997 pp 419-420).

Moreover, an outcome can be of the same order of magnitude as its standard error. For instance, Diesendorf (1997b p 2) claims that MEGABARE's result of a loss in GNE of between 1.0-1.5% is smaller than the model's level of uncertainty. Evans (1997 pp 420-427) makes the point that issues over models are resolved by rhetoric (as found by Collins 1985) and concludes that macroeconomic models "tell us little about how the world actually works".

Having said this, McKibbin (1997 pp 52-62), who acknowledges the criticism of economic models and that they can be misused, argues that they are useful because of the key insights and the information they can provide in understanding "key driving variables" under different policy scenarios. Hence, their value is not in specific answers but in the way in which they aid our understanding of interactions. In any case, these models are a significant improvement on analysis of the future by the extrapolation of trends.

A particular concern for this thesis is that economic models necessitate the use of the past to forecast the future. Evans (1997 p 404) discusses this in terms of the 'Lucas Critique' which, in general terms, runs as follows: a macroeconomic model which represents an existing policy will contain certain parameters, but a change in policy will often require the inclusion of new parameters which the model should be able to predict if it is to successfully test policy changes. The problem is that these parameters are unknown until they are predicted but they cannot be predicted unless they are quantified and they cannot be quantified if they are not already included in the model as a parameter. Consequently, it is not possible to determine unknown parameters empirically (Diesendorf 1997a p 3). Hence, the model will be constrained by the *status quo* and the past will continue to determine the future if policy is based only on its projections and forecasts. Of course, in some circumstances, this might be a reasonable outcome, however, these circumstances limit the use of these models in the development of policy that requires innovation and new solutions such as how to transform an economy to significantly reduce its reliance on coal for energy generation.

The quantified nature of economic models means that they cannot address issues of equity. In the climate change debate, for instance, questions of who is primarily responsible for the greenhouse gases already in the atmosphere; who has benefited from their emission to date; who will suffer most from global warming, who can realistically undertake mitigation and how circumstances will change in the future are crucial questions. Economic models, of mathematical necessity, reduce these questions to controversies over conflicting valuations of land and human life or discount rates (Ekins 1996 pp 232-236).

The valuation of the damage costs, the treatment of risk aversion, the choice of discount rate, and the need for fairness all introduce complications and uncertainties before which the seeming rigor of the methodology dissolves (Ekins 1996 p 237). ... "[T]hrough the choice of appropriate parameter values

almost any abatement policy can be justified" (Fankhauser 1993 cited by Ekins 1996 p 237).

A macroeconomic model is a representational device. It is a frame of reference through which the external world of the economist is viewed - it acts as a filter to put order into the expanse of information that can be drawn from the external world. Consequently, economic models embody the communal cognitive and normative frameworks, hypotheses and assumptions of a discipline of economics and the properties of phenomena theorised to exist in the 'real' world (Lynch 1988 pp 204-231). The result of this is that different models using the same data can derive different outcomes (Andersen 1995 p 329). This is illustrated by attempts to estimate the mitigation costs of climate change. For instance, estimates of the cost to the United States economy of a carbon tax ranges from a 1.7% loss to a 1.1% gain in GDP depending upon assumptions about how the carbon tax is recycled within the economy. By directing the revenue specifically to reduce labour and capital taxes instead of reducing the overall taxation rates results in a gain in GDP. It can be seen that the way in which the carbon tax is recycled is more a political issue than an economic one, but an economist has to decide on the way that this is to be done so that he or she can carry out a model simulation.

In Australia, the results of two macroeconomic model studies on the implications of adopting the Toronto target also illustrate this point. A CRA Limited study projected a cost of \$9-32 billion (depending on the discount rate) whilst a study conducted by the Victorian Solar Energy Council (VSEC) projected net benefits of \$5-8 billion to the economy (IC 1991 G21). On this basis, it can be seen how different forecasting teams using even the same model could derive different forecasts (Evans 1997 p 427). These examples do not necessarily demonstrate contrivances in the development of the models, they are merely illustrations of the extent to which economic models are susceptible to being designed and constructed in such a way that

their outcomes reflect the philosophical and political assumptions of the analyst. This is a consequence of the language of mathematics which requires the exercise of judgement and introduction of informal rules to apply it, and the extent of uncertainty inherent in economic modelling. This scenario is at odds with the conventional view of quantification as a rule-bound, mechanical and objective methodology.

The number of equations that macroeconomic models can contain is phenomenal. For instance, ABARE's MEGABARE and GIGABARE models contain *several hundred thousand* mathematical equations each³⁸. This is an example of extraordinary confidence in quantification and the application of rules. It gives credence to the comments of Andersen (1995 p 327): "In general, models are so complicated that not even the model builders themselves can comprehend the entire model." The implications of these circumstances can be understood in light of the contradictions achieved by rules which have been documented by Wynne (1988 pp 152-154). He makes point that a rule-bound system will be modified at the discretion of local interests by the implementation of informal local rules. The "interpretative flexibility" (or the 'interpretative gap') that exists simultaneously with official rules can result in systems being developed in ways "unanticipated". Wynne refers to this as a system being "normalized" by *ad hoc* adaptations or new rules which are negotiated to meet local circumstances. Furthermore, the introduction of informal rules that only address part of a system - "contextualization" - can be at "cross-purposes" with the system that the rules were designed to guide or make transparent. For instance, a standard economic model - with the general commitments of the discipline of economics embodied in its mathematical language, standardised categories and measurements - is a prototype. It can be modified by various groups of economists to reflect their philosophical and political assumptions, preferred practices and disciplinary commitments. Also, it can be influenced by the circumstances and

³⁸ Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11.9.97.

practices of other domains. The crucial point is that informal rules in economics can differ with each economist depending on how they view the functioning of an economy. How an economy should function is a fundamental political question for which there is a spectrum of conflicting answers. Informal rules can direct the design of economic models which support certain outcomes and ignore others, in alignment with political interests. Indeed, the notion of objectivity invoked by quantification ensures that the informal rules remain, in large part, undisclosed despite calls for transparency and accountability. The models become black boxes³⁹. The informal rules become so extended and complex, it is impossible to decipher their foundation, their implications or their combined effects. Also, it makes a meaningful comparison of models virtually impossible (Ekins 1996 p 238). Hence, any discussion of assumptions and commitments (if such a discussion can take place at all) is usually characterised (and hindered) by claims and counter-claims of misinterpretation.

An economic model can be thought of as the embodiment of the 'interpretative gap'. In abstract terms, it is a bridge between the 'real' world and what we come to agree is in existence. The path which the bridge takes is contingent upon judgements which are influenced by rhetoric. An economic model is a particularly powerful rhetorical device because it is a method of quantification - it is conventional and it represents authority and objectivity. Models can be 'contextualised' and 'normalised' to reflect divergent philosophical and political assumptions, disciplinary practices and commitments which was demonstrated by the differences in the results derived from the CRA Limited and VSEC models which represent the varying paths that the bridge

³⁹ An economic model is similar to a scientific measuring instrument or technique. Over time and via negotiation between actors a model gains acceptance; the answers it produces are accepted without question as being neutral and are assumed to be objective, hence it would be referred to as a black box. The assumptions and judgements that went into creating the instrument will be hidden (Latour & Woolgar 1979 pp 176-182). Furthermore, the existence of phenomena is detected by instruments (or economic models) which are themselves human representations of nature (or the global economy) which embody the theory that the phenomena exists. Hence, the answer which a model produces is the one the model is designed to detect based on what the actor hypothesises exists, which is not necessarily the one that actually exists in the global economy (cf. Le Grand 1990 pp 263-268).

could follow and hence, the directions in which the construction of knowledge could take depending upon the judgements that are made.

Porter (1995) claims that quantification is the technology of distance and trust. It has become a substitute for trust because it is considered to be rule-bound and therefore objective. Our trust is not necessarily based on the numbers themselves but on the assumption that explicit rules have derived the numbers. However, it has been shown that it is possible that the complacent reliance upon rules in the process of knowledge construction can be a misplacement of trust. The emphasis on rules to remove judgement and generate objectivity can lead us too far away from understanding how to deal with important issues that can affect our well-being. For instance, quantification and economic models tend to reinforce and perpetuate the *status quo* (Evans 1997 p 407; Andersen 1995 p 325). For the most part, the pursuit of objectivity has been in good faith and in many cases, in the name of fairness. However, risks we now face, such as climate change, cannot be dealt with in the realm of the *status quo*. Our faith in economic modelling could be taking a risk much larger than our methods of quantification allow us to recognise.

CHAPTER FIVE

The 'contextualisation' of MEGABARE and the proliferation of informal rules to create a useful rhetorical device in support of the Australian government's position in climate change negotiations

The government argues that a uniform carbon dioxide emission reduction target is not fair as it imposes vastly different economic costs on different countries, in particular Australia. To protect future economic growth, Australia needs to increase its emissions, not reduce them. Therefore, the government makes no apology for its stand in opposing legally binding reduction targets. The domestic political rhetoric gives the impression to the Australian community that the government is acting in its best interests. On the face of it, it does appear unfair that the international community expects Australia to bear such a high and disproportionate cost when its emissions are only about 1.4% of the total (DFAT 1997 p 6). Anyone in favour of Australia adopting the target, however, would point out that on a per capita basis, Australia is the sixth highest emitter of carbon dioxide in the world⁴⁰. Australia bases its position on the economic modelling of ABARE. Again, anyone in favour of Australia adopting the target will point out that this modelling is fundamentally flawed and lacks credibility because it has been partly paid for by companies with a vested interest in the continued use of fossil fuels. In an attempt to understand these claims and counter-claims, the focus of this thesis will now turn directly onto ABARE and MEGABARE to begin an interpretation of their role in formulating and mobilising the government's position in light of the theoretical issues that have been discussed in preceding chapters.

⁴⁰ Australia is lead by Canada, the United States, Kazakhstan, the United Arab Emirates and Singapore (DFAT 1997 p 6). According to the World Resources Institute (1992), reporting 1989 per capita carbon dioxide emissions, Australia was lead only by Canada and the United States.

ABARE is Australia's largest applied economic research agency specialising in commodities. It is a unit of the Department of Primary Industries and Energy (DPIE). It was established in its present form in 1987 by the amalgamation of the Bureau of Agricultural Economics (BAE), established in 1945, and the Bureau of Resource Economics (BRE). ABARE conducts economic research and provides analyses principally to government policy makers but it is also commissioned by the private sector to conduct research. For instance, the organisation provided analyses to the government's negotiators for the Uruguay Round of multilateral trade negotiations. ABARE's focus is "adding value to the information it collects, analyses and disseminates." (Lawrence 1995 pp 3-8). ABARE's strategic goal is:

To efficiently and effectively provide high quality economic information of direct relevance to Australia's primary and energy industries in order to enhance their economic performance and that of Australia as a whole (ABARE 1992b p 15).

The BAE began the publishing of commodity forecasts and projections, which ABARE continues to do. In the 1950s, 80% of Australia's exports were from the rural sector. At that time ABARE (as the BAE) was involved in the analysis of profitable areas of expansion for agricultural production. In the 1960s world commodity markets were oversupplied bringing about a rural recession in Australia. This changed ABARE's focus to market outlook assessments and the economic analysis of policy options to restructure economically unviable schemes or non-competitive Australian markets. In 1971 ABARE began its annual Outlook conferences which disseminated information to the government, farmers and industry. These conferences became a forum for the debate of policy issues and directions by federal and state governments, industry representatives and ABARE (Lawrence 1995 pp 3-6).

In the 1970s, ABARE's analyses were used to establish what is now known as the Rural Adjustment Scheme. In 1974 the Industries Assistance Commission (IAC) was set up to review government subsidies provided to various sectors of the

economy (e.g. manufacturing and primary industry). ABARE (as the BAE) researched and analysed the role and economic costs to government of interventionist policies when preparing submissions for the IAC (Lawrence 1995 6).

A particular focus of ABARE's research is current and prospective foreign markets in which Australia does or could compete internationally. It provides to the government economic analyses of Australia's minerals, energy, fishing, agriculture and forestry industries. These industries account for approximately 65% of Australia's export income (ABARE 1992c p 5). ABARE's involvement in natural resource management research has increased since the 1987 amalgamation which formed ABARE (Lawrence 1995 p 7). Its role in analysing current and prospective markets and making future resource projections both within and outside Australia has resulted in ABARE's findings having a considerable influence on public policy in Australia.

ABARE is currently required to earn approximately 40% of its income from external sources, such as industry or other government agencies (Stuart *et al.* 1997 p 2)⁴¹. During 1991-92 ABARE received approx. \$17 million from the government and approx. \$4 million from commissioned research, sales of publications, conference admissions, *etc.* (ABARE 1992c p 5). Revenue from commissioned research alone during this period was approx. \$3 million which had increased from \$876,000 during 1988-89. ABARE has to compete with other economic research organisations for private research contracts and it values customer satisfaction very highly. So much so, ABARE has funded the placement of new research graduates into private sector

⁴¹ This policy was introduced in 1989. At that stage ABARE was required to earn 10% of its income from outside sources which was subsequently increased to 30%. With the change of government, the Coalition increased the outside earnings requirement to 40% (interview with Vivek Tulpule on 24.10.97).

industry organisations so that it could find out their needs to provide them with better service (ABARE 1992c pp 40-55). This program has since been "wound down"⁴².

For the 1991-92 year, ABARE's performance was measured by a cost-benefit analysis whereby 10% of "potential gain to the Australian economy" from ABARE's input to policy decisions was compared to the cost of research. For instance, ABARE carried out research in relation to the Blue Fin Tuna industry which cost \$15,000. ABARE valued the industry at \$34.6 million, however, the Japanese fishing fleet was only paying \$3 million for access to the fishing zone. Consequently, the government renegotiated the access fee which was raised to \$4.5 million. Therefore, 10% of \$1.5 million was attributed to ABARE's input which justified part of its budget for the year and therefore its existence (ABARE 1992c pp 28-33)⁴³.

ABARE was involved in the economic modelling carried out for Ecologically Sustainable Development Working Groups in 1991. ABARE's MENSA⁴⁴ model was one of two models used for this analysis. The general conclusion of the report was:

In broad terms, the modelling suggests that the emission reduction target could be met but that achieving the target would require extensive energy system and macroeconomic adjustments involving at least some economic cost. In all scenarios involving an emissions constraint, the contribution of coal to meeting total demand for energy services would decline substantially eventually coal-based technologies for power generation are eliminated (ESD Working Groups 1991 pp ii-iii).

For the environmentalists and the sustainable energy supporters, this would be a favourable outcome. However, for ABARE it simulates the demise of the Australian economy's most important commodity. Hence, it also stimulates a questioning of

⁴² Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 13 October 1997.

⁴³ However Blue Fin Tuna populations have been seriously depleted over the past decade and the species has a greater than 50% chance of extinction by the year 2020 if overfishing at the current rate continues (ABC On Line News, 8.9.97).

⁴⁴ Multiple ENergy Systems of Australia is a multi-period, linear programming model of the Australian energy system designed to determine least cost ways of meeting energy demand when cost, policy and market conditions are specified (Dickson & Pakravan 1995 pp 8-9).

model assumptions about the constant elasticity of technological substitution (to be discussed). An ABARE address to the Industry Commission in 1995 reported that results from further MENSA modelling indicated the highest emission reductions at 'least-cost' would be achieved by increasing efficiency in the energy conversion sector (i.e. the generation of electricity) and by changing fuel carbon intensity through a switch from coal to gas fired power generation (Dickson & Pakravan 1995 pp 1-18). Findings such as these focus the climate change debate on the coal industry⁴⁵. Given that 'least-cost' is the optimal criterion for choosing the best option, the modelling results put the government in a difficult position. If the government was serious about meeting the reduction target, it would have to convince coal generation and mining organisations to go beyond 'no regrets' measures. This would require the premature retirement of capital and the upgrading of existing capital at a high cost, which is economically inexplicable to shareholders. Furthermore, according to the modelling, to sustain the low emission levels, the contribution to energy generation by coal would be significantly reduced over time. Hence, if the government used this modelling to formulate policy, it would be asking the coal industry to pay for its own demise. Obviously the government would be reluctant to do this and industry would be unwilling to participate. The current problem for the government is that the legally binding reduction targets which have been proposed internationally could force the scenario modelled by MENSA on the coal industry⁴⁶. This goes some way in explaining why the Australian government is opposed to legally binding targets.

In 1993 ABARE began the development of a macroeconomic model of the global economy, known as MEGABARE. A report setting out the results of

⁴⁵ The pressure felt by the coal industry was expressed by the Chief Executive Officer of CRA Limited in his comments about how there was an erroneous public perception of coal as the "villain in causing predicted global warming" (Ralph 1992 p 859).

⁴⁶ Of course, this modelling is subject to the concerns about rules discussed in Chapter 3 and the limitations of economic models discussed in Chapter 4. The demise of the use of coal might be a misrepresentation of 'reality'. For instance, based on the presentations at the Bridge to the Future Forum, this modelling would omit a large contribution to emission reductions that can be made by energy efficient use. The Forum was convened by the National Environmental Law Association, AGL and the Australian Conservation Foundation and it was held in Canberra on 23 October 1997.

MEGABARE and ABARE's conclusions, *Global Climate Change: Economic Dimensions of a Cooperative International Policy Response beyond 2000*, was published in November 1995 and its general findings were presented at the Second Conference of the Parties at Geneva in 1996. MEGABARE is a dynamic multiregion, multicommodity, computable general equilibrium model. Its purpose is to calculate the possible future impacts of policy changes on the global economy for assessment and interpretation by ABARE analysts. ABARE initially developed MEGABARE to analyse climate change policy (ABARE 1996 p 1). However, this use has been extended to other applications, such as the impact of trade liberalisation⁴⁷.

The number of sectors (e.g. coal/oil/gas) and regions (e.g. Australia/Formal Soviet Union) that can be analysed by MEGABARE has increased since its inception due to the disaggregation of MEGABARE's foundation database, the GTAP (Global Trade Analysis Project). The various regions and commodities can be aggregated or disaggregated and incorporated into the MEGABARE model to simulate a particular scenario (ABARE 1996 p 2). Currently MEGABARE identifies 30 regions, 41 commodities and 7 different technologies for electricity production. For MEGABARE to simulate various carbon dioxide emission abatement scenarios, 16 commodity sectors and regions were chosen by ABARE⁴⁸. The extension of the use of MEGABARE by expanding its categories and the development of GIGABARE (to be discussed) is standardising ABARE's economic analyses. It is also extending the scope of ABARE's influence on government policy by making its analyses applicable to more areas of the economy and public policy. Such influence also extends to industry, governments and trade groups outside Australia such as the Asia Pacific Economic Cooperation group, APEC.

⁴⁷ For example: 'APEC trade liberalisation: The effects of increased capital mobility' in *Australian Commodities*, 3(4), December 1996; pp 520-526; 'Coal's role in APEC' in *Australian Commodities*, 3(4), December 1996 pp 527-543. *Australian Commodities* is a publication produced by ABARE.

⁴⁸ These are set out in Appendix 2.

The Global Trade Analysis Project (GTAP) model and database provide the fundamental framework for MEGABARE - its core equations and standardised data definitions. The GTAP's headquarters is at Purdue University, Indiana in the United States. The GTAP is a consortium of 15 international and national agencies⁴⁹. Each member agency has a place on the GTAP Advisory Board which guides and provides support to the GTAP. For instance, the Board determines the types of commodity and regional disaggregation to be undertaken by the GTAP. Consortium members have priority, but not exclusive, use of the database. Each organisation contributes \$30,000 initially and then \$15,000 per year. Consortium members are "expected to help keep GTAP 'on track' so that it is well-placed to contribute to public debate on issues of global trade analysis." Since 1993, the GTAP database of the world economy has been disaggregated from 16 to 30 regions (GTAP 1997).

A major reason for establishing the GTAP database was to minimise the costs of each agency having to set up a new database for their respective models. It is considered that the centralised GTAP approach produces a database superior to any that could be produced solely by one agency (ABARE 1996 p 2). Accordingly, considerable standardisation of definitions has taken place so that the data collected by the various consortium agencies can be combined. The database contains detailed trade data which is linked together by sectoral input and output tables from each country or region. Disaggregation of data requires the input and output values to be broken down into a standard form for incorporation into the GTAP database (GTAP 1997). The database is updated at 12-18 month intervals⁵⁰.

⁴⁹ For instance, ABARE, Australian Industry Commission, Australian Council for International Agricultural Research, the World Trade Organisation, Asian Development Bank, OECD Development Centre, European Commission, Japanese Economic Planning Agency and the World Bank.

⁵⁰ Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997.

To date, the priority of the GTAP has been to improve the representation of agricultural data in the database, although an improved representation of energy data is expected to be available from the GTAP later this year⁵¹. From a summary of a 1997 GTAP Advisory Board Meeting (GTAP 1997), it appears that there have been significant difficulties in disaggregating the energy data in relation to carbon emission values. Four consortium members (including ABARE) have attempted to update the energy data and reconcile it with emission physical volume flow data from the International Energy Agency (IEA):

In order to say something about carbon emissions ... one must be able to refer to physical volume flows. However, when the IEA physical volume flows are matched up with GTAP value flows, the prices necessary to reconcile the two don't make sense. This is perhaps not surprising in some instances, due to the arbitrary splits required to disaggregate, e.g. oil and gas, in many of the individual country IO [input/output] tables. Thus it seems quite clear that there will be benefits to bringing the IEA data to bear in the actual data base construction process. (We recognize that the IEA itself has some problems as well, including limited price information, so one is often forced to assume common prices across different users.) (GTAP 1997)⁵².

ABARE have recently reconciled the two data sets⁵³. However, this means that the carbon emission data ABARE now uses would be different to that which it originally used in MEGABARE. The above comments at the GTAP meeting and these circumstances give some insight into the difficulties in standardising and categorising such large amounts of quantified data. Contrary to the conventional notions of

⁵¹ *ibid.*

⁵² To explain this further, the extended discussion at the GTAP Advisory Board Meeting indicates that there are three sets of data which are used in this case to standardise and combine information for its inclusion into the GTAP database, namely: physical flow being a measured quantity of, for instance, carbon dioxide emissions or commodities, prices which are region specific and value flow being a quantified monetary amount. The price information is used to convert physical quantities in the input/output tables for each region into values which become part of the database for use in economic models. To obtain information about carbon emissions a conversion back from the value flow data could be carried out and prices used to check it. However, if disaggregation of the energy data has taken place in the interim, there will be a lack of correspondence between the value flow and physical flow data which will be reflected in the nonsensical prices. Oil and gas need to be disaggregated because they each emit a different level of carbon dioxide. This would not have been an issue when the database was first established. It has since become important with the increased use of gas to generate electricity.

⁵³ <unknown@agecon.purdue.edu>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan, circa 5 August 1997. A person from the GTAP advised that Kevin Hanslow of ABARE headed the ABARE team that made the adjustments. The hard copy message cannot be located.

quantification, judgements have to be involved at many levels. However, the existence of these judgements are dismissed when they are input to the economic models and completely hidden from view in the output of the models (Shackley & Wynne 1995b pp 114-119). For instance, in ABARE's technical papers, reference is made to the energy disaggregation and the IEA data:

Data used for these disaggregations [coal sector separated from electricity gas and water sectors and the breakdown of coal into four technologies] was taken from published International Energy Agency statistics and country specific input-output tables (ABARE 1997c).

The disaggregated data base was used by ABARE to determine a baseline to the year 2010 for APEC electricity output and APEC investment requirements for steaming coal supplies.

In the development of these two papers [documenting the APEC baseline to 2010] a number of consistency checks of the GTAP data base have been made, and adjustments performed for a number of countries. These changes have been made using the latest available published information of the International Energy Agency, with the result that the baseline is more consistent with market expectations (ABARE 1997c).

ABARE discusses "consistency checks" and "adjustments" but there is no indication that they are initially "arbitrary splits", that users are "often forced to assume common prices across different users" or that the database is inconsistent without IEA data. The impression given is that the adjustments are not judgements but that they are in accordance with some standard which has been formalised by the IEA. Based on the authority economists and industry organisations attribute to the market, the reference to "market expectations" gives a final note of assurance that ABARE's formulations are 'correct'. This rhetoric generates credibility for ABARE's projections.

The 'normalisation' and 'contextualisation' of the GTAP model in transforming it into MEGABARE have required for instance: the inclusion of greenhouse gas emissions as a by-product of different economic activities; the summing of emissions on a regional and a global basis; equations to test policies for reducing growth in emissions; the inclusion of the "technology bundle" instead of CES (constant

elasticity of substitution); and the inclusion of a demographic module to enable MEGABARE to determine population and labour force growth rates endogenously (ABARE 1997c). ABARE (1996 pp 4-5) considers that MEGABARE's notable modifications are the 'technology bundle' approach and the endogenous determination of the population growth rate. It is claimed that these features make MEGABARE superior to other computable general equilibrium (CGE) models being used to assess the impacts of climate change policies⁵⁴. The discussion to follow will focus on these two aspects of the model.

MEGABARE is a 'top down' model, but it incorporates features of both 'bottom up' and 'top down' models (ABARE 1996 pp 30-38). ABARE illustrates the difference between 'top-down' and 'bottom-up' models in relation to 'no regrets' measures and describes how the economic impact of such measures is captured by the model (ABARE 1996 p 61). A technology that increases energy efficiency saves the energy producer money thus producing a welfare gain at the sectoral level. However, this has repercussions within the sector and on the overall economy because the inputs that would have otherwise been purchased and used by the energy producer are no longer required. This loss of demand results in a welfare loss in the overall economy. The welfare gain at the sectoral level is determined by a partial equilibrium model, which is a 'bottom-up' model. The welfare loss in the overall economy is determined by a general equilibrium model, which is a 'top-down' model. MEGABARE incorporates features of both these types of models and therefore can, it is claimed, capture the impacts of the changes at both levels of the economy to determine the net effect (ABARE 1997c)⁵⁵.

⁵⁴ The GTAP CGE model has been used as a base for several climate change models, however, details of the climate change models were not given. The MIT Global Change Group is looking at using the GTAP database. Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997.

⁵⁵ This model structure assumes that energy efficiency is likely to have a detrimental effect on the economy. However, this assumption would disregard the movement of the money saved by the energy producer (or like actor in an economy) into other parts of the economy not specified by the model.

ABARE has deliberately not adopted the nested constant elasticity of substitution (CES) approach that is usual in 'top down' CGE models because these typical models assume that inputs can be continuously substituted to produce an energy output. The continuous "perfect" substitution is influenced by movements in input prices, hence, the input elasticity is determined by the model endogenously. ABARE is of the view that perfect substitution is implausible because small changes in prices would shift global production of a commodity between countries or create sudden shifts in the production of an output from one technology to another. ABARE contends that this does not and cannot happen in the 'real' world (ABARE 1997c).

Just as commodities from different regions defined to be the same have different underlying characteristics, different technologies producing the 'same' output have different characteristics. ... in the case of electricity, available water storage capacity, location and size of coal and natural gas reserves and environmental impacts of alternative technologies place constraints on the substitution options between the alternative technologies (ABARE 1996 p 34).

To illustrate this point, in MEGABARE, solar technology would be assumed to be an imperfect substitute for coal fired technology power generation because additional inputs, such as capital, would be required to establish its general use. ABARE's view is that the typical CES approach would, in a sense, automatically make this substitution and its 'real' cost would not be reflected in the model outcome or included in the calculations as a loss in welfare. 'Bottom up' models, on the other hand, are considered to be more realistic in modelling energy substitution options because they allow control over the inclusion in the model of known alternative technologies and their inputs. Consequently, in MEGABARE values for inputs or levels of capital required for technology substitutions can be set by the analyst. ABARE has structured MEGABARE to reveal the assumed "lack of smoothness" in technology substitution. In this way, it is claimed that the 'real' cost of emission abatement can be quantified (ABARE 1996 pp 30-38). McKibbin is of the view that ABARE's dismissal of the CES approach ignores history because the oil shocks of the

1970s demonstrate unequivocally that price does change fuel use and that substitution can take place without disastrous consequences⁵⁶. ABARE has 'contextualised' the technology substitution section of MEGABARE by bringing together two different modelling approaches in a novel way. Consequently, MEGABARE has been constructed so that it reflects ABARE's 'worldview' of the possibilities for fuel switching.

The government, ABARE and the sustainable energy supporters all predict that the adoption of co-generation technology and gas fired power generation can significantly reduce carbon dioxide emissions in the energy sector in the future⁵⁷. ABARE has included the emission reductions from this technology into their 'business-as-usual' scenario. A 'business-as-usual' scenario is a projection of carbon dioxide emissions which are expected to increase on the basis that no policy action is taken - it is a benchmark from which the impact of policy changes is measured. Emissions can be reduced by a set amount with a simulation of a carbon tax in the economy which encourages fuel switching and therefore, emission reductions below the 'business-as-usual'. The deviation between the 'business-as-usual' emissions and the carbon tax simulation is, in general terms, the cost of reducing emissions by the specified amount (ABARE 1997a p 19). The higher the 'business-as-usual' projection, the higher a carbon tax will need to be to reduce emissions by the specified percentage of the 'business-as-usual' projection value. However, because ABARE has included these emission reductions from co-generation and gas generation into their

⁵⁶ Interview with Warwick McKibbin on 4 August 1997.

⁵⁷ When fossil fuels are burned, approximately two-thirds of the heat generated is wasted. Co-generation uses the heat and can increase energy efficiency typically by 60-75% but can be up to 85% (DPIE 1996b p 51). The use of co-generation technology is expected to quadruple by the year 2010 (DFAT 1997 p 41). Gavin Gilchrist of SEDA claims that the incentive for the usual gas-fired co-generation systems has been discouraged because of the low cost of electricity (interview on 15.10.97). The NSW government's Sustainable Energy Development Authority (SEDA), web site: <<http://www.seda.nsw.gov.au/>>, promotes co-generation as an effective means of increasing energy generation efficiency. The federal government is very enthusiastic about co-generation. See Senator Warwick Parer DPIE media release 192P, 8.8.97 and DPIE (1996b pp 51-52). Dickson & Pakravan (1995, pp 13-16) state that MENSEA modelling projects a significant increase in gas fired generation in place of coal. From a sustainable energy supporter perspective see Diesendorf (1997c pp 216-221).

'business-as-usual' projection these options are not available for reducing the level of the carbon tax⁵⁸. This situation would not be an issue if the efficiency gains from these technologies lowered the 'business-as-usual' projection. However, it is more likely that the increases in efficiency have been absorbed by industry production growth projections which have been reported in the media as extraordinarily high and at odds with the intention of the FCCC⁵⁹. Therefore, all reductions have to be 'forced' from a high level by a high carbon tax. This would result in the loss in GNE being overstated.

A particular concern expressed by the sustainable energy supporters is that possible gains from energy efficient use are being dismissed by the government and ABARE in their modelling. ABARE does, however, claim that it allows for increases in efficiency in its 'business-as-usual' projection. When questioned on this point, Tulpule indicated:

In the modelling we account for (a). steadily increasing levels of energy efficiency over time (at slightly greater than historical rates and faster for us than for other OECD countries with the exception of the US) and (b). a declining cost of renewables based on expert information obtained over time. Given these, under the CO2 stabilisation [*sic*] scenario the penetration of renewables rises to 60 per cent of total electricity production by 2020. Many

⁵⁸ Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 30 September 1997 confirmed the inclusion of cogeneration and gas fired generation emission reductions in the 'business as usual' projection. Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997 confirmed that the carbon tax and technology substitution are co-dependent. The adoption of these technologies is assumed to take place at no capital cost to firms (ABARE 1997a p 18). Hence, it appears that these measures are being treated as 'no regrets' measures but they are not being referred to as such. They are in line with the government's energy policy (DPIE 1996b).

⁵⁹ As discussed, DFAT (1997 p 6) states that Australia's emissions are expected to increase by 40% above 1990 levels by 2010. A view expressed by industry is that any gains in efficiency will be taken up by increased production, hence these gains cannot be attributed to meeting a reduction target. For instance, in its submission to the IC (1991 p F70), BHP Limited indicated it could reduce its emissions by 15% per tonne below 1988 levels by 1998, however, it expected to increase its steel production by 44% within the same timeframes. On 20.8.97 the Deputy Prime Minister Tim Fischer stated that Australia needs to increase its emissions, not reduce them (ABC On-line news). Also, it was reported on 9.8.97 that a government report leaked to the Australian Conservation Foundation concluded that Australia's emissions were projected to increase by 65% by the year 2020 (ABC On-line news). BHP Limited claims that in most of its business in Australia, emissions have in general decreased over the past decade. However, its report (BHP 1996 p 3) shows that emissions have increased in all its sectors during the years 93-95. Indicative of the scope for interpretative flexibility in this debate, the emission reductions are per unit of production.

people have told us that they believe this level of renewables uptake unrealistically high. (recent comments by many of our critics about us not taking energy efficiency improvements into account are completely wrong)⁶⁰.

In light of the discussion in Chapter 4, these comments highlight the extent to which economic models perpetuate a situation whereby the past determines the future, why judgements can change model outcomes and how analyst assumptions can be hidden from view. In a country that is heavily reliant upon coal, with energy prices so low and no reason as yet to reduce consumption or emissions, the "slightly greater than historical rates" would be miniscule. On this basis, it is not surprising that ABARE dismisses efficient use as an important contribution to reducing emissions. Also, the outcome of the model would obviously differ depending on the advice of experts. Moreover, a transition between now and 2020 to 60% renewable technology was described recently by Diesendorf as absurd and unrealistic. Consequently, the amount of a carbon tax to bring about such a scenario under market conditions would be extraordinarily high and therefore, the welfare losses would be significantly overstated. Diesendorf argues that energy efficient use and co-generation technology are the optimal short term solutions to significantly reduce emissions over the next 15 years. This should be followed by combined cycle gas fired generation (within the next 15-30 years) and thereafter non-emitting renewable technologies could be increasingly relied upon because they would have had sufficient time to develop and improve their cost effectiveness for access to the market. Diesendorf claims that such a scenario is, in large part, currently prevented from being implemented due to market failures which could be rectified by various institutional rearrangements and political will⁶¹.

⁶⁰ Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997 in response to a question about the difficulties of including renewable technology into simulations because, algebraically, the rate of increase could not be captured by the model. This was a point raised at the National Academies Forum on 29-30 April 1997.

⁶¹ These views were expressed at the Bridge to the Future Forum and in an interview on 17.9.97. See also Diesendorf (1997c pp 216-221) and Diesendorf (1996 pp 33-48).

Although ABARE's 'business-as-usual' projection is a 'no policy' scenario and many of the measures Diesendorf advocates would require policy intervention, it is possible that there is some confusion here. ABARE considers that such a large uptake of renewables over-accounts for "energy efficiency improvements". However, renewable technology and energy efficient use are two separate issues. It is for this reason that Diesendorf, and many other sustainable energy supporters, envisage the use of renewable technologies in the *distant* future. It appears that ABARE conflates the concepts of energy efficiency and renewable technology. This is a typical problem of 'supply side' versus 'demand side' economics - ABARE's focus is on energy generation, not energy use whereas the sustainable energy supporters focus on providing energy services. Achievement of the emission reduction targets by taking into account energy efficient use would result in the calculation of a much lower carbon tax than that simulated by ABARE and the welfare losses would also be lower. MEGABARE is constrained by 'supply side' economics which assumes that energy efficiency is a loss to the economy. Sustainable energy supporters would argue that energy efficient use creates jobs in small business and manufacturing to install and produce appropriate devices, *etc.* and that the savings made by energy consumers would be spent elsewhere in the economy. That this money is not captured by MEGABARE perhaps indicates the limitations of economic modelling and a misrepresentation of 'reality'.

MEGABARE incorporates a demographic module to determine population growth rates and thus labour market growth rates endogenously (ABARE 1996 pp 39-46). The underlying assumptions of the module are that fertility and mortality rates decline as welfare improves. The result of this is an increase in the proportion of working age people in the population and an increase in the growth of GDP per person. This has implications for the calculation of emissions, particularly for developing countries. ABARE considers that the capacity of MEGABARE to determine these growth rates endogenously increases the model's accuracy.

McKibbin is very sceptical of ABARE's assumption that there is such a close relationship between income and fertility and considers the exogenous input of a population growth rate as determined by worldwide agencies is better than ABARE's own linear regression⁶².

MEGABARE, like most macroeconomic models, is constrained by the 'Lucas Critique' which was discussed in Chapter 4. For instance, renewable energy is only identified in the 'technology bundle' to quantify the inputs (capital and labour) required to establish it, as a direct substitute for coal-based energy. It does not incorporate a category or sector for renewable technology⁶³. The sectors defined by ABARE are commodities (e.g. non-ferrous metals, iron and steel) or well established sectors (e.g. agriculture and manufacturing) all of which ABARE constantly monitor and for which international markets exist. There is no provision in the model for investment flows to a renewable energy sector - it is not a commodity. Its input is solar radiation which is not tradable or exportable. The result of this is that the renewable technology sector does not really exist at present and it is unlikely to in the future given the mathematical and structural constraints of economic models.

It has been shown that despite the notions of objectivity and authority attributed to quantification, judgements and assumptions have guided the structure and outcomes of MEGABARE. The judgements have been required at the fundamental level of data standardisation. In light of the claims of Wynne (1988), that the refinement of standardisation increases opportunities for reinterpretation, the difficulties and the judgements involved in combining the global GTAP data can be appreciated. ABARE's 'reality' of fuel switching and population growth have been incorporated into MEGABARE by introducing various informal rules and the model

⁶² Interview with Warwick McKibbin on 4 August 1997.

⁶³ See Appendix 2. It is notable that ABARE project the energy consumption of renewable energy to fall from 5.7% in 1995-96 to 4.9% through to 2009-10 and renewable energy production to fall from 2.4% in 1995-96 to 1.5% through to 2009-10 (ABARE 1997d pp 2-3). These projections are a strong contrast with the 60% uptake of renewables included in ABARE's 'business-as-usual' projection.

has calculated an abatement cost consistent with this 'reality'. The concern for this thesis is that ABARE's questionable judgements and assumptions are hidden from view by the model and its quantified results. The discussion will now turn to the actions taken by ABARE and the government to mobilise the findings of MEGABARE in their attempt to demonstrate, both domestically and internationally, that a legally binding uniform reduction target would be unfair to Australia.

CHAPTER SIX

The mobilisation of MEGABARE and its role in overshadowing the 'environmental reality' of climate change with an 'economic reality'

The Industry Commission (1991) concluded that the negative impact of adopting the Toronto target on Australia's trade would be inversely proportional to the number of its trading partners that committed themselves to reduce their emissions. Given this conclusion and the multilateral agreement by many of Australia's trading partners to reduce emissions by adopting legally binding targets, the government's concerns are understandable. The problem for the government is that it is not in any country's interest to compensate Australia for the devaluation of its prize resource. It will be argued that MEGABARE has provided the government with a means to get the attention of other countries by showing them how they too could lose (and the countries that might win) from the implementation of a uniform target. The mobilisation of the quantified rhetoric has been an attempt to shift attention away from the environmental impacts of climate change and the benefits of avoiding it to focus on the economic costs of mitigation. In doing so, ABARE and the MEGABARE model have been strongly criticised. This chapter will examine some of the ways in which ABARE and the government have attempted to mobilise MEGABARE's findings as well as some of the criticisms that have been directed at these actors and the model in doing so.

ABARE sought external funding to develop MEGABARE to ensure that it was completed within the shortest possible time frame. The "stakeholders" contributed a total of \$387,000 between 1993 and 1995 to ABARE to develop MEGABARE⁶⁴. This amount was approximately 25% of the model's development cost. The funding entitles each stakeholder representative a position on the advisory

⁶⁴ See Appendix 3.

project steering committee⁶⁵. A more sophisticated version of MEGABARE, GIGABARE, is now being developed which is expected to be completed by 30 June 1998 (Stuart *et al.* 1997 pp 5-6 & 16). GIGABARE is envisaged to enhance MEGABARE by including more variables, in particular, several of an environmental nature⁶⁶. The stakeholders involved with GIGABARE are also expected to contribute approximately 25% of development costs⁶⁷. A curious statement regarding ABARE's funding was made by Senator Parer in the Senate on 4 December 1996:

As regards funding, the development of the model [MEGABARE] was funded by a range of government departments such as the Department of Sports & Territories, the Department of Industry, Science and Technology, the Department of Primary Industry & Energy, the Business Council of Australia and industry groups including the New South Wales Coal Association. But no funding was provided by those groups or by any of the industry groups, I understand, in regard to the research associated with the Megabare [*sic*] model (*Senate Hansard* 4.12.96 p 6664).

The distinction which is made here between the development of the model and research associated with it is a rather mysterious one. Perhaps the Senator is alluding to the GTAP database and inferring that because the data used in the model was not funded by these organisations, the findings of the model are 'objective' and that the assumptions in the construction of the model have no bearing on its results. Obviously, the contrary is the case as we have seen.

⁶⁵ Senator Parer stated in the Senate: "Steering committee members have no influence over results and the manner in which the results are reported publicly." (*Senate Hansard* 15.5.97 p 3517).

⁶⁶ For instance, it will include climate change impact modules to simulate climate change impacts on temperature, agriculture, human health and sea level to: assess feedbacks on economic variables; determine when it is economically optimal to adopt adaptation instead of abatement strategies; and to estimate greenhouse gas concentration contributions from developed and developing countries. It will also include engineering databases of energy systems to give a more 'realistic' indication of "when" fuel switching is possible. For instance, an abatement action might be unjustified because technology to achieve the same outcome is likely to be introduced by market forces at some predictable time in the future. It will also include information on forest sinks (as an alternative to emission abatement) (Stuart *et al.* 1997 p 15-16). See Appendix 4 for ABARE's web site promotional information which sets out in more detail GIGABARE's improvements on MEGABARE. There is a notable correspondence between these enhancements and those being made to global circulation models to increase the regional resolution of the *environmental* impacts of climate change which have been analysed by Shackley & Wynne (1995a), such as biological carbon dioxide exchange, vegetation feedbacks and atmospheric chemistry. GIGABARE's improvements will resolve, to an extent, the *economic* regional impacts of climate change.

⁶⁷ See Appendix 3. Funding to ABARE increased with more participants joining the GIGABARE consortium.

Although GIGABARE is still in the development stage, the long list of stakeholders tells quite a story. All industry representatives are major fossil fuel producers, converters or users. ABARE invited these organisations to join the consortium. It advertised that it was calling for sponsors by sending out several hundred brochures⁶⁸. It is notable that from sending out several hundred brochures, all respondents have a vested interest in retaining the carbon dioxide emissions *status quo*. These organisations obviously consider that ABARE interprets the situation and represents it in a way that is favourable to their interests (cf. Jasanoff 1988 p 216). In light of the significant influence ABARE and MEGABARE have had on the government's position on climate change, it is not surprising that ABARE has received such a positive response from fossil fuel vested interests to join the new consortium. As with MEGABARE, each stakeholder is entitled to a position on the steering committee. Questions put to ABARE about possible conflicts of interest elicit a dismissive response (to be discussed). The disproportionate presence of fossil fuel and industry interests on the steering committee for both projects is simply not seen by ABARE as a conflict of interests or unbalanced representation. The findings of a study conducted by Pusey (1991 pp 95-96) into the culture of economic rationalism within the federal government, which documented the widespread perception of Senior Executives in the resource and industry divisions as "captives of their clients" and "too close to business interests", could go some way in explaining this attitude.

ABARE encourages organisations to join its consortium via its web site. The benefits of joining are "influencing policy debate" and to "have an influence on the direction of the model development ..." (ABARE 1997c; see Appendix 4). In light of

⁶⁸ Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997. Tulpule states: "At the end of the day taking the MEGABARE and GIGABARE projects together only 13 per cent of the funding for the project came from industry sources. The remainder was from government."

ABARE's influence on public policy, this is an irresistible invitation to the fossil fuel lobby to use the government as a vehicle to pursue its interests. Having said this, all of the consortium organisations have either an economic interest in the continued use of fossil fuels, an interest in preventing the introduction of a carbon tax or an interest in increasing emissions not reducing them. All of these interests align well with those of the government and ABARE. Therefore, it is doubtful that the model development would require much input from the steering committee in any case⁶⁹. The important point is not so much that these organisations might have an influence on the development of the model, but that these organisations obviously see MEGABARE as an effective way of mobilising their interests. The funding allows the economic arguments against taking strong abatement action on climate change to be voiced at the same time as the environmental arguments encourage strong action.

When accepting the Prime Minister's Award for Innovation in the Public Sector for the development of MEGABARE the Executive Director of ABARE, Brian Fisher, stated:

⁶⁹ A question (suggested by David Miller, UNSW) was put to Vivek Tulpule asking if there was an interaction between modellers and members of the steering committee: Do the modellers anticipate what the members want or do the members get to critique what modellers produce before it gets used? Tulpule gave the following response: "There is a steering committee meeting about every quarter ... there is discussion of the work program, the rate of progress and model development, *etc.* The steering committee has no role in vetting what we [ABARE] do. We do receive and get their advice on a range of modelling issues (e.g. at the last meeting a point of debate was whether aluminium could be considered a perfect substitute across different exporting sources). The technical expert on the committee often plays a role in helping us with a range of modelling issues. We [ABARE] use a whole range of sources to determine modelling needs, not just the steering committee. In fact our most recent efforts at analysing endogenous technological change were motivated by green critiques of our work." Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 13 October 1997.

MEGABARE has achieved international recognition as one of the world's leading climate change policy models ... [t]he analytical results of the MEGABARE project are being used to directly influence international policy development as well as policy making in Australia⁷⁰.

There is no doubt that the results of MEGABARE have been used to influence policy making in Australia, however, its use in international policy making and its description as "one of the world's leading climate change policy models" are both points of contention.

MEGABARE was included in an international model evaluation conducted by the Stanford Energy Modellers Forum prior to winning the Prime Minister's award⁷¹. However, this appears to be the only instance of international critical scrutiny. Recently this Forum carried out a technical comparison of the various climate change models for presentation at Kyoto, however, a submission was not made by ABARE⁷². This exercise could have generated international credibility for ABARE, MEGABARE and the government's position, although a negative analysis would not have been in their interests. The government needs MEGABARE's results to be taken seriously in the international diplomatic arena so that its representatives have some credibility with which to enlist support for its stand. Given that MEGABARE has already been part of this Forum, it could have been a opportunity for this.

A question regarding MEGABARE's credibility was put to Clive Hamilton.

He responded as follows:

MEGABARE has no international credibility at all, despite huge diplomatic effort by Australia. At a satellite hookup today, US Undersecretary for Global

⁷⁰ ABARE media release 26 February 1997 'MEGABARE a best practice climate change model'.

⁷¹ *ibid.* ABARE give no further details except that the model was included in the Forum. A question was put to Vivek Tulpule in an interview on 23.10.97 about the outcome of the evaluation but the answer was not clear.

⁷² Warwick McKibbin <wmckibbin@economics.anu.edu.au>. 'Just two more'. Private e-mail message to Ronlyn Duncan. 14 October 1997 advised the evaluation would be undertaken and that ABARE's model was not included. A question was put to Vivek Tulpule about why a submission was not made by ABARE and he replied that they missed the deadline due to a heavy workload (interview with Vivek Tulpule on 23.10.97).

Affairs Tim Wirth said that the modellers who came up with these huge numbers must of [*sic*] been smoking something!! True. MEGABARE has been funded principally by the fossil fuel industries⁷³.

On ABC News⁷⁴, Wirth stated: "I think you take claims made by industry groups with 10 grains of salt ... [and] take models overall with 2 grains of salt ...". This was Wirth's response to advice that Australia's high cost forecasts for cutting emissions were partly funded by the fossil fuel industry⁷⁵. Wirth also stated that the United States did not understand the Australian government's 'differentiation' proposal. The sustainable energy supporters take this as evidence of the lack of credibility of ABARE and MEGABARE. However, it is curious because the results of ABARE's research and Australia's position were presented at Geneva in 1996 and since that time, at other international climate change forums. Furthermore, the two countries have very close diplomatic links. It more likely indicates a breakdown in communication resulting from the close association of the government and ABARE together at these conferences. As discussed in Chapter 1, the government opposes legally binding targets but this is necessary for a global 'differentiated' tradable quotas scheme which ABARE has been promoting.

Hamilton commented that at a conference in Bonn, Germany, Brian Fisher got upset when giving his presentation in response to comments relating to ABARE's findings and MEGABARE being made by Hamilton in Bonn, and that Fisher's behaviour presented a negative image of Australia. It was Hamilton's impression that the criticism of MEGABARE and its interpretations by ABARE had moved from "scepticism" to "derision" amongst the diplomats⁷⁶. Hamilton referred to a discussion with the Japanese Finance Minister in particular who indicated that Japan had made its own assessment of the economic costs of reducing emissions. Given that Japan

⁷³ Clive Hamilton<austinst@ozemail.com.au>. 'Climate Change/ABARE/Honours Thesis'. Private e-mail message to Ronlyn Duncan. 22 August 1997 in response to questions to the effect: Does MEGABARE have international credibility and is it being used overseas?

⁷⁴ ABC 7.00 pm television news on 22.7.97.

⁷⁵ *The SMH* (24.7.94 p. 10), 'US can't understand our greenhouse view'.

⁷⁶ Interview with Clive Hamilton on 11.8.97.

has proposed a 5% reduction in emissions⁷⁷, their own assessment would appear to have been more optimistic than that simulated for Japan by ABARE (1997e) and set out in its *Current Issues 3*.

During April this year President Hashimoto of Japan, visited Australia for discussions with the Australian Prime Minister, John Howard. Australia's position in relation to greenhouse targets was a topic of these discussions. At that time ABARE (1997e) produced its *Current Issues Volume 3* entitled 'International Climate Change Policy: Economic Implications for Japan'. It is almost identical to *Current Issues Volume 2* (ABARE 1997b) also issued in April entitled 'International Climate Change Policy: Economic Implications for Australia'. Tulpule had indicated a month prior to this that *Current Issues 2* would be available some time in May. Its publication appears to have been brought forward for the Japanese Prime Minister's visit. Whilst the text is virtually identical, the figures differ. For example: the welfare loss to a Japanese person is predicted to be 18 times greater than that of a European person and for Australia it is 22 times more. Hamilton indicated that ABARE was not commissioned by Japan to do this analysis and that "ABARE is scaremongering"⁷⁸.

There seems to have been a change in the political rhetoric since the issue of ABARE's *Current Issues 2*. From about the end of April to the end of July this year the adoption of targets was being equated with the cost to every Australian of \$9,000 or a reduction in wages of 20% or each Australian citizen paying 22 times more than each European citizen. These claims were specifically made in ABARE's *Current Issues 2*. However, they have since been challenged by various members of the public who worked out that the \$9,000 was an amount aggregated over a 30 year period. On a per annum basis, these people concluded that this was a small price to

⁷⁷ ABC television 7.00 pm News, 6.10.97.

⁷⁸ Clive Hamilton<austinst@ozemail.com.au>. 'Climate Change/ABARE/Honours Thesis'. Private e-mail message to Ronlyn Duncan. 22 August 1997 in response to questions to the effect: Do you know if Japan asked ABARE to carry out this work [analysis in *Current Issues 3*] on their behalf?

pay for a stable environment⁷⁹. More recently, the rhetoric has been firmly fixed on jobs. However, job losses are not a prediction derived from MEGABARE nor a conclusion made by ABARE in its publications. Indeed, according to Hamilton (1997b p 30), a loss of \$9,000 or a reduction in wages of 20% is arrived at because the model assumes that there are no job losses. This is why there is a reduction in welfare and wages⁸⁰. Hamilton states that in general equilibrium models an assumption has to be made about the labour market - either the employment level is fixed (and wages vary) or employment varies (and the wage rate is fixed). The assumption in MEGABARE is that wages vary and the employment level is fixed. Hence, it seems that the government has been able to 'transform' the findings of MEGABARE into a topic it considers is politically valuable - jobs - whilst retaining the notion of credibility that is generated by quantified rhetorical claims.

ABARE representatives have been presenting papers on climate change and promoting the conclusions and interpretations of MEGABARE at various conferences over several years. It is notable that the audiences are generally commodity or energy industry representatives⁸¹. These conference presentations have been an opportunity for ABARE to reinforce the ideas set out in Chapter 1⁸². Based on the audiences to which the presentations have been made, they have not been conducted for the

⁷⁹ These claims are stated in *The SMH* 30.4.97, 'Threat to Quit UN Greenhouse Pact' and *The SMH* 23.6.97. Editorial, 'Fairness on Greenhouse'. For public responses see: Letters to the Editor in *The SMH* on 3.5.97 and 12.5.97. On 23.6.97 the Herald's Editorial indicated \$9000 would be payable "per year by 2020". This is incorrect. At the National Academies Forum on 29 April 1997 McKibbin pointed out that over the time period simulation, an average person's income could be millions of dollars.

⁸⁰ ABARE (1997b p 6) discusses how a loss in wages is required to sustain employment levels. In contrast, the IC (1991 p 70), in its preliminary analysis, predicted that an emissions reduction of 40% and 60% below 1988 levels by 2005 (the Toronto target) would result in a reduction in real disposable income of 1.2% and 6.5% respectively. The Commission noted, however, that these values were sensitive to assumptions about fuel switching. In contrast, ABARE's loss of 20% in wages is based on a 15% reduction target below 1990 levels by 2010 which is to be held until 2020.

⁸¹ See Appendix 5 for details of various conferences attended by representatives of ABARE on climate change between 1994 and 1997.

⁸² This was witnessed at the National Academies Forum in Canberra, 29-30 April 1997 in the presentation given by Brian Fisher.

purpose of discussing the assumptions or parameters of MEGABARE or for promoting peer review.

A lack of peer review is a particular criticism directed at ABARE and MEGABARE by McKibbin. He claims that such review has not been possible because the model equations have not been made available. ABARE's *The MEGABARE Model: Interim Documentation* (1996) does set out various model equations and this publication (less appendices) is reproduced on ABARE's web site. However, McKibbin stated that he had inspected this documentation and that the information was insufficient for a thorough review of the model. McKibbin claims that all of the conferences ABARE representatives have attended regarding climate change are the result of government invitations - the criticism being that they are not presentations for the purpose of scrutinising the assumptions, the methodology and equations of the model. McKibbin further claims that there has been no academic peer review because no papers by ABARE regarding MEGABARE have been published in academic journals.

As far as it can be ascertained, with the exception of a paper published by the CSIRO⁸³, the only published papers which discuss MEGABARE or refer to its findings are papers in the publication *Australian Commodities* which is ABARE's own journal in which its commodity projections, articles and conference papers are published. An inspection of the reference lists of various articles displays a substantial number of ABARE's own articles, research reports and conference papers

⁸³ The paper of Stuart *et al.* (1997) lists the "MEGABARE based publications on climate change policy". Of 14 papers, the following paper is the only one that is not an ABARE conference presentation paper or an ABARE publication. Hanslow, K., Hinchy, M. and Fisher, B., 'International greenhouse economic modelling' in *Greenhouse: Coping with Climate Change*, Bouma, S.J., Pearman, G.I. & Manning, M.R. (eds), CSIRO Publishing, Melbourne, 1996, pp 641-649. A CD-Rom search was carried out on the following databases: Australian Business Index (ABIX) on Silverplatter; ECONLIT on Webspirs, ABI/INFORM on Ovid and Business Periodicals Index (BPI) on Wilson. One reference was found for MEGABARE which was an *Australian Commodities* article: Kennedy, D., 'Carbon Dioxide Emissions: 'Business as Usual' Projections for Australia from MEGABARE', 1(4), 1996, pp 537-543.

cited in support of ABARE's own statements, claims and findings⁸⁴. When reading the articles this is not obvious because the personal names of the authors are used in the text of the article. One gets the impression that the authors are using a cross section of references and information to substantiate claims when in fact the claims are supported by previous ABARE claims. There appears to have been a change in procedure in the past year or so which could be an attempt to generate credibility for the claims made by ABARE and its researchers. For instance, the 1995 report *Global Climate Change: Economic Dimensions of a Cooperative International Policy Response Beyond 2000* is cited as ABARE & DFAT (1995) yet the 1997 report *The Economic Impact of International Climate Change Policy* would be cited by the names of the authors (e.g. Brown *et al.*) not ABARE (1997). On this basis, not only do McKibbin's claims that there is a lack of peer review of ABARE's work seem valid but there are also signs that their work occupies an increasingly closed intellectual universe.

Despite this, ABARE asserts that its views and findings have been subjected to "critical expert review" and that its involvement in various conferences, meetings, forums and workshops has ensured "transparency and objectivity" (Stuart *et al.* 1997 p 6). Tulpule was asked who he considered would be ABARE's peers for peer review purposes and he responded as follows:

⁸⁴ For example: Stuart, R. 'Climate change: International policy institutions and directions' in *Australian Commodities*, 1(2), 1994, pp 209-215. Of the 9 references, five are directly from ABARE, one is co-written with Roger Stuart (the author of this paper) and two have authors in common with the authors of the ABARE papers. It appears that the only independent reference is the United Nations *United Nations Framework Convention on Climate Change* 1992. See also Melanie, J., Phillips, B. and Tormey, J., 'Greenhouse: An international comparison of factors affecting carbon dioxide emissions' in *Australian Commodities*, 1(4), 1994 pp 468-483.

Once our work is released it is fair game for any researcher in any field (and I use the term researcher in its broadest possible context) to pass judgement on it. The only pre-requisite for being a 'peer' is that you read the work and base your judgements not on newspaper reports and Australia Institute media releases but on a first hand account⁸⁵.

This idea of peer review is not the same as that of McKibbin. The concept of peer review has been interpreted differently in accordance with the difference in their audiences. For instance, as an academic, McKibbin's audience is primarily made up of fellow economists who are involved, as a discipline, in generating and validating economic theory. ABARE's audiences are primarily industry organisations and government agencies for which there is no institutionalised peer review protocol. Despite this, the vocabulary of peer review is used. A question regarding ABARE's lack of credibility generated by claims of vested interests was put to Roger Stuart, who responded as follows⁸⁶:

Yes, we have come in for a bit of comment on the funding question of late. Most of this has constituted a partisan attempt to discredit our results indirectly rather than critiquing the results themselves. We retain full control over our results and make objectivity our highest priority and our results are all put into the public arena, subject to peer critique, etc.

Based on the comments of Tulpule and McKibbin and the fact that ABARE publishes and uses its own results and findings in its own journal, claims of the existence of peer critique would appear to be rhetorical - a utilisation of the many possibilities for interpreting the 'rules' in accordance with different circumstances (Mulkay & Gilbert 1981 pp 389-407). Claiming that findings have been subjected to peer critique invokes the authority of science and hence, notions of 'objectivity'.

⁸⁵ Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997.

⁸⁶ Roger Stuart<rstuart@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 31 July 1997. Stuart was asked for his view on media reports regarding MEGABARE that were usually accompanied by references to ABARE's support by the coal industry which insinuated a lack of credibility for ABARE and MEGABARE..

In terms of funding, Stuart is correct that many critics have focused on this issue to discredit ABARE and MEGABARE. Given that MEGABARE contains several hundred thousand equations, its complexity would prohibit scrutiny by even experienced economists. The result of this is that the credibility of ABARE and the findings that MEGABARE generates is a matter of trust. According to Porter (1995), quantification is a means to generate this trust. The monetary contributions by the stakeholders represent bias which erodes trust. The government (by forcing a 40% funding requirement on ABARE) and ABARE itself have given their critics the ammunition they need to discredit ABARE, MEGABARE and the government's position without looking at the model itself or the results in detail.

The Australian Democrats have been particularly critical of the government's position on climate change, ABARE and MEGABARE. For instance, the then Leader of the Democrats, Senator Cheryl Kernot stated in the Senate:

Let us not forget who ABARE is. It is the ideological cousin of the Industry Commission and it never misses an opportunity to slip the boot into environmental or social causes, churning out statistics from its largely discredited macro-economic modelling, showing how much better off we would all be if only we mined more coal, produced more electricity and puffed more carbon dioxide every day. I am willing to bet that if ABARE existed 150 years ago, it would have produced a whopping great spreadsheet proving that the economy could not afford to ban child labour in the coal mines (*Senate Hansard* 26.11.96 p 6014).

In response to a question put to Senator Hill by Senator Kernot (which asked why Australia could not adopt legally binding targets when it was possible for countries such as the United States, Britain and Germany to do so), Senator Hill replied that Australia's economy is different to the economies of these countries and stated:

[the government will not] sacrifice Australian jobs in order to contribute to the greenhouse outcome. We do not apologise for that. We think it is what the Australian people expect from us, and it is what they will get (*Senate Hansard* 25.11.96 p 5883).

These assertions, like many of the government's arguments, sound sensible. Of course it would be irresponsible for the government to deliberately "sacrifice Australian jobs". However, various groups contend that the adoption of a legally binding reduction target which was accompanied by energy efficient use and a transition to renewable energy generation would create many more jobs than are likely to exist in coal based power generation⁸⁷. For instance, the coal industry has already lost 40% of its jobs in the last 12 years (Senator Kernot *Senate Hansard* 28.11.96 p 6273). Senator Kernot also pointed out that Peter Dixon of Monash University, the person ABARE claims has domestically refereed MEGABARE, has stated that "he wishes ABARE would stop quoting him as a referee for this interpretation because he is not, that the government's interpretation of the data is 'crazy' and that the misuse of the model is 'extraordinary' " (Senator Kernot *Senate Hansard* 5.12.96 p 6800). Dixon is the Director of Policy Studies at Monash University and a member of the ORANI-F economic model team. This model was used, with ABARE's MENSA model, in the economic modelling undertaken for the ESD Working Groups (1991). Dixon, when interviewed by *4 Corners*⁸⁸, stated that he only edited a paper for ABARE regarding MEGABARE and that he did not referee the model. Dixon claims that ABARE does not have the intellectual expertise needed to develop a model of the global economy to adequately test the changes in policy it purports to be able to do. Hence, Dixon is directing his criticism at ABARE, not the model.

An interpretation of ABARE's conclusions by Dixon is that Australia could reduce its emissions by 10% with a reduction in its GDP of 0.5%. Dixon further indicated that for an economy growing at 3% per annum, this reduction in GDP would

⁸⁷ For instance, this was claimed by Mark Diesendorf of the Institute for Sustainable Futures in an interview on 17.9.97. Also, Senator Kernot referred to a 1994 House of Representatives committee which concluded that 20,000 jobs could be created by the year 2000 in the domestic pollution control industry and that capturing 2% of the world market could generate \$8 billion and create 150,000 Australian jobs (*Senate Hansard* 26.11.96 p 6014).

⁸⁸ ABC television 18.8.97.

delay growth for two months⁸⁹. This interpretation of MEGABARE's results as involving little pain for the Australian economy illustrates how effective quantification can be in mobilising rhetorical claims. In the political arena, quantification obscures important details such as, instead of a cost of \$50 billion, a reduction in GDP of 0.5% actually means a delay in growth for two months. For a layperson this is inconsequential, but a cost of \$50 billion is obviously a cause for concern.

In August this year, the Australian Conservation Foundation lodged a complaint with the Commonwealth Ombudsman in relation to MEGABARE and ABARE's funding. Subsequently, the Ombudsman determined that an investigation into the matter was warranted to determine the validity and independence of MEGABARE and GIGABARE. On 5 August 1997 Senator Kernot called for the Federal Government to "suspend use of the dubious ABARE greenhouse models until the completion of a full Ombudsman's investigation"⁹⁰. The use of the model has not been suspended and the investigation by the Ombudsman has not yet been completed.

Despite the extensive criticism, ABARE's insularity and the circumstances surrounding the funding, MEGABARE has provided politicians with many rhetorical statements for mobilisation in the political arena to draw attention to the economic implications they consider will eventuate if strong abatement action is taken sooner rather than later (or not all). In this way, the 'environmental reality' of climate change

⁸⁹ *The SMH* (25.6.97) p 4, 'Our greenhouse stand may lead to trade sanctions'. Peter Dixon addressed the Bridge to the Future Forum on 23.10.97 and highlighted the ways in which quantitative results can be manipulated for political purposes. He referred to a claim made by Alexander Downer, the Foreign Minister, that a 15% reduction in emissions would cost \$50 billion. Dixon gave his opinion on how this amount was arrived at. It began with a loss in GDP of 0.5%. This percentage was converted to a GDP value which was then aggregated over 30 years. This amount was divided by the population and then multiplied to represent an average family welfare loss. Dixon indicated this was a complete misrepresentation of the model results. Dixon stated he was not as sure about how the 90,000 jobs figure was arrived at but he illustrated a similar process as that for the \$50 billion. See also Hamilton (1997a p 10).

⁹⁰ Senator Cheryl Kernot media release for the Australian Democrats dated 5.8.97, 'Government must put dubious greenhouse models on hold'.

has been overshadowed by an 'economic reality'. The problem is that the results of MEGABARE have been distorted and manipulated by the government for political purposes. Moreover, claims now being made by the government are no longer empirical findings of MEGABARE. It seems that the numbers the government is using are getting bigger as Kyoto draws closer.

CHAPTER 7

Climate change might be happening elsewhere in the world, but it is not happening in Australia

In this chapter the nexus between the domains of science, politics and economics of the climate change debate in Australia will be explored within the context of 'regulatory science'. The concept of 'regulatory science' will be extended from that documented by Jasanoff (1990) and the dynamics of the debate will be interpreted in light of the theoretical claims made by Shackley & Wynne (1995a) and Wynne (1996). It will be argued that given the policy-relevant nature of the IPCC science, the imperatives and limitations of the domains of politics and economics in Australia have acted to contextualise the scientific consensus in such a way that it concurrently serves to legitimise the government's policy direction and its economic rhetoric.

In the arena of international environmental politics, which has been analysed and documented by Sprinz & Vaahoranta (1994 pp 77-105)⁹¹, a country would be characterised as a "dragger" if its abatement costs are considered to be high and its ecological vulnerability is considered to be low. Given the discussion so far, the comments and behaviour of the Australian government and ABARE could certainly justify Australia being characterised as a 'dragger' on both these criteria. However, high abatement costs and low ecological vulnerability are contentious issues domestically. The sustainable energy supporters would argue that Australia should be a "pusher" due to low abatement costs and high ecological vulnerability. They

⁹¹ Sprinz & Vaahoranta (1994) use an international perspective to make their assessments in relation to past international protocols and agreements on the regulation of ozone depleting substances and sulphate aerosols.

disagree that the costs of abatement will be as high as the government claims⁹². Nor would they agree that Australia's ecological vulnerability is low.

In the public arena, views on both abatement costs and ecological vulnerability appear to depend, to a large extent, upon a philosophical commitment to either neo-classical economics or ecological economics⁹³. The arguments of each group are underpinned by different judgement networks (Barnes 1981). The government understands climate change foremost as an economic issue. The sustainable energy supporters understand it foremost as an environmental issue. Therefore, it appears that high abatement costs, as evidenced by ABARE's economic modelling, elicit the judgement of low ecological vulnerability and perhaps environmental benefits from climate change⁹⁴, and high ecological vulnerability, as evidenced by the IPCC SAR, elicits the judgement of low abatement costs because Australia has considerable scope to reduce its emissions. Consequently, the sustainable energy supporters contest the economic claims whilst stating that the IPCC science is conclusive⁹⁵. Conversely, the government (as well as industry and

⁹² Hamilton (1997b p 4) asserts that various studies indicate "that energy-related emissions in Australia could be cut by 20-48% at no net cost." The Australia Institute arranged for 131 professional economists to sign a statement that stated, *inter alia*, that policy options are available that could be adopted to reduce emissions substantially without detrimentally affecting employment and living standards, and that the government's economic modelling overestimate the costs (Hamilton 1997b p 6 p 28).

⁹³ Of course, there is a spectrum of differing views and to describe the domestic debate in terms of two extremes is oversimplified. However, in the public domain, many commentators in support of Australia adopting legally binding targets also advocate the principles of ecological economics (e.g. Clive Hamilton and Mark Diesendorf) and those not in favour of the adoption of such a target advocate the principles of neo-classical economics by promoting least-cost economic mechanisms (e.g. the government, ABARE, industry). These paradigms also separate 'demand side' and 'supply side' economic practices (Diesendorf & Hamilton 1997).

⁹⁴ For instance, the Parliament witnessed Senator Parer lamenting the benefit climate change might have on another Senator's marginal farm (*Senate Hansard* 4.12.96 p 6655). Also, see Chisholm (1997 p 27) which states in the conclusions of the paper which was presented at the National Academies Forum on 29 April 1997: "... the export-orientated Australian rural sector would benefit from higher world commodity prices resulting from a negative impact of climate change on global agricultural production potential ... global agricultural damages are likely to be smaller than previously estimated or there may be overall global benefits. However, a number of unresolved issues, such as change in occurrence of extreme climatic events, could lead to large damage estimates." It should be noted that it is the extremes of temperature that ultimately determine the ecological range of organisms, not mean temperatures.

⁹⁵ For instance, such comments were made by Peter Kinrade of the Australian Conservation Foundation (Letters of Editor, *The SMH* 25.9.97). The IPCC science supports the prospect of

ABARE) contest the scientific claims by focusing attention on the uncertainties in the IPCC science and claim that the economic conclusions are objective, authoritative and have to be taken into account in any decision. It can be seen that for both sides of the controversy, it is not only a matter of changing judgements, it is also a matter of reinforcing them. In abstract terms, the purpose of the government's rhetoric is to ensure that the network of judgements connected to neo-classical economics and the coal industry remain in place but at the same time it is attempting to loosen the judgements connected to concepts of the severity of climate change to replace them with judgements of moderate and adaptable climate change impacts. The sustainable energy supporters are attempting to reinforce the judgements of the severity of climate change whilst loosening judgements on the *status quo*, neo-classical economics and the coal industry to replace these with judgements about sustainability and the need for a new economic regime, ecological economics.

To put the debate into context, climate change should be recognised as a 'regulatory science' issue. It has been proposed by the FCCC that the greenhouse gas emissions of Annex 1 countries are to be regulated by international agreement and reduced by a uniform amount within specified time limits. The need for a regulatory decision has been recognised by the United Nations as a result of scientific investigations carried out by the IPCC. However, the scientists cannot determine the level to which emissions should be reduced. Any proposed reduction level, therefore, is a matter of judgement to be made by policy-makers. This is the domain of 'regulatory science'.

The Australian position on reduction targets is similar to that taken by industry in many 'regulatory science' debates - plans for regulation are challenged with arguments that it will result in high and unnecessary costs. Industry and ABARE

detrimental environmental impacts which supports the rhetoric of sustainable energy supporters and environmentalists to force out the old paradigm.

would prefer a market-oriented 'least-cost' solution such as tradable quotas. It is no secret that the government is attempting to protect industries (e.g. coal and aluminium) from an increase in costs that would be imposed if a carbon tax had to be introduced to reach the legally binding reduction targets⁹⁶. It would be industry that the government would have the most difficulty in explaining itself to if it adopted the proposed targets because their processes are capital and energy intensive. Due to the very close links that the government has with industry, in the FCCC negotiations the government can be characterised as in the same position as 'industry' in 'regulatory science' debates.

Gilchrist (1996) reporting for *The Sydney Morning Herald* refers to the relationship between industry and the government as "Canberra's Revolving Door"⁹⁷. It is claimed that many government senior executives now involved in making a contribution to Australia's greenhouse policy have very strong links with industry organisations that are opposed to reducing emissions⁹⁸.

The Australian position has changed from being a very wide one that recognised the science, the need to be putting new technologies into developing countries and giving them financial assistance, and that recognised the need for adaptation strategies but also included trade concerns ... [n]ow, instead of the holistic approach, we've zoomed in on the bottom line and trade is the only driving consideration (Gilchrist quoting an anonymous official, 1996 p 6).

⁹⁶ A carbon tax is only one economic instrument that could be used to encourage the reduction of emissions. ABARE proposes an international differentiated tradable quotas as already discussed. McKibbin & Wilcoxon (1997) propose a national tradable permits scheme which would reduce the growth in emissions. Each government could distribute permits equal to 1990 emissions and then sell additional permits for a certain fee which would encourage firms to reduce emissions when the cost of doing so was less than the price of a permit. Warwick McKibbin <wmckibbin@economics.anu.edu.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 10 October 1997 indicated that it is possible that the United States will adopt this system.

⁹⁷ Gavin Gilchrist, a former journalist with *The SMH*, now works for the NSW State government's Sustainable Energy Development Authority (SEDA).

⁹⁸ For instance: Paul Barratt (appointed Head of DPIE in the Howard government) is a former Executive Director of the Business Council of Australia; Tony Beck, a former research economist of the DPIE now runs the Business Council greenhouse campaign; David Buckingham, a former senior official in the Environment Department, is now the Executive Director of the Minerals Council; David Whitrow, a former Executive Director of the Tasmanian Minerals Council is now a senior advisor to the Minister of the DPIE, Senator Parer; and David Coutts, a former senior official in the DPIE is now the Executive Director of the Aluminium Council.

Consequently, it is difficult to differentiate the rhetoric in support of Australia's position between representatives of government agencies, ABARE and industry. In many cases, the comments of one set of actors is representative of, or in support of, the position of the other actors. The involvement of these bureaucrats in determining the Australian government's policy direction should not be underestimated. Pusey (1990 pp 7-8) considers that the findings of Aberbach (1981) published in *Bureaucrats & Politicians in Western Democracies* well describe the bureaucratic state of affairs in Canberra and states:

It [*Bureaucrats & Politicians in Western Democracies*] ... demonstrated that top bureaucrats are centrally involved with ministers and elected politicians, not only in implementing policy, but also in its formulation and, equally, in the brokerage of interests and the articulation of national ideals and goals (Pusey 1991 pp 8).

In line with the behaviour of industrial actors in 'regulatory science' debates, the behaviour of the government can be seen as an attempt to avoid or delay regulation. In the 'regulatory science' debates discussed by Jasanoff (1988 & 1990), industry usually attempts to avoid having the decisions that affect it being made by an entity that it perceives will not act in its interests. Industry will advocate that any regulatory decision must be based on science⁹⁹. It will then draw attention to the uncertainties in the scientific findings which justifies its calls for more scientific certainty and which results in delaying the decision making process. It can also demand that the economic implications of regulatory decisions be taken into account. It appears that the government and industry have adopted both of these strategies in the debate over emission reduction targets. ABARE's solution (with conditional support from the government) for the FCCC is the adoption of a 'least-cost' economic mechanism of differentiated global tradable quotas. Gaining agreement to implement

⁹⁹ For instance the Business Council of Australia (1993 p 28) states: "... it is essential for policies and responses to this potential threat to be soundly based upon science." The Global Climate Coalition (1997 p 1) (an organisation that acts on behalf of United States business and trade interests) state: "... science must serve as the foundation for overall global climate policy decisions and enhanced scientific research must be the first priority ... even if all the uncertainties were resolved, sound policy decisions must consider the economic and social impacts of alternative policy choices."

global tradable quotas is a contentious issue in itself that would take a long time to resolve. In addition, agreement on how the initial differentiated quotas should be distributed would be even more contentious. Australia's formula was discussed in Chapter 1 and largely rests on per capita calculations. However, a per capita initial distribution would result in a vastly different distribution to a proportionate distribution of any parameter. Essentially, climate change negotiations come down to these issues but they are impossible to use because of the controversy they create, *inter alia*, between developed and developing countries (Ahuja 1992 pp 83-87; McCully 1991 pp 157-165). Therefore, if the government did get agreement on its 'differentiation' proposal, a final agreement on abatement action would be delayed for a considerable time. Obviously, any delay will be favourable to Australia.

Despite the difference between the 1990 and 1995 IPCC assessment reports, the scientific consensus of the 1995 IPCC SAR has made the public expression of doubt about the existence of climate change unacceptable for political leaders. To publicly discredit the science (which was commissioned by the United Nations) would be a diplomatic error in both the scientific and political domains, internationally and domestically. In any case, the authority of science needs to be upheld because it is a rhetorical resource which can be used by all parties in such debates. Science is attributed authority based on the notions of objectivity and rules it embodies. These concepts are crucial to the legitimacy of political rhetoric. The government could not introduce its own local, objective and rule-bound (economic) findings if it discredited those of the climate change scientists. Hence, the government and some industry representatives are careful to draw the appropriate boundaries when discussing the IPCC science. It is important for the credibility of the government's position that its representatives publicly agree with the findings of the IPCC and that its actions are characterised as participating in the process¹⁰⁰. This

¹⁰⁰ ABARE's publications are introduced by comments such as "The purpose of this report is to contribute analytical input to the international climate change policy development process by providing

does not mean, however, that the uncertainties in the IPCC science cannot be highlighted. In fact, Senator Hill states that despite the uncertainties, Australia is moving ahead in taking action on climate change, such as establishing co-operative agreements with industry to undertake 'no-regrets' measures¹⁰¹. In an address to the "Countdown to Kyoto" conference on 21 August 1997 Senator Hill stated:

I have stated many times and I will do so again, that Australia accepts the balance of scientific evidence which suggests that human activity is accelerating the increase in the earth's average temperature ... it would be counterproductive ... to revisit the science underpinning the SAR of the IPCC. It would also be foolish to act other than in a cautionary way.

Comments such as these lend credibility to the government because they uphold the authority of science. Having made it clear that the government accepts the IPCC science, it can then draw attention to the uncertainties in the science to justify its actions and policy stand which are at odds with the FCCC. This boundary-work allows the government to state its case domestically and internationally without it actually saying that it considers action on climate change should be limited and that it considers (or hopes) Australia will actually benefit from climate change¹⁰².

The changes in the IPCC reports have been characterised as "increasing realism" and said to "increase our confidence in their use for projection of future climate change" (DPIE 1996a p3)¹⁰³. These comments give an impression of a decrease in scientific uncertainty. However, the differences have actually created a larger resource of uncertainty for utilisation in the debate. The differences have provided opportunities for a range of arguments to be expressed by government and

an assessment of the economic impacts of policies to reduce carbon dioxide emissions ..." (ABARE 1997 p 1).

¹⁰¹ Address to the National Academies Forum on 29 April 1997.

¹⁰² Senator Parer seems to be an exception. For instance, at the Australasian Institute of Minerals and Metallurgy Annual Conference at Ballarat Senator Warwick Parer said: "I don't have any figures to back this up, but I think people will say in 10 years that it [greenhouse] was the Club of Rome" and "The attitude of this government is to look for ways to allow projects to go ahead." *The SMH* (14.3.97 'Greenhouse effect? No worries says Parer').

¹⁰³ A sceptic predicts that the problem of climate change might disappear, i.e. with the differences in the IPCC reports, taking account of error and reports that half the warming is due to the sun's variability, there is 0.25C left which is attributable to the greenhouse effect. It is concluded: "How small does this figure have to be to become a non-problem?" (Michaels, 1996 p 19).

industry actors which can be juxtaposed with the interpretations of ABARE's economic modelling to justify limiting abatement action. This view was expressed by Dick Wells, the Director of the Minerals Council and Chairman of Industry's Greenhouse Network¹⁰⁴. Wells emphasises the uncertainty in the science and this meshes well with the economic arguments. Therefore, limiting action until more is known about the impacts of climate change appears justified. Wells did, however, criticise the government for abolishing the Energy Research & Development Council and some energy programs and states that his organisation has proposed that the government establish a Sustainable Energy Department. The Chairman of the Aluminium Council was also critical of the government in this regard¹⁰⁵. This rhetoric distances industry from the government. It gives a public impression that industry is acting responsibly which generates credibility for its comments regarding scientific uncertainty and the need to limit action on the basis of economics until more scientific and economic certainty is available. The common position of both the government and industry gains plausibility and credibility from their different but mutually enhancing rhetoric.

¹⁰⁴ In an interview on ABC television, *7.30 Report* on 20.8.97, Dick Wells stated that industry did not support the assertion that most scientists believe a build up of gases will cause climate change. Instead, industry supports the IPCC results which, he asserts, conclude that there is doubt about the science. Mr Wells goes on to say industry takes the issue seriously, that there is a "need for caution and we like good science ... we're a science based industry ..." and concludes "there are a wide range of scientific opinions about what the impacts are going to be of any global warming and what we're saying is it's still prudent to do cost effective measures now and that's what we're embarking on with government but to go beyond those measures which deliver economic benefits, we think it would not be prudent to do so at this stage." Reference to these uncertainties is a matter of emphasis of the IPCC (1995) conclusions. The IPCC (1995) is divided into five sections. Sections 1-3 set out how the finding of anthropogenic warming (discussed in Section 4) was arrived at. Section 5 discusses uncertainties but it is a disclaimer on the previous sections which is to be expected. It is not a consensus of uncertainty.

¹⁰⁵ Interview on ABC television, *4 Corners* on 18.8.97. Also, in responding to Senator Parer's comments regarding the "Club of Rome" reported in *The SMH* on 14.3.97, both BHP Limited and CRA Limited executives were reported to confirm their commitment to environmental performance. The CRA Limited executive made it clear that his company considered climate change a serious issue. In contrast to this, on 16.10.97 Hugh Morgan, the Executive Director of Western Mining Company Ltd. stated the change in the science indicated that the experiment test of climate change had not been met which implied that climate change was no longer an issue (ABC radio news, *AM* program).

Using the concept of 'regulatory science'¹⁰⁶, the change in Australia's position on emission reductions since the endorsement of the Toronto target in 1990 can be seen as moving through three phases from "applied science" (the subject of the 1988 Toronto meeting), through "regulatory science" (agreeing to reduce emissions) and into "applied policy" (testing abatement action proposals). It appears that in Australia the issue had moved only very slightly into the "applied policy" phase before it was quickly ejected. The quantification and modelling of the economic consequences of the Toronto target conducted by the IC (1991), the ESD Working Groups (1991) and with MENSA have prompted the government to reassess its initial judgements about the impact of climate change and consequently its commitment to reducing emissions. The government now assumes that the movement of the issue into the policy domain by international agreement would mean a considerable change from the *status quo* which is perceived as a threat to industry, the economy and jobs. In response to these circumstances, ABARE's quantification of the economic costs of abatement action (for Australia and other countries) has been an attempt to pull back the progress of the debate both domestically and internationally. The rhetoric and actions of the government are consistent with the depiction of analogous cases by Jasanoff (1990) - the government is trying to prevent the climate change issue from moving into the policy domain. As long as the issue remains in the domain of 'regulatory science', there is scope for the utilisation of scientific uncertainty, negotiation and political rhetoric - judgements can still be changed. However, unlike normal 'regulatory

¹⁰⁶ This concept of regulatory science, in abstract terms, can be thought of as three discrete domains: "applied science", "regulatory science" and "applied policy" with regulatory science impinging slightly into the other domains. In this case, existing knowledge is drawn from "applied science" into the regulatory science domain and policy decisions are based on a synthesis of this existing knowledge. This is the regulatory science documented by Jasanoff (1988 & 1990) but illustrated by Shackley & Wynne (1995a p 220). This is different to the "fiducial" (mutual construction) regulatory science discussed by Shackley & Wynne (1995a) whereby the three domains are intermingled so that regulatory science impinges substantially into the other domains and therefore has much more influence on them. The knowledge in this case is in the process of being constructed at the same time as regulatory decisions are being made (and such a relationship is expected to continue into the future as policy decisions evolve with the science and *vice versa*). Consequently, the direction that the construction of knowledge takes is determined by an interaction between both the science and policy domains and it is guided by the institutional constraints and imperatives of regulatory science. In general terms, policy legitimises a certain direction in science which in turn constrains and legitimises a certain policy direction. Knowledge is constructed by this process.

science' debates, in the international arena the government cannot demand a judicial review of the decision to delay it or have it overturned. And despite its arguments for waiting until there is greater scientific certainty, internationally the issue has moved past the science. The IPCC SAR moved the issue out of the domain of science and into that of 'regulatory science' when it was agreed in Geneva in 1996 that Annex 1 countries would adopt legally binding reduction targets. Consequently, internationally, the issue will be well into the policy domain if there is an agreement on these targets at Kyoto¹⁰⁷. Therefore, the differences in the IPCC reports and the inherent scientific uncertainty alone cannot pull back the progress of the debate. It is suggested, however, that by juxtaposing the scientific uncertainty with the purported high cost of abatement, which is demonstrated by the comments of Wells of the Minerals Council, the economic arguments have become intertwined with the scientific uncertainty so that they mutually enhance each other. As a result, in abstract terms, judgements in relation to the severity of climate change have been 'loosened' and made contingent upon economic judgements. Hence, the limitations of the IPCC science have been utilised to legitimise the findings of MEGABARE and the government's position. The anticipated capacity of GIGABARE to resolve future regional economic impacts further legitimises the government's current stand because information is expected to be available some time in the future in the midst of continued uncertainty. The development of GIGABARE justifies waiting until more information is available. Moreover, GIGABARE will perpetuate the policy response of making abatement action contingent upon economic judgements. The knowledge constructed under these circumstances is about the very existence of climate change - whether or not it is a severe threat. A major concern is, however, that the institutional imperatives and constraints from the economic and political domains in Australia which will contribute to this knowledge direction are the product of an economic model which incorporates assumptions and commitments that are incapable of

¹⁰⁷ Of course, scientific investigations are continuing concurrently with a policy agenda on the basis that we cannot take the risk of waiting in accordance with the precautionary principle.

diverging from the *status quo* in terms of a reliance on coal and energy production and which embodies only one of several perspectives on how to deal with climate change. MEGABARE appears to be misrepresentation of 'reality' which could create a false sense of security about the impacts of climate change.

The idea of Australia's low ecological vulnerability to climate change seems to be gathering momentum. Indeed, there are indications of the belief that there could be benefits for Australia from climate change. This is the impression given from attending the National Academies Forum in Canberra in April this year. Of particular note are the comments made by Stuart Harris¹⁰⁸. Harris is confident that:

While we have a reasonable grasp of economic costs, we don't know the environmental cost ...[t]he arguments may run either way: we may have benefits that exceed costs, or we may have costs that exceed benefits and these differences may be quite large. The problem is that we simply don't know (Harris 1997 p 122).

Ian Noble from the Ecosystem Dynamics Research School of Biological Sciences, ANU challenged Harris's comments regarding a lack of information on environmental costs and impacts. Harris responded by indicating that he was referring specifically to the Australian context and states:

We have problems because it seems to be possible to argue as convincingly, or as falsely, in a sense, that Australia could benefit environmentally from global warming [*sic*] of the degree we've been talking about in the next hundred years, as we could argue that it will be negative. as we heard yesterday from Tony Chisholm¹⁰⁹, we would gain as much as we could lose. If you're to sell this to the community you face a reality some people can demonstrate quite clearly: it will cost, it will cost in employment in particular areas, it will cost in money terms and it may cost in revenue terms. If, then we say, well, lets do that because there are other benefits [of avoiding climate change] out there we can't cost in quantifiable terms, it seems to me we are

¹⁰⁸ Stuart Harris is a Professor with the Department of International Relations, Research School of Pacific and Asian Studies, Australian National University, Canberra. Also, Harris is a member of the Australian Academy of Social Sciences and the Chair of the organising committee of the National Academies' Forum on climate change. Of particular note, Harris is also the independent chair of ABARE's MEGABARE and GIGABARE steering committees Vivek Tulpule<vtulpule@abare.gov.au>. 'MEGABARE'. Private e-mail message to Ronlyn Duncan. 11 September 1997.

¹⁰⁹ Tony Chisholm is a Professor with the School of Business, Agricultural & Resource Economics, La Trobe University.

looking to the scientists to demonstrate to the community at large that there are benefits [in avoiding climate change] from doing something in the Australian context as well as in the international context (Harris 1997 p 126).

Curiously, the possibility of regional benefits seems to confirm their existence, even if they are not known at this stage. And they are taken to justify delaying serious abatement action. It seems that the severity of the costs predicted on an international scale - damage to agriculture, unpredictable weather patterns, rising sea levels - are being queried or dismissed at the local level on the basis that they are not region-specific yet the benefits - improvements for agriculture from carbon dioxide fertilisation, increased rainfall in arid areas - which are equally not region-specific and predicted on an international scale are being adopted and promoted at the local level (DFAT 1997 pp 47-54)¹¹⁰. However, it is incongruous that the possibility of unknown benefits can be used as a justification for limiting action to 'no regrets' measures¹¹¹ in the face such uncertainty and with the knowledge of the impact of *El*

¹¹⁰ The government's recent Issues Paper *Australia and Climate Change Negotiations* states: "It is clear that the possible effects of climate change ... could have substantial impacts on Australia, with all sections of the community affected. While many effects would be adverse, others would be favourable. Strategies to take advantage of, or 'adapt' to, climate change are being developed and more of these would need to be implemented to minimise the risk and take advantage of the opportunities of climate change. the need for adaptive responses to climate change is not yet widely accepted, and a range of poorly understood institutional and behavioural barriers to adaptation still exists [*sic*]. Nevertheless, recognition is growing of the importance of effective adaptation strategies (DFAT 1997 p 54). It is a concern, however, that adaptation actions will generate exactly the same problems that are being faced now which will in turn generate the same inertia. For instance, adaptation like abatement will require the spending of money and the time limits for action will be just as unpredictable. Therefore, the same question will be asked: do the costs outweigh the benefits which will elicit the same answer, "we simply don't know". It should be recognised that *El Nino* cycles are instances of climate change and they give a surrogate indication on a regional basis of what happens to the environment and the people dependent upon it when weather patterns change from what is expected, and remain that way for long periods of time. Graham Chittleborough (1992 p 156), a research scientist with the Australian Antarctic Division, the CSIRO and the W.A. Dept. for Conservation & Environment believes that *El Nino* could become permanent if the temperatures increase with global warming. On the basis that many parts of Eastern Australia have been in drought for over 10 years and the prediction that the current *El Nino* cycle could be severe (*Lateline*, ABC television, 2.10.97), this could be a valid concern. Concerns about the 'non-natural nature' of *El Nino* have been expressed by Kevin Trenberth, head of the Climate Analysis Section at the US National Centre for Atmospheric Research who considers the *El Nino* cycles since 1976 were "so unusual they were a 1-in-2,000 year event" (Gilchrist 1996 p 6). The current cycle has been disastrous for Papua New Guinea which is an example of a country that was not prepared for such dramatic and unpredictable changes in its weather patterns (ABC television 7.00 pm news on 2.10.97). An ABARE media release (17.6.97) states that *El Nino* is expected to reduce agricultural production in Australia by 5% during 1997-98.

¹¹¹ This is the government's idea of 'no regrets' measures which it considers are substantially limited due to assumptions about current energy use efficiency in many sectors. Also, the possibility of policy intervention to reduce emissions is not part of a 'no regrets' scenario.

Nino episodes. This is where the 'precautionary principle' is supposed to be invoked. The comments of Harris illustrate the effectiveness of quantification and its role in creating an 'economic reality' that is proving to be, at least in some political and bureaucratic circles in Australia, more convincing than the 'environmental reality' (Wynne 1996 pp 363-365). ABARE's economic costs are being attributed a notion of 'reality' greater than the environmental impacts of climate change.

Regional impacts research is being conducted by many countries but in most cases it is being done in conjunction with agreeing to commitments and taking actions to reduce emissions based on the assumption that the impact of climate change could be severe and too high a risk to avoid abatement action. In contrast, in Australia action seems to be guided by an 'economic reality' which begins with the assumption that there could be benefits for Australia from climate change or that it is likely that it will not be as severe as it was initially thought¹¹².

The implementation of actions to avert climate change will require new judgements to be accepted and various past judgements deemed wrong or in need of revision. New contingent judgements have to be located within the existing framework of instantiated knowledge and old judgements have to be realigned. To bring about change, therefore, can be very difficult. This is not only because it is difficult to motivate psychological readjustments but also because currently instantiated knowledge is embodied in culture, institutions and technology. Hence, even when cultural readjustments are made, technology and institutions serve to hold the *status quo* in place. In the climate change debate, there are many groups and institutions in their formative stages (e.g. The Australia Institute, the Sustainable Energy Development Authority and the Institute for Sustainable Futures) that are

¹¹² *The SMH* (11.10.97 p 1 'Climate Threat to World Markets') reported details of an analysis to be released at Kyoto describing the predicted environmental impacts of climate change (e.g. \$18 billion wiped off the Australia economy, Japan could lose 80% of its beaches). A spokesman for Senator Robert Hill stated: "there [is] still a great deal of variation in scientific opinion on the real consequences of global warming."

promoting the need for new judgements. On the other hand, billions of dollars have been invested in the coal industry (e.g. mining and transport infrastructure, ports and electricity generators) in Australia. Many regions are dependent upon the coal industry, and the country's coal resources are massive. Accordingly, claims by the proponents of both new and old knowledge will be strenuously contested.

Based on the size of Australia's coal reserves and the expanse of infrastructure and institutional support connected to the coal industry, the change in Australia's position on reduction targets which occurred after investigating the possible economic implications of the adoption of the Toronto target is understandable. This does not mean that Australia's position is 'right' or 'wrong'. The important point is that the cultural, technological and institutional practices, commitments and imperatives that are bound up and connected to the coal industry are acting as "closure mechanisms" on Australia's technological direction in energy production, which might not be in the country's best long term interests. The current mode of electricity generation can be justified on the basis that future efficiency and reduced (but non-binding and unspecified) emission levels (per unit of production) will be achieved by the adoption of co-generation systems and fuelling existing power stations by gas. The government's commitment to conventional forms of power generation and these future technological developments are documented in its *Sustainable Energy Policy for Australia Green Paper* (DPIE 1996b) which sets out directions for the government's energy policy for the next 25 years¹¹³. Despite the prospect of climate change and legally binding reduction targets, the government clearly intends to continue its commitment to the use of conventional energy generation methods which will be made 'sustainable' by co-generation and gas fired power stations.

¹¹³ The government's White Paper has not yet been released although the Green Paper states it will be finalised in 1997.

One can imagine the details of the conventional and future supplementary energy options being discussed by the members of the MEGABARE and GIGABARE steering committee meetings. It is important to recognise the shared commitments, understandings and judgements that would exist amongst these representatives and the array of institutional constraints and expectations within which they work - they share a culture (Shackley & Wynne 1995a) and it is connected by judgements and generalisations about coal and energy production (Barnes 1982 pp 16-40). Consequently, the development of a model which predicts that Australia will suffer substantial economic loss if restrictions are imposed on the use of coal is the product of a "material institutional and cultural enterprise" (Shackley & Wynne, 1995a p 221) rather than a conspiracy (Wynne 1996).

Within this enterprise, the prospects for energy services and the renewable energy industry are not promising. This is made patently clear by the comments of the Minister for Resources & Energy, Warwick Parer upon the release of a report on the renewable energy sector. The Minister promotes the industry as a "growth sector for employment" as it employed 6,370 people in 1995-96 and goes on to say that "4000 of these jobs were in *wood heater* [emphasis added] manufacturing, sales and services; 1000 in hydro-electricity generation; 570 in solar water heater manufacture and sales and 320 in photovoltaics manufacture and systems"¹¹⁴. To include wood heaters as part of the renewable energy sector is astounding (in terms of emissions), and many people would argue that hydro-electricity has no place in it either. Without them, the hapless state of Australia's renewable energy sector is obvious with 890 jobs. The virtual non-existence of this sector is demonstrated in the structure of MEGABARE and its future is depicted as equally bleak because of the limitations of economic modelling.

¹¹⁴ Media Release DPIE 97/175P 17 June 1997 'Renewable Energy A Growth Industry'.

The Australian federal government actors assert that the findings of MEGABARE demonstrate that a uniform regulatory reduction target does not result in uniform economic costs. A uniform reduction target is, however, workable bureaucratically, particularly at an international level. It is simple and it can be monitored by existing recording methods¹¹⁵. These are important issues from an international perspective. This can be clarified by returning to one of the examples used by Porter (1995) in his general analysis of processes of standardisation and quantification in modern societies - the standardisation that occurred with the centralisation of the Chicago Wheat Board. In the interests of the farmers as a collective and the Board, the bureaucracy had to impose arbitrary judgements on quality so that it was possible for it to collect the wheat by viable means, measure it to ensure each farmer was given a fair price and sell it in large enough quantities. In terms of carbon dioxide emissions, a uniform target below a base year makes monitoring relatively straightforward. For instance, inventories of emissions have been developed over several years and therefore, the means, in large part, already exist to measure a set reduction target. A major problem with an international tradable quotas system is its complexity, in both its establishment and operation. Also, major difficulties would arise in monitoring and enforcing it (McKibbin & Wilcoxon 1997 p 8), although the same argument can be made for any legally binding system. Consequently, the simplicity of a uniform reduction target and the means to monitor it are very important attributes for an international agreement. Having said this and returning again to Wynne (1988 p 156), however, the more circumstances or situations a rule has to apply to, the less specific that rule can be. Therefore, the global application of a rule (to Annex 1 countries at this stage) would require the minimum of specifications. This has the potential to result in the introduction of a large number of informal rules which would impose just those extensive complexities that the initial standardisation was designed to avoid. This could subvert the effectiveness of the overall regulatory system.

¹¹⁵ It also allows each country to choose the mechanism by which it reduces its own emissions.

The language of mathematics is the ultimate example of standardisation. It is the least specific or context-dependent a rule can be. As a result, quantified information or mathematical systems and the like are transformed into complex sets of informal rules. This can be done deliberately but it is also done by necessity. A quantified rule does not have any meaning unless it is made context-dependent. The problem is, if the informal rules which create the meaning are also in quantified form, it is impossible to sort out what they are, why they were adopted and their implications. For instance, ABARE has taken the GTAP general equilibrium model and modified it to create MEGABARE. Its modifications are informal rules, for instance, the 'technology bundle' and its endogenous population growth rate¹¹⁶. The informal rules have produced a model that contains *several hundred thousand* equations. MEGABARE is so complex it is impossible for it to be independently scrutinised - it is a black box by default. Hence, its authority rests on the notion of objectivity vested in the methods of quantification. Of course, it is also supported by considerable institutional authority and political power. In the end, this can make the difference because the success of knowledge-claims depends upon the mobilisation of the rhetoric which can be done more effectively when backed by political power¹¹⁷.

The products of black boxes are particularly appealing for use by politicians in their political rhetoric. For instance, the government has taken a quantified conclusion from ABARE of a loss of GNE equal to \$9,000 per person between the years 2000-2020 and over time transformed it into a loss of 90,000 jobs. This is not even a finding of ABARE. The rhetoric is: if you accept that climate change will be severe, the economic implications are large - thousands of job losses. What is hidden

¹¹⁶ The computer code which "implements the special features of MEGABARE is roughly double the volume of the original GTAP code. However, only a relatively small proportion of the original GTAP equations have been changed to introduce new hypotheses". (ABARE 1997c).

¹¹⁷ In a conversation with Mark Diesendorf, it was noted that it had been difficult to get papers published in journals and that there were very few journalists that would give ecological economists or environmentalists a fair go.

by this rhetoric (and the economic model) is that the model's calculations are based on a carbon tax (which is only one means of achieving a reduction target); that the cost of technology transfer is high (as determined by ABARE with its industry-based rationality); that energy use projections from which baseline emissions levels are calculated are based on surveys sent out to industry and major energy consumer organisations by ABARE (1997d p 1); and that it is assumed that energy markets are efficient (when there is evidence to the contrary). Furthermore, it hides assumptions about how the revenue raised from the carbon tax would be spent and how this can range from a loss to a gain in GNE depending on how it is recycled in the economy¹¹⁸. The point is not whether these assumptions are 'right' or 'wrong' but that they exist and that they can be mobilised out of view in quantified form.

The movement of quantified statements away from their source of production into the public arena has considerable political value because it makes them difficult to deconstruct. For instance, a 2% loss in GDP¹¹⁹ would be qualified by an economist (to express its standard error) but when it is stated publicly by a politician or an industry representative using arguments of uncertainty and economic rationalism, it becomes a 'reality'. In this case, the rhetoric serves to make existing judgements resistant to revision. Utilisation of ABARE's results in the political arena effectively disconnects the findings from their source of production, MEGABARE (Latour & Woolgar 1979 pp 176-183). The rhetoric of political actors can make this disconnection complete. However, sustainable energy supporters actors can discredit such claims by reconnecting them with ABARE and MEGABARE by stating that

¹¹⁸ Vivek Tulpule<vtulpule@abare.gov.au>. 'Just one more'. Private e-mail message to Ronlyn Duncan. 2 October 1997 indicated that ABARE has recycled this revenue back into the model "in a lump sum non-distortionary fashion". See also ABARE (1997b p 29). As discussed in Chapter 3, a loss or a gain in GDP can depend on the way in which tax revenue is recycled. Tulpule indicates that tax recycling theory is "extremely contentious" and states: "The literature on this issue indicates that under such assumptions [benefits from tax recycling], models will generally find benefits from carbon related tax reform associated with recycling carbon tax revenue to reduce payroll taxes. However, if you change the closure of the model to allow for greater flexibility in domestic labour markets and international capital markets (i.e. change the assumptions about structural adjustment) and you can easily get costs from such tax shifts."

¹¹⁹ Media Release of Senator Warwick Parer, DPIE 97/176P of 17 June 1997.

MEGABARE has been funded by fossil fuel vested interests¹²⁰. Drawing attention to ABARE's funding, the assumptions MEGABARE hides and the information it leaves out lowers the resistance of existing judgements and opens the way for the acceptance of new judgements. These are the dynamics of the construction of knowledge. The dimensions and magnitude of climate change (and to some extent its existence) are still in the process of being negotiated. The acceptance of the concept of ABARE's economic implications is associated with the rejection of the concept of the severity of the impacts of climate change.

ABARE's funding, its claims of objectivity and the many plausible criticisms of MEGABARE's findings are unfathomable. The government's mobilisation of ABARE's findings can be understood domestically as an attempt to muster public support for its international stand (and perhaps preparing ground for the acceptance of its withdrawal from negotiations). However, in the end, it needs international support. In the arena of international diplomacy ABARE has been characterised as incompetent and the findings of MEGABARE verging on an embarrassment. However, most of these claims have come from the sustainable energy supporters. In any case, international diplomats and economists are not the only audiences ABARE have. The list of conferences¹²¹ indicates that ABARE has been lobbying its 'natural' audience. It has considerable credibility with like-minded business and industry representatives, all of whom are interested in holding on to the *status quo* and who cannot envisage a world without the dominant use of fossil fuels. These representatives will apply political pressure where they can which could have implications after Kyoto. It should be recognised that once an international protocol or convention is agreed to it does not take force until it is ratified by a specified number of countries. To ratify a convention or protocol, its signatories have to obtain

¹²⁰ For instance, see Lunn (1997) and Gilchrist (1997).

¹²¹ See Appendix 5 which sets out ABARE's conferences from which papers were produced and made available for sale. Of course, ABARE's publication *Australian Commodities* which contains articles on trade and climate change together with resource and energy projections is subscribed to by members of the industry, mining, business and agricultural sectors.

approval from their respective Parliaments¹²². Agreement on legally binding reduction targets at Kyoto will not necessarily force countries to adopt the targets¹²³. The organisations ABARE has drawn together are part of a network of global institutional and economic power which, in abstract terms, represent currently instantiated knowledge. The extent to which this old knowledge can resist new knowledge cannot be underestimated. Hence, an agreement at the Kyoto meeting might not be the end of the story.

¹²² In Australia Commonwealth legislation has been passed, the *Administrative Decisions (Effect of International Instruments) Bill* 1995, to ensure that there is no doubt about the non-applicability of international law unless its provisions are contained within statute law, brought into existence by State or Federal Parliaments (Astill 1994 p 2). The government refer to a process of "National Interest Analysis" which looks at the implications of becoming a party to international treaties (DFAT 1997 p 14).

¹²³ If a legally binding target is agreed at Kyoto, implementation is unlikely to take place straight away in any case because there will be many matters of monitoring, *etc* to be sorted out. Of course, moral and diplomatic obligations will have some bearing on encouraging countries to adopt any targets agreed to.

CONCLUSIONS

In 1990 both levels of government in Australia endorsed the Toronto target at a special Premiers' Conference. The comments of the Chief Executive Officer of CRA Limited, J.T. Ralph, quoted in the introduction, demonstrate that the government was, at that time, genuinely committed to the Toronto target. They also indicate that the government had made attempts to convince industry to co-operate and reduce emissions. This thesis has sought to understand how this has changed.

The findings of the Industry Commission (1991), the ESD Working Groups (1991) and MENSA modelling would have been alarming for industry because they implied a movement away from energy intensive production, a change in industry structure and the demise of the coal industry. For the sustainable energy supporters the outcomes of the reports would have represented a future shift in paradigm in their favour. One has to wonder, however, how accurate these depictions of the future are. The modelling used to support these findings would be just as limited and constrained as the modelling used by ABARE to support the government's current stand. It is suggested that both sets of modelling are misrepresentations of 'reality' that have both distracted our attention too far away from the 'real' world and have encouraged reactions unwarranted by the circumstances. The reaction of the government, ABARE and industry to the conclusions of this initial modelling is embodied in MEGABARE. Its findings are intended to prevent the acceptance of new knowledge in relation to sustainable energy into the existing network of judgements on coal and power generation. This is an over-reaction because a transition to sustainable energy does not equate with the mass closure of power stations and it does not require a cut in emissions to zero.

The government, ABARE and industry believe that the Australian economy would be devastated by the adoption of legally binding reduction targets (with or without the involvement of developing countries) which will result in the loss of tens of thousands of Australian jobs. There is no evidence of this although the purported findings of MEGABARE have been used to support these claims. The problem is that the quantified nature of the rhetoric hides the assumptions characteristic of the rationality of ABARE and those with a vested interest in the continued high levels of use of fossil fuels.

This thesis has shown how narrow the government's information base on this issue really is. ABARE is an organisation interested only in trade and commodities which has extraordinarily close links with fossil fuel related industries that either profit from increased energy use or cannot take any other position except to reject calls to reduce their emissions in absolute terms. For public companies, the issue can only be economic despite their best environmental intentions. A major concern is that the government's policy direction, based on limited information, will not be in Australia's best long term interests for exactly the reasons the government refuses to adopt legally binding targets and reduce its emissions - the economy and jobs.

Such a narrow information base and economic focus perpetuates a commitment to the *status quo*. This is a feature of quantification, standardisation and economic modelling which conforms well with the interests of industry, ABARE and the government on the climate change issue. ABARE have clearly constructed MEGABARE to reflect its 'worldview' of fuel switching and population growth. On this basis, the possibility of these actors recognising a different 'reality' is seriously inhibited. The problem is that the FCCC represents a new 'reality'. Despite its provisions for differentiation and economic growth, which are claimed by the government to justify concessions and an increase in emissions, the FCCC is designed

to change the *status quo*, otherwise its existence is futile. The policy focus adopted by the government completely obscures such a 'reality'.

This thesis has also shown that scientific, political and economic judgements are interconnected and interdependent. It has been demonstrated that a change in the dynamics of one of these domains can change the judgements and commitments determining the nature of the others. In Australia, judgements about the severity of climate change have been made contingent upon judgements about the costs of mitigation. This has been achieved by overshadowing the 'environmental reality' by an 'economic reality'. MEGABARE has played a pivotal role in this process. This is not to say that the government, ABARE and industry have conspired to bring about this end. Their statements and behaviour are consistent with the culture that they share. Having said this, they have been deliberate in constructing a rhetoric that stands with the environmental claims of the debate and in juxtaposing this economic rhetoric with the uncertainty inherent in the IPCC science. Consequently, the scientific uncertainty and economic arguments have become intertwined so that they mutually enhance and perpetuate each other. This has generated plausibility for the claims of the government, ABARE and industry that abatement action should be restricted to 'no regrets' measures and their 'reality' that climate change is not a serious environmental threat.

ABARE and the MEGABARE model have been strongly criticised in Australia by economists, sustainable energy supporters, politicians and the public. In the media, Australia's stand has been characterised as isolated. More will be known about the success or failure of MEGABARE as Kyoto draws closer and, of course, afterwards. However, the extent to which the 'economic reality' can be shown to have overshadowed the 'environmental reality' would be a measure of the success of MEGABARE as a rhetorical device. Already the South Pacific Forum has agreed to sign its communiqué which gave tacit support for Australia's position, there is limited

scope for differentiation in the Japanese proposal, the United States has pushed back the time limits to begin reducing emissions to allow for a phase-in period and has suggested differentiation concessions, and the Commonwealth Heads of Government Meeting (CHOGM) has endorsed the idea of differentiation¹²⁴. On this basis, the success of the rhetoric of MEGABARE cannot be discounted.

If the government is successful at Kyoto, it will have restored confidence in the coal industry which will benefit Australia economically in terms of export income. However, it will have actually undermined the intentions of the FCCC and sustained, domestically as well as internationally, its judgement that climate change is not a severe threat. It has been argued throughout this thesis that knowledge is contingent and that it is ultimately determined by us. Based on the direction that the FCCC negotiations are currently moving, the government is on the verge of constructing knowledge in its favour. This thesis has shown that this knowledge would be based on a misrepresentation of 'reality'. This 'reality' has obscured an understanding of the benefits of avoiding climate change simply because they cannot be quantified. Our reliance on quantification seems to have progressed to a point that when it is absent, qualities are deemed not to exist. So much for the numbers.

¹²⁴ The South Pacific Forum communiqué was signed (ABC On-Line news 20.9.97) despite a sub-group of the Forum, the Alliance of Small Island States (AOSIS) which are nations smaller than, for instance, Fiji, having called for a reduction level of 20% below 1990 levels (DFAT 1997 p 2; ABC On-Line News 14.9.97 & 16.9.97). See also: *The SMH* (23.10.97 p 13) 'Clinton urges 4-year 'window of flexibility'; *The SMH* (10.10.97 p 10) 'US backing for PM's stand on greenhouse gases'; *The SMH* (23.10.97 p 2) 'Howard jubilant over greenhouse victory'.

WORKS CONSULTED

Private e-mail messages, details of *Senate Hansard*, ABARE & DPIE media releases and newspaper articles (appearing in footnotes as *The SMH* for *The Sydney Morning Herald*) have not been listed here as they have been adequately notated in the text or the footnotes.

ABARE (Australian Bureau of Agricultural & Resource Economics), *Reducing greenhouse gas emissions from the energy sector*, ABARE research report 92.3, Commonwealth of Australia, Canberra, 1992a.

ABARE (Australian Bureau of Agricultural & Resource Economics), *Strategic Plan 1992-1995*, Commonwealth of Australia, Canberra, 1992b.

ABARE, *Assessing ABARE's Performance*, Commonwealth of Australia, Canberra, 1992c.

ABARE and the Department of Foreign Affairs and Trade (DFAT), *Global Climate Change: Economic Dimensions of a Cooperative International Policy Response Beyond 2000*, Commonwealth of Australia, Canberra, 1995.

ABARE, *The MEGABARE model: Interim Documentation*, Commonwealth of Australia, Canberra, 1996.

ABARE, *The Economic Impact of International Climate Change Policy*, Commonwealth of Australia, Canberra, 1997a.

ABARE, 'International climate change policy: Economic implications for Australia', *ABARE Current Issues*, 1997b, **2**.

ABARE, 'ABARE - The MEGABARE Model' (introduction and technical papers reproduced from ABARE (1996)).
<<http://www.abare.gov.au:80/new/GIGABARE/.html>>. July 1997c.

ABARE, *Australian Energy Consumption and Production: Historical Trends and Projections to 2009-10*, Bush, S. Harris, J. & Ho Trieu, L., ABARE Research Report 97.2, Commonwealth of Australia, Canberra, 1997d.

ABARE, 'International climate change policy: Economic implications for Japan', *ABARE Current Issues*, 1997e, **3**.

Ahuja, D.R., 'Estimating national contributions of greenhouse gas emissions: The CSE-WRI controversy', *Global Environmental Change*, June, 1992, pp 83-87.

Andersen, K.V., 'Computers, Economic Modeling [*sic*], and Politics: A Review of the Literature', *Social Science Computer Review*, 1995, **13:3**, pp 320-340.

Astill, F., *An Introduction to Legal Principles Environmental Law*, Postgraduate Program, Macquarie University, 1994, pp 1-9.

- Barnes, B., 'On the Conventional Character of Knowledge and Cognition', *Philosophy of Social Science*, **11**, 1981, pp 303-333.
- Barnes, B., *T.S. Kuhn and Social Science*, Columbia University Press, New York, 1982.
- BHP Limited, *BHP Greenhouse Report 1996*, BHP, Melbourne, 1996.
- Bloor, D., *Knowledge and Social Imagery*, Second Edition, University of Chicago Press, Chicago, 1992.
- Brown, J.R., *Scientific Rationality: The Sociological Turn*, D. Reidel Publishing Company, Dordrecht, 1984.
- Business Council Australia, 'Industry and Greenhouse - One Year after Rio' in *Business Council Bulletin*, **99**, 1993, pp 28-29.
- Carraro, C. & Galeotti, M., 'Economic growth, international competitiveness and environmental protection: R & D and innovation strategies with the WARM model', *Energy Economics*, **19**, 1997, pp 2-28.
- Chalmers, A.F., *What is this thing called Science?*, University of Queensland Press, St. Lucia, 1976.
- Chisholm, T., 'Impact of Global Climate Change on Australian Agriculture', *National Academies Forum: The Challenge for Australia on Global Climate Change, Summary of Proceedings*, Academy of Social Sciences in Australia, Canberra, 29-30 April 1997, pp 23-29.
- Collins, H.M., *Changing Order: Replication and Induction in Scientific Practice*, SAGE Publications, London, 1985.
- Commonwealth of Australia, *Greenhouse Challenge 1996 Progress Report*, Canberra, 1996.
- CRA Limited, *The Greenhouse Challenge - a cooperative agreement with the Commonwealth Government: CRA Abatement Action Plan Summary*, CRA Limited, Melbourne, June, 1996.
- DEST (Department of Environment, Sport and Territories), *National Greenhouse Response Strategy December 1992*, Commonwealth of Australia, Canberra, 1992.
- DEST, *Future Directions for Australia's National Greenhouse Strategy*, Commonwealth of Australia, Canberra, 1997.
- Dickson, A. & Pakravan, P., 'Using ABARE's data and modelling resources to aid decision making', *ABARE Conference Paper 95.29* to Australian Industry

- Commission Conference, Sydney, 9-10 October 1995, ABARE, Canberra, 1995.
- Diesendorf, M., 'How can a "competitive" market for electricity be made compatible with the reduction of greenhouse gas emissions?', *Ecological Economics*, **17**, 1996, pp 33-48.
- Diesendorf, M., 'Australian Economic Models of Greenhouse Abatement' to be published in *Environmental Science: International Journal of Science & Policy*, 1997a, **1:1**.
- Diesendorf, M., 'Critique of Australian Government's Position', *Proceedings of Bridge to the Future Forum: A positive view of reducing Australia's greenhouse gas emissions*, 23 October 1997b, pp 1-3.
- Diesendorf, M., 'Greenhouse Response in the Energy Sector', *Human Ecology Human Economy: Ideas for an ecologically sustainable future*, M. Diesendorf & C. Hamilton (eds), Allen & Unwin, Sydney, 1997c, pp. 205-241.
- Diesendorf, M. & Hamilton, C. (eds) *Human Ecology Human Economy: Ideas for an ecologically sustainable future*, Allen & Unwin, Sydney, 1997.
- DFAT (Department of Foreign Affairs & Trade), *Australian and Climate Change Negotiations, An Issues Paper*, September 1997, Commonwealth of Australia, Canberra, 1997.
- DPIE (Department of Primary Industries & Energy), 'IPCC Second Assessment Report', *Climate Change Newsletter*, **8**(1), Commonwealth of Australia, Canberra, 1996a.
- DPIE, *Sustainable Energy Policy for Australia Green Paper*, Commonwealth of Australia, AGPS, Canberra, 1996b.
- Ekins, P., 'Economic Implications and Decision-Making in the Face of Global Warming', *International Environmental Affairs: A Journal for Research and Policy*, 1996, **3**, pp 227-243.
- Evans, R., 'Soothsaying or Science?: Falsification, Uncertainty and Social Change in Macroeconomic Modelling', *Social Studies of Science*, 1997, **27**, pp 395-438.
- ESD (Ecologically Sustainable Development) Working Groups, *Economic Modelling*, December, Commonwealth of Australia, Canberra, 1991.
- Feyerabend, P., 'How to Defend Society Against Science', *Radical Philosophy*, **2**, Summer, 1975, pp 156-167.
- Fisher, B., 'The development of international climate change policy', *Australian Commodities*, 1994, **1**(1), pp 50-54.

- Gieryn, T.F., 'Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists', *American Sociological Review*, 48, 1983, pp. 781-795.
- Gilbert, G.N. & Mulkey, M., *Opening Pandora's Box: A sociological analysis of scientists' discourse*, Cambridge University Press, 1984.
- Gilchrist, G., 'Too much hot air', *The Sydney Morning Herald*, 30 August 1997, p. 5S.
- Gilchrist, C., 'The Greenhouse Stand-off', *The Sydney Morning Herald*, 8 July 1996, pp 1 & 6.
- Global Climate Coalition, 'Statement of Purposes and Principles', <<http://www.worldcorp.com/dc-online/gccc/whoweare.html>> September 1997.
- GTAP (Global Trade Analysis Project), 'GTAP: The Global Trade Analysis Project'. <<http://www.agecon.purdue.edu/gtap/gtap/htm>>. July 1997.
- Hamilton, C., *A Policy Without a Future: Australia's International Position on Climate Change*. The Australia Institute, Canberra, Background Paper No. 8, 1997a.
- Hamilton, C., *Climate Change Policies in Australia: A briefing to a meeting of the Ad Hoc Group of the Berlin Mandate, Bonn, Germany, 5 August 1997*, The Australia Institute, Canberra, 1997b.
- Hammond, A.L., Rodenburg, E. & Moomaw, W.R., 'Calculating National Accountability for Climate Change', *Environment*, **33**(1), 1991, pp 10-35.
- Harris, S., *National Academies Forum: The Challenge for Australia on Global Climate Change, Summary of Proceedings*, Academy of Social Sciences in Australia, Canberra, 29-30 April 1997.
- Haynes, J., Fisher, B.S. & Jones, B.P., 'An economic perspective on the greenhouse effect', *Agriculture and Resources Quarterly*, (now known as *Australian Commodities*), **2**(3), 1990, pp 307-316.
- Henderson-Sellers, A., 'An antipodean climate of uncertainty?', *Climatic Change* **25**, 1993, pp 203-224.
- IC (Industry Commission), *The Costs and Benefits of Reducing Greenhouse Gases*, Commonwealth of Australia, Canberra, 1991.
- IPCC, 1995, 'Summary for Policymakers: The Science of Climate Change - IPCC Working Group I', <<http://www.unep.ch/ipcc/ipcc95.html>>. August 1997

- Jasanoff, S., *The Fifth Branch: Science Advisers as Policymakers*, Harvard University Press, Cambridge, 1990.
- Jasanoff, S., 'Contested Boundaries in Policy-Relevant Science', *Social Studies of Science*, **17**, 1987, pp 195-230.
- Kuhn, T.S., *The Structure of Scientific Revolutions*, Second Edition, University of Chicago Press, Chicago, 1970.
- Latour, B. & Woolgar, S., *Laboratory Life: The Social Construction of Scientific Facts*, SAGE Publications, London, 1979.
- Lawrence, M. *ABARE: Fifty years of applied economic research 1945-1995*, Commonwealth of Australia, Canberra, 1995.
- Le Grand, H., 'Is a Picture Worth a Thousand Experiments?', H. Le Grand (ed), *Experimental Inquiries: Historical, Philosophical and Social Studies of Experimentation in Science*, Kluwer Academic Publishers, Dordrecht, 1990, pp 241-270.
- Lunn, S., 'Dirty Politics', *The Weekend Australian*, 28-29 June 1997, p 28.
- Lynch, M., 'The externalised retina: Selection and mathematization in the visual documentation of objects in the life sciences', *Human Studies*, **11**, 1988, pp 201-234.
- Marshall, G., *The Concise Oxford Dictionary of Sociology*, Oxford University Press, Oxford, 1994.
- McCully, P., 'Discord in the Greenhouse: How WRI is Attempting to Shift the Blame for Global Warming', *The Ecologist*, **21**(4), 1991, pp 157-165.
- McKibbin, W.J. & Wilcoxon, P.J., *A Better Way to Slow Global Climate Change*, Brookings Policy Brief No. 17, Washington DC, The Brookings Institution, 1997.

- McKibbin, W.J., 'Issues in Global Climate Change: Insights From the G-Cubed Multi-Country Model', *National Academies Forum: The Challenge for Australia on Global Climate Change, Summary of Proceedings*, Academy of Social Sciences in Australia, Canberra, 29-30 April 1997, pp 52-62.
- Melanie, J., Phillips, B. & Tormey, J., 'Greenhouse: An international comparison of factors affecting carbon dioxide emissions', *Australian Commodities*, 1994, 1(4), pp 469-483.
- Merton, R.K., *The Sociology of Science: Theoretical and Empirical Investigations*, University of Chicago Press, Chicago, 1973.
- Michaels, P., 'Climate, and the dawn of new error', *The Australian Financial Review*, 30 May 1996, p. 19.
- Miller, D.P., 'Finitism interruptus? 'Interests' and the Foundations of SSK', *Metascience*, 11, 1997, pp 22-30.
- Mulkay, M., *Science and the Sociology of Knowledge*, Allen & Unwin, London, 1979.
- Mulkay, M., & Gilbert, G.N., 'Putting Philosophy to Work: Karl Popper's Influence on Scientific Practice', *Philosophy of Social Sciences*, 11, 1981, pp 389-407.
- Porter, T.M., 'Quantification and the Accounting Ideal in Science', *Social Studies of Science*, 22, 1992a, pp 633-652.
- Porter, T.M., 'Objectivity as Standardization: The Rhetoric of Impersonality in Measurement, Statistics, and Cost-Benefit Analysis', *Annals of Scholarship*, 9(1/2), 1992b, pp 19-53.
- Porter, T.M., *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*, Princeton University Press, New Jersey, 1995.
- Pusey, M., *The Impact of Economic Ideas on Public Policy in Canberra*, Public Sector Research Centre, Discussion Paper 10, UNSW, Kensington, 1990.
- Pusey, M., *Economic Rationalism in Canberra: A Nation-Building State Changes its Mind*, Cambridge University Press, Cambridge, 1991.
- Ralph, J.T., 'Greenhouse: Political Posturing or Sensible Solutions?', *International Conference on Coal, the Environment and Development: Technologies to reduce greenhouse gas emissions, Proceedings*, Sydney, Australia 18-21 November 1991, OECD/IEA, 1992, pp 857-864.
- Salter, L., *Mandated Science: Science and Scientists in the Making of Standards*, Kluwer Academic Publishers, Dordrecht, 1988.

- Shrader-Frechette, K.S., *Science Policy, Ethics and Economic Methodology*, D. Reidel, Dordrecht, 1985.
- Shrader-Frechette, K.S., *Risk and Rationality: Philosophical Foundations for Populist Reforms*, University of California Press, Berkeley, 1991.
- Shackley, S. & Wynne, B., 'Mutual construction: Global climate change: the mutual construction of an emergent science-policy domain', *Science and Public Policy*, **22** No. 4, 1995a, pp 218-230.
- Shackley, S. & Wynne, B., 'Integrating knowledge for climate change: Pyramids, nets and uncertainties', *Global Environmental Change*, 1995b, **5** No. 2, pp 113-126.
- Sprinz, D. and Vaahtoranta, T., 'The interest-based explanation on international environmental policy', *International Organization*, **48**, 1994, pp 77-105.
- Stegg, H., 'Coal outlook and the role of the international energy agency' in *International Conference on Coal, the Environment and Development: Technologies to reduce greenhouse gas emissions, Proceedings*, Sydney, Australia 18-21 November 1991, OECD/IEA, 1992, pp 19-24.
- Stuart, R., 'Climate change: International policy institutions and directions', *Australian Commodities*, 1994, **1**(2), pp 208-215.
- Stuart, R., Brown, S. & Hanslow, K., 'The MEGABARE model and climate change policy: The role of research in policy development', *ABARE Conference Paper 97.16*, Canberra, 1997.
- Treadwell, R., 'Will 'no regrets' energy policy options reduce greenhouse gas emissions', *Agriculture and Resources Quarterly* (now known as *Australian Commodities*), **5**(1), 1993, pp 85-92.
- Neck, M., Barnes, P. & Cox, A., 'Greenhouse Policies and the Australian Aluminium Industry', *Agriculture and Resources Quarterly* (now known as *Australian Commodities*), **4**(3), 1992, pp 345-354.
- United Nations, Framework Convention on Climate Change, 1992.
<<http://www.unfccc.de/fccc/conv>>, 7 August 1997.
- Weinberg, A.M., 'Science and Trans-science', *Minerva*, **10**, 1972, pp 209-222.
- Willis, K., 'Voluntary greenhouse program launched', *Search* **26**(10), 1995, p 291.
- Willis, K., 'Industry agrees to reduce greenhouse gases', *Search* **27**(6), 1996, p 165.

Woolgar, S., 'Interests and Explanation in the Social Study of Science', *Social Studies of Science*, **11**, 1981, pp 365-394.

World Resources Institute, *The 1993 Information Please Environmental Almanac*, Houghton Mifflin Company, Boston, 1992.

Wynne, B., 'Unruly Technology: Practical Rules, Impractical Discourses and Public Understanding', *Social Studies of Science*, **18**, 1988, pp 147-167.

Wynne, B., 'SSK's Identity Parade: Signing-Up, Off-and-On', *Social Studies of Science*, **26**, 1996, pp 357-391.

APPENDIX 1

TIME LINE OF INTERNATIONAL AND AUSTRALIAN CLIMATE CHANGE MEETINGS AND IMPORTANT DATES

1988	First World Climate Conference was held in Toronto. Agreement on non-legally binding targets for developed countries to reduce carbon dioxide emissions by 20% below 1988 levels by 2005.
1988	IPCC was instructed to report on elements for inclusion in Framework Convention.
1990	In August the First IPCC Assessment Report was released.
1990	In October/November the Second World Climate Conference which led to negotiations on an international framework convention was held.
1990	In October the Australian federal and state governments endorsed the Toronto commitment.
1990	In December the Industry Commission was directed to investigate the costs and benefits of reducing greenhouse gases in line with the Toronto Target.
1991	In February the First Session of Intergovernmental Negotiating Committee for a Framework Convention met.
1991	In June the Second Session of the Intergovernmental Negotiating Committee for a Framework Convention met. Many meetings have been held since this time. For instance, the 11th meeting was scheduled for February 1995.
1991	Industry Commission Report was released.
1991	Ecologically Sustainable Development Groups Economic Modelling Report was released.
1992	IPCC submit supplementary report for discussion at the Earth Summit.
1992	Earth Summit in Rio de Janeiro established the United Nations Framework Convention on Climate Change (FCCC) which was signed by 155 countries.
1992	Australian federal government launched the National Greenhouse Response Strategy.
1993	ABARE begin the development of MEGABARE.
1993	In December the FCCC was ratified.
1994	FCCC comes into force on 21 March 1994.
1995	In March the Australian federal government launches the Greenhouse 21C program which incorporates the Greenhouse Challenge Program.
1995	In March the First Conference of the Parties was held in Berlin.

1995	In September the IPCC Second Assessment Report was released which presented the scientific consensus of a human influence on climate..
1995	In November ABARE's report <i>Global Climate Change: Economic dimensions of a Cooperative international policy response beyond 2000</i> setting out the findings of MEGABARE was released.
1996	In July the Second Conference of the Parties was held in Geneva when it was agreed that Annex 1 countries would adopt legally binding carbon dioxide reduction targets.
1997	In April ABARE released <i>Current Issues 2</i> which sets out quantified claims of a loss in welfare of \$9000 per person, a reduction in wages of 19% and a cost for each Australian being 22 times more than that for a European person.
1997	In June ABARE release <i>The Economic Impact of International Climate Change Policy</i> which concludes that the economies of non-Annex 1 countries will be detrimentally affected if only Annex 1 countries take measures to reduce emissions.
1997	In August the Commonwealth Ombudsman determined that an investigation into ABARE's models was warranted.
1997	In September the government (DFAT) released an Issues <i>Paper Australia and Climate Change Negotiations</i> which requests public comment.
1997	In October the United States rejects the EU's proposal of a 15% reduction in emissions below 1990 levels and CHOGM endorses the idea of differentiation.
1997	In December the Third Conference of the Parties will be held in Kyoto, Japan.

References:

IC (1991); Stuart (1994); DFAT (1997), DFAT & ABARE (1995); Stuart *et al.* (1997), *The SMH* 10.10.97 & 27.10.97.

APPENDIX 2:**REGIONS AND SECTORS INCLUDED IN MEGABARE CLIMATE CHANGE SIMULATIONS**

Regions		Sectors	
1	Australia	1	Coal
2	New Zealand	2	Oil
3	United States	3	Gas
4	Canada	4	Other minerals
5	Japan	5	Petroleum and coal products
6	European Union (15)	6	Chemicals, rubber and plastics
7	EFTA*	7	Nonmetallic mineral products
8	South Korea	8	Primary iron and steel
9	China	9	Primary non-ferrous metals
10	Chinese Taipei	10	Fabricated metal products
11	Indonesia	11	Electricity, gas and water
12	Rest of ASEAN**	12	Agriculture
13	India	13	Processed agricultural products
14	Mexico	14	Capital Goods
15	Brazil	15	Manufacturing
16	Rest of America	16	Services
17	Former Soviet Union and Eastern Europe		
18	Rest of the world		

* Comprises Norway, Switzerland and Iceland

** Comprises Malaysia, the Philippines, Singapore and Thailand

(ABARE 1997a p 17).

APPENDIX 3**Details of contributions to ABARE for the development of MEGABARE & GIGABARE models:****MEGABARE**

1993-94:

Australian Coal Association \$50,000

Department of Foreign Affairs and Trade \$27,000

Department of Primary Industries & Energy \$100,000

1994-95

Australian Coal Association \$50,000

Bureau of Industry Economics (DIST) \$50,000

Business Council of Australia \$60,000

Department of Environment, Sports and Territories \$50,000

GIGABARE

1996-97

Australian Aluminium Council \$25,000

BHP Limited \$50,000

Business Council of Australia \$50,000

CRA Limited \$25,000

Den Norske Stats Oiljeselskap (Statoil) \$50,000

Department of Environment Sports & Territories \$50,000

Department of Primary Industries and Energy \$50,000

Electricity Supply Association of Australia \$50,000

Exxon Corporation \$50,000

Mobil Oil Australia Limited \$50,000

Texaco Corporation \$50,000

Senate Hansard (15.5.97 p 3517).

Stuart *et al.* (1997 pp 5 & 16-17) also provide details of these contributors. It is noted that Rio Tinto is mentioned by Stuart *et al.* (1997 p 16) but is not set out above. Also, CRA Limited is stated above but are not referred to by Stuart *et al.* (1997).

APPENDIX 5**PRESENTATIONS BY ABARE AT CONFERENCES RELATING TO CLIMATE CHANGE BETWEEN FEBRUARY 1994 AND APRIL 1997.**

'The economic implications of international climate change policy' to the Australian Petroleum Production and Exploration Association Conference in Melbourne, April 1997.

'Policy directions in the greenhouse debate' to the International Energy Agency Conference' in Paris, May 1996.

'Equity considerations in climate change negotiations' at a Workshop on Differentiation in Climate Change in London, June 1996.

'Effects of greenhouse gas abatement in OECD countries on developing countries' to IPIECA Symposium on Critical Issues in the Economics of Climate Change Tour in Paris, October 1996.

'Modelling the impact of OECD carbon taxes with the MEGABARE model' to the International Association for Energy Economics 18th Annual Conference in Washington in July 1995.

'Modelling the regional implications of reductions in global warming potential from Australian agriculture' to the First International Symposium on Mathematical Modelling and Simulation in Agriculture and Bio-industries, Brussels in May 1995.

'Using ABARE's data and modelling resources to aid decision making' to the Australian Industry Commission Conference, Sydney in October 1995.

'Joint implementation. A co-operative approach to global climate change' to PECC Minerals & Energy Forum. Asia Pacific Electricity Development Specialist Group Meeting, Vietnam in August 1995.

'Climate change. What is the optimal international policy response?' to the Climate Change Session of the National Agricultural and Resources Outlook Conference at Canberra in February 1995 (convened by ABARE).

'Optimal greenhouse policy in a multi-country world of growing economies' presented at a Conference of Economists, Gold Coast, 25-28 September 1994.

'Trade and welfare effects of policies to address climate change' presented to the IPCC Workshop on 'Equity and Social Considerations Related to Climate Change' in Nairobi, Kenya, 18-22 July, 1994.

'The development of international climate change policy' to the Greenhouse session of the National Agricultural and Resources Outlook Conference, Canberra, February 1994 (convened by ABARE).

It should be noted that this list of conferences was taken from a list of publications setting out conference papers which were available for purchase from ABARE as well as those listed by Stuart *et al.* (1997). ABARE has made other presentations which are not listed here, for instance, presentations were made at two National Academies Forums on 25 November 1996 and 29-30 April 1997 and the Bridge to the Future Forum on 23 October 1997.