

Environment Economics Research Hub

Research Reports Abstracts

Research Report 1

Choice modelling in the development of natural resources management strategies in NSW

Kasia Mazur and Jeff Bennett
February 2008

Protecting environmental services generates social benefits. At the same time, private landholders supplying these benefits may face some costs. To provide these services efficiently, policy makers need information about community values for the environment as well as landholders' costs.

This study explores how choice modelling (a non-market valuation technique) is used to estimate comment values. These include use and non-use values for increasing environmental quality in NSW catchments. Non-market valuation techniques for estimating environmental values are reviewed. This is followed by a discussion of methodological aspects of the choice modelling technique and its potential as a regional planning tool for Catchment Management Authorities (CMA's)

Keywords: [Nonmarket valuation, choice modelling, trade-offs, bio-physical modelling](#)

Research Report 2

Using focus groups to design a choice modelling questionnaire for estimating natural resource management benefits in NSW

Kasia Mazur and Jeff Bennett
February 2008

In this study, focus group discussions were used to design a choice modelling (CM) questionnaire to estimate community wide values for the environmental and social benefits provided by natural resource management changes in the Namoi, Lachlan and Hawkesbury-Nepean catchments.

This report describes the logistics of the focus groups and outlines the main conclusions drawn from the discussions. The research team conducted eight focus groups in the main urban areas of the regions where the CM survey will be conducted (Tamworth, Cowra, Goulburn and Sydney). How the CM questionnaire was developed with focus group participant input is also discussed in the report. The focus group meetings resulted in a draft questionnaire to be refined in consultation with scientists, managers and policy makers.

Keywords: [Focus groups, choice modelling, questionnaire design, natural resource management.](#)

Research Report 3

Designing choice experiments to incorporate tests for geographic scale and scope differences

John Rolfe, Jill Windle and Jeff Bennett
August 2008

Designing a choice modelling (CM) experiment to place a value on increasing protection of the Great Barrier Reef (GBR) raises complex issues. The size and diversity of the GBR, and the number of different pressures impacting on it, mean protection and improvement scenarios can be drafted in several different ways.

This report discusses some of the considerations in selecting, describing and combining choice attributes. It also looks at how to incorporate tests for geographic scale (size) and scope (complexity) differences into the design of the CM survey instrument. The potential to include information about management options designed to achieve increased protection, and the associated risk and uncertainty, is also discussed.

Keywords: choice modelling, scale, scope, coral reef

Research Report 4

Taking Stock: Seventeen Years after the Murray-Darling Basin Agreement

Lisa Yu-Ting Lee and Tihomir Ancev
November 2008

There has now been almost two decades of natural resource management by signatory states under the Murray-Darling Basin Agreement. Despite significant public expense, the success of initiatives to improve the Basin's environmental remains ambiguous. This confusion is partly due to poorly distinguished investment outcomes, a blurring of the transparency of public spending and a lack of accountability of decision makers.

The aim of this study is to demonstrate that significant environmental improvements could have been achieved at a much lower cost if decisive action been taken early. The research report outlines the myriad of Murray-Darling Basin related policies and its funding. It also notes the achievements and impediments to program success.

Keywords: water reform, water policy, cost efficiency, Murray-Darling Basin

Research Report 5

Economic growth and pollution in the long run: the case of carbon dioxide

Paul Bourke

November 2008

The concept underpinning the Environmental Kuznets Curve is that economic growth results in reduced pollution in the long run. In this report, an extension of Andreoni and Levinson's (2001) theoretical model is presented. It demonstrates that an Environmental Kuznets Curve relationship can occur because high incomes allow more adoption of low-emission technologies at higher income levels. Evidence on the determinants of carbon dioxide emissions changes for OECD countries over the period 1961-2004 is presented. It highlights the importance of technology adoption in explaining whether countries have achieved emissions reductions at the same time as experiencing long-run economic growth. However, it is shown that technology adoption is affected by policy decisions and other factors in addition to income level. Hence the Environmental Kuznets Curve hypothesis is more appropriately framed as a conditional relationship.

Keywords: Economic growth; pollution; carbon dioxide; environmental Kuznets curve

Research Report 6

Environmental value and valuation over time

Gabriela Scheufele and Jeff Bennett

November 2008

Time and value are related concepts that influence human behaviour. Although classical topics in human thinking throughout the ages, few environmental economic non-market valuation studies have attempted to link the two concepts. Economists have estimated non-market environmental values in monetary terms for over 30 years. This history of valuation provides an opportunity to compare value estimates and how valuation techniques have changed over time.

This research aims to compare value estimates of benefits of a protected natural area. In 1978, Nadgee Nature Reserve on the far south coast of New South Wales was the focus of the first application of the contingent valuation method in Australia. This research aims to replicate that study using both the original 1978 contingent valuation method questionnaire and sampling technique, as well as state of the art non-market valuation tools. This replication will provide insights into the extent and direction of changes in environmental values over time. It will also highlight the impact on value estimates of methodological evolution. These insights will help make allocating resources more efficient.

Keywords: Environmental values; temporal variability, non-market valuation, contingent valuation method, choice experiments, incentive compatibility, natural resource management.

Research Report 7

Exploring scope and scale issues in Choice Modelling design

John Rolfe and Wang Xuehong

November 2008

The key tasks in the design of a choice modelling (CM) experiment are to define the scope, scale and frame of the tradeoffs presented to respondents.

This study explores the scale and scope of choice tasks and then develops definitions of these terms. The **scope** of a good in a stated preference experiment refers to the dimensions used to define the good as well as the tradeoffs involved. The **scale** refers to the quantities involved. The **framing** refers to the context in which the choices are made. The discussion helps identify issues when setting the contingent market for a choice experiment.

Keywords: choice modelling, scale, scope, framing, embedding

Research Report 8

Developing a questionnaire for valuing changes in Natural Resource Management in the George Catchment, Tasmania

Marit E. Kragt and Jeff Bennett

November 2008

In this study a combination of literature review, expert interviews, biophysical modelling and focus group discussions were used to design a Choice Modelling (CM) questionnaire. This questionnaire was used to value changes in natural resource management in the George catchment, Tasmania.

This report describes the questionnaire development, the selection of George catchment attributes and the assessment of attribute levels. The (experimental) design and delivery of the questionnaire are also presented.

Keywords: choice experiments, valuation, survey development, Tasmania, catchment management

Research Report 9

The challenges of finding efficient policy measures to reduce Australia's Agricultural greenhouse gas emissions

Helen King

November 2008

A comprehensive emissions trading scheme (ETS) is Australia's principal climate change policy instrument. There are undoubtedly benefits of full ETS coverage. However, if emissions that cannot be affordably, reasonably and accurately measured are included, these must be balanced against potential costs.

This report explores why agriculture is different from other sectors. Agriculture's diffuse and diverse emissions are inherently difficult to measure. They also fluctuate in response to environmental factors such as climate and biophysical characteristics. It is problematic to include the agriculture sector in the ETS, at reasonable cost and with incentives for behaviour change at the emission source. This is because of the climate and biophysical characteristics combined with the scale of over 130,000 farm enterprises. Worse, the emphasis on including agricultural emissions in the ETS is a disincentive for early abatement action.

Alternative abatement policies are considered in this report which concludes that a 'carrot and stick' approach, using a range of policy instruments, is the best way to deliver cost effective abatement for agriculture.

Keywords: agriculture; greenhouse; abatement; emissions trading

Research Report 10

Designing choice experiments to test for anchoring and framing effects

Marit E. Kragt and Jeff Bennett

December 2008

Choice experiments (CE) are increasingly used as a stated preference technique to value changes in non-market goods. Respondents to a CE survey are asked to make repeated choices between alternatives. Each alternative is described by a number of attributes – the attributes levels vary across alternatives and choice sets. A monetary attribute is typically included so that marginal values for changes in the non-market attributes presented can be estimated.

The monetary attribute has central importance. However, there has been limited research on the impacts on respondents' choices of changing the (range in) levels of the monetary attribute presented in CE surveys. This is known as the 'anchoring' effect. The 'framing' of non-market attributes may also affect value estimates. Attribute framing refers to the context in which the attributes are presented to respondents in a CE survey. The challenge for CE practitioners is to identify how particular attribute frames may influence respondents' choices.

This research report provides a review of anchoring and framing effects in CEs. A CE questionnaire is described to incorporate tests for anchoring and framing effects. Ten hypotheses are developed about the impacts of various attribute 'anchors' and 'frames' on respondents' choices and subsequent values estimated.

Keywords: choice experiments, valuation, anchoring effect, starting point bias

Research Report 11

Climate change economics and policy in the Asia-Pacific

Frank Jotzo
January 2009

The Asia-Pacific region is the major source of global growth in greenhouse gas emissions. Strong action is needed in Asian countries, particularly China and India, to reduce these global emissions. Driven by the desire to limit energy consumption, some Asian countries already have domestic policies to limit greenhouse gas emission. But much more ambitious policies are needed to turn emission trends around.

This research report examines the implications of international efforts to mitigate the impacts of human activity on climate in the Asia-Pacific region.

Keywords: climate change policy, Indonesia, CDM, central-local coordination

Research Report 12

Incorporating risk and uncertainty issues into choice modelling experiments

Xuehong Wang and John Rolfe
January 2009

Many policy issues, as well as policy funding and management choices, have elements of risk and uncertainty. This means that choice experiments, such as those used in choice modelling (CM), may need to frame trade-offs so that risk and uncertainty are included.

This research aims to explore some methodological approaches to identify and treat uncertainty in CM experiments. A review of theoretical models, as well as a case study application in the CM technique reported by Roberts et al. (2008), suggests that including uncertainty information in the choice sets should influence responses significantly. However, key challenges remain to define and describe the elements of risk and uncertainty that are to be included in a choice experiment, to communicate the issues to respondents, and to develop appropriate forms of analysis.

Keywords: Choice experiments, risk, uncertainty, information, framing.

Research Report 13

A choice modelling survey of community attitudes to improvements in environmental quality in NSW catchments

Kasia Mazur and Jeff Bennett

January 2009

The survey was designed to estimate environmental values suitable for integration into MOSAIC, a bio-economic model for catchment and farm level planning. Local residents, as well as distant rural and distant urban communities, were surveyed in three NSW catchments (Lachlan, Namoi and Hawkesbury-Nepean) using choice modelling (CM). The survey aimed to find out respondents' attitudes about, and preferences for, potential natural resource management (NRM) improvements. In total, 3,997 responses were collected from seven different locations in NSW. Fourteen split samples were established to allow for testing of incentive compatibility in CM, the impact of respondent location on values held, and scale effects.

This research report describes the development of the CM questionnaires, the survey design and the data collection process.

Keywords: Nonmarket valuation, choice modelling, survey, questionnaire design

Research Report 14

Linking the Australian Emissions Trading Scheme

Frank Jotzo and Regina Betz

February 2009

A detailed proposal for an economy-wide emissions trading scheme in Australia was tabled by the government in December 2008 with a proposed start date for mid-2010. The government proposes unilateral linking, with no initial bilateral linkages, through the clean development mechanism and joint implementation. The proposal has resulted in serious concern about significant permit price increases and price capping, leading to a ban on permit sales.

This research paper evaluates the proposed Australian scheme in relation to international emissions trading and linkages. Different scenarios for the Australian permit price under unilateral linking are considered. Options for bilateral linking with the European Union and New Zealand schemes are also evaluated, including access to 'hot air' units.

The research paper argues that Australia needs to dismantle linking obstacles, such as the price cap, and move towards suitable bilateral linking schemes.

Keywords: climate change policy, Australia, emissions trading, international linkages

Research Report 15

Integrated hydro-economic modelling: Challenges and experiences in an Australian catchment

Marit E. Kragt and Jeff Bennett
February 2009

Integrated catchment policies are widely used to manage natural resources in Australian catchments. Integration of environmental processes with socio-economic systems is often difficult due to the limitations of decision support tools. To support assessments of the environmental and economic trade-offs of changes in catchment management, fully integrated models are needed.

This research demonstrates a Bayesian Network (BN) approach to integrating environmental modelling with economic valuation. The model incorporates hydrological, ecological and economic models for the George catchment in Tasmania. Choice experiments were used to elicit information about the non-market costs and benefits of environmental changes. This allows the efficiency of alternative management scenarios to be assessed.

Keywords: Hydro-economic modelling, Integrated catchment modelling, Ecological modelling, Valuation, Bayesian networks, Water quality

Research Report 16

Using choice experiments to value river and estuary health in Tasmania with individual preference heterogeneity

Marit E. Kragt and Jeff Bennett
February 2009

Choice experiments (CE), also known as choice modelling (CM), are now used widely in environmental valuation in Australia. Many examples assess the trade-offs between river catchment management and socio-economic impacts. There is, however, limited information about the values of Australian estuaries and none of the existing valuation studies addresses catchment management changes in Tasmania.

The CE study described in this report aims to elicit community preferences for protecting the rivers and estuary of the George catchment in north-eastern Tasmania. Results from conditional and mixed logit models show that respondents are, on average, willing to pay between \$2.47 and \$4.46 for a one kilometre increase in native riverside vegetation, and between \$9.35 and \$10.97 per species for the protection of rare native plants and animals, *ceteris paribus*.

The study results are ambiguous about respondents' preferences for estuary seagrass area. It also shows significant differences between logit models when accounting for individual heterogeneity, and repeated choices made by individual respondents.

Keywords: Choice experiments, Preference heterogeneity, Mixed Logit models, River health, Estuary health, Tasmania, Environmental valuation

Research Report 17

What's appropriate? Investigating the effects of attribute framing and changing cost levels in choice experiments

Marit E. Kragt and Jeff Bennett
February 2009

Choice experiments (CE) are increasingly used to estimate the values of non-market goods and services. A cost attribute is typically included in a CE questionnaire to estimate monetary values for changes in the non-market attributes presented. Although the cost attribute is centrally important, there has been limited research into the impacts of varying cost attribute levels on respondents' choices in CE surveys. The context in which non-market attributes are presented to respondents (the 'attribute frame') may also affect value estimates. The challenge for CE practitioners is to identify the 'appropriate' attribute frames and cost level range.

Results from a CE study in Tasmania show that respondents' preferences are not impacted by describing an attribute in 'presence' versus 'loss'. The absolute attribute levels, therefore, were most important in this study. Comparisons between different split samples are evidence that changing the cost attribute level does affect respondents' preferences – higher levels lead to significantly higher estimates of willingness to pay for one of the three environmental attributes.

Keywords: Choice experiments, Mixed Logit models, Environmental valuation, Attribute framing, Cost bias

Research Report 18

Public values for improved water security for domestic and environmental use

**Jill Windle, John Rolfe and Roy
Brouwer**
January 2009

Metrics for evaluating environmental trade-offs can be developed with varying levels of consistency across case study sites. A key issue is whether standard evaluation experiments can be conducted over multiple sites, or whether experiments have to be tailored to each case study application. To test how useful a consistent approach is, choice modelling (CM) has been used in a number of countries. Choice modelling assess the trade-offs households are prepared to make between water use restrictions, maintaining environmental conditions in waterways, and increased water costs.

This research paper reports the results of the Queensland survey. The results show that it is not possible to downplay case study framing issues and that it is not appropriate to standardise applications across case studies that have different characteristics.

Keywords: choice modelling, water, environment, framing

Research Report 19

Household perceptions of climate change and preferences for mitigation action: the case of the Carbon Pollution Reduction Scheme in Australia

Sonia Akter and Jeff Bennett

February 2009

This study aims to show how Australian households perceive climate change and what they are prepared to do to reduce the harmful effects of climate change.

A web-based survey in November 2008 asked approximately 600 New South Wales households about their willingness to pay additional household expenses caused by the Carbon Pollution Reduction Scheme (CPRS) proposed by the Australian government.

The Contingent Valuation Method (CVM), a widely used non-market valuation technique, was applied. Results of the study show there is a positive demand to mitigate climate change in Australia resulting from a wish to avoid climate change. Households' willingness to pay (WTP) for climate change was, however, significantly curbed as households was uncertain about the extent of climate change and whether climate change policies are effective. Australian household support for the CPRS is influenced by schemes of other major greenhouse gas emitting countries (global co-operation).

Only when people who didn't answer the survey are assumed to value climate change mitigation the same as people who did answer the survey, do the benefits of the CPRS, as estimated by respondents' WTP, exceed its costs.

Keywords: Contingent valuation, climate change, Carbon Pollution Reduction Scheme, willingness to pay, uncertainty, Australia

Research Report 20

Modelling the Global Diffusion of Energy Efficiency and Low Carbon Technology

David I Stern

February 2009

The aim of this study is to measure and understand the long-term factors behind trends in energy and carbon intensity in different economies. It also looks at how improvements in energy efficiency are spread to countries around the world.

Of particular interest is the rate at which efficiency improvements spread from developed to developing countries and what affects this diffusion. Countries that are considered are Australia, major European economies, USA, Canada, Mexico, Japan, China, and India.

Keywords: Energy efficiency, carbon emissions, environmental Kuznets curve, economic growth

JEL Codes: Q43, Q55, Q56

Research Report 21

Location differences in communities' preferences for environmental improvements in selected NSW catchments: A Choice Modelling approach

Kasia Mazur and Jeff Bennett
March 2009

To elicit household willingness to pay (WTP) for improvements in environmental quality in three NSW catchments (Lachlan, Namoi and Hawkesbury-Nepean), a choice modelling (CM) study was conducted.

This report presents results of research designed to investigate variations in WTP across different communities. The communities included local residents, distant/urban and distant/rural residents. Nine split samples were established to test for 'location effects'. The analysis involved both conditional logit and random-parameters logit models.

Natural resource management (NRM), including Catchment Management Authorities (CMAs), can use the non-market values obtained from this study to guide their investment decisions.

Keywords: Choice modelling, location effects, non-market valuation, catchment planning, environment

Research Report 22

Cod today and none tomorrow: The Economic Value of a Marine Reserve

R. Quentin Grafton and Tom Kompas
March 2009

The northern cod fishery was once one of the world's largest capture fisheries. Using data from the fishery, this research calculated the economic value of a marine reserve using a stochastic optimal control model with a jump-diffusion process.

The analysis shows that, an optimal-sized marine reserve in this fishery would have prevented the fishery's collapse and generated a triple payoff. Even if harvesting had been 'optimal' the profits from fishing would have been raised. The recovery time would also have decreased for the biomass to return to its former state and smoothed fishers' harvests and profits. Following a negative shock, the chance of a catastrophic collapse would have been lowered.

Keywords: Marine reserves; Stochastic control; Fisheries

JEL codes: C61; Q22

Research Report 23

Residential Water Consumption: A Cross Country Analysis

R. Quentin Grafton, Tom Kompas, Hang To and Michael Ward
March 2009

Survey data from over 1,600 households in ten countries were used to analyse the determinants of residential water demand. Results show that in every country the price elasticity is negative and statistically significant.

Households that do not have to pay for the water they use (volumetric water charges) consume about a third more water than similar households that do have to pay such charges. Consumers' attitudes do not have a statistically significant effect on total water use, although they do increase the probability of households using some water saving behaviours. Volumetric water charges also have an impact on the adoption of water saving actions.

Full-cost water pricing appears to be a highly effective instrument to manage residential water demand.

Keywords: [water demand](#); [water consumption](#); [water pricing](#)

JEL codes: [C21](#), [Q25](#), [Q50](#)

Research Report 24

The logic of collective action and Australia's Climate Policy

John C.V. Pezzey, Salim Mazouz and Frank Jotzo
Research Report 24, May 2009

The Australian Government's Carbon Pollution Reduction Scheme (CPRS), March 2009, set a target of 5 to 15 per cent emission cuts during 2000 and 2020. The proposed target is weak and is likely to increase mitigation costs in Australia in the long run.

This research report analyses the target's efficiency as well as provisions for preventing carbon leakage. The research also looks at the nature of changes to the CPRS made during 2008 as well as the likely cause of these changes.

The free allocation of output-linked, tradable permits to Emissions-Intensive, Trade-Exposed (EITE) sectors was much higher than previously proposed and greater than what is needed to prevent carbon leakage. This means EITE emissions could rise by 13 per cent during 2010 and 2020. To meet the proposed national targets, non-EITE sectors must also cut emissions by 34 to 51 per cent (or make equivalent permit imports). This is far from a cost-effective outcome.

The weak targets and over-generous EITE assistance illustrate how collective action by the 'carbon lobby' can damage economic efficiency. To resist this, new national or international institutions to assess lobby claims impartially are needed. More government publicity about the true economic importance of carbon-intensive sectors is also required. Over-concern that voluntary emission cuts will be nullified by the CPRS is another, different, demonstration of lobby power.

Keywords: [climate policy](#), [Australia](#), [targets](#), [emission trading](#), [carbon leakage](#), [lobbying](#)

Research Report 25

Non-Market Values and Optimal Marine Reserve Switching

Satoshi Yamazaki, R. Quentin Grafton and Tom Kompas

Research Report 25, May 2009

A stochastic bio-economic model is constructed to analyse the effects of marine reserve 'switching' between a 'no take' area and a harvested area. The model accounts for both market and non-market values of the fishery. Estimated parameters from the red throat emperor fishery from the Great Barrier Reef are used.

Simulations show that an optimal switching strategy is, under a range of scenarios, preferred to fixed reserve and no reserve strategies. An important outcome is that the non-market values associated with the size of the fishery substantially affect both the returns from switching and the closure time.

Keywords: marine reserves, stochastic control; non-market values

JEL codes: C61; Q22

Research Report 26

Environmental value transfer and species conservation

Sonia Akter and R. Quentin Grafton

Research Report 26, May 2009

Decision tools for species conservation, such as benefit cost analysis (BCA) and project prioritization protocol (PPP) use monetary values to measure benefits or to assign priorities across species. Non-use (or passive) values are an important, yet difficult to quantify, category of benefits. When not estimated they may be assigned a zero value by decision makers. This results in the under-provision of conservation dollars to substantial non-use values generating projects and actions.

To overcome the problem, we provide a guide to environmental value transfer (EVT) that allows decision makers to derive indirect estimates of non-use values. Environmental value transfer, together with consideration of estimated benefits uncertainty, promise better decision making and improved species conservation outcomes.

Key words: environmental value transfer, species conservation, non-use values

Research Report 27

Guide to the ex-ante socio-economic evaluation of marine protected areas

R. Quentin Grafton, Sonia Akter and Tom Kompas

Research Report 27, May 2009

Marine protected areas (MPA) potentially offer a wide range of use and non-use benefits. These include critical habitat protection, conservation of marine biodiversity, recovery of threatened and endangered marine species, and increased biomass of targeted marine species.

To assess whether such benefits exceed the potential costs, we provide the first-ever comprehensive ex-ante, socio-economic guide to MPA evaluation. Our framework shows how to quantify four key values of MPAs: consumptive, non-consumptive, indirect, and non-use values. The framework also shows how to use decision tools to determine the desirability of establishing MPAs. Overall, the guide offers the promise of improved information and better decision making for marine protected areas.

Keywords: Marine protected areas, use value, non-use value, benefit-cost analysis.

Research Report 28

In or out? Efficient inclusion of installations in an emissions trading scheme

Regina Betz, Todd Sanderson and Tihomir Sanderson

Research Report 28, May 2009

Regulators around the world are currently considering national emissions trading systems (ETS) as a cost-effective way to reduce greenhouse gas emissions. ETS installations coverage is one of the numerous design issues confronting them. 'Blanket coverage' that includes all an economy's industrial emitters of greenhouse gases has some intuitive appeal. Although it seems equitable it does not, however, take into full account all the costs related to the extent of coverage.

This report shows how an alternative approach of 'efficient coverage' can achieve the same emission reduction outcome at lower social cost. The approach is based on maximising the benefits of including installations in an ETS, while at the same time taking into account all relevant transaction costs. A broad definition of transaction costs is used – the regulatory costs to the government as well as regulatory costs imposed on covered installations. Particularly for relatively modest emissions reduction targets, the study found there are significant cost savings with an 'efficient coverage' compared with 'blanket coverage'.

Keywords: Emissions Trading Scheme, Environmental Policy, Installation Coverage, Transaction costs.

JEL: Q50, Q58, H23

Research Report 29

Auctioning greenhouse gas emissions permits in Australia

Regina Betz, Stefan Seifert, Peter Cramton and Suzi Kerr
Research Report 29, May 2009

Allocating permits based on individual historical emissions ('grandfathering'), or industry benchmark data, is an important design aspect of an emissions trading scheme. Free permit allocation has proven complex and inefficient (particularly in the European Union) with distribution implications also politically difficult to justify. For these reasons, auctioning emissions permits has become more popular than allocating permits.

The European Union is now moving towards auctioning more than 50 per cent of all permits in 2013. In the US, the Regional Greenhouse Gas Initiative (RGGI) has started with auctioning 100 per cent of permits. The Australian proposal for a Carbon Pollution Reduction Scheme (CPRS) also provides for auctioning a significant share of total permits.

This report discusses important theoretical and practical auction design aspects for allocating emissions permits in Australia. Particularly interesting is the proposal to simultaneously auction multiple emissions units of different vintages. The specific design details proposed have been adopted by the Australian Government in their CPRS White Paper.

Keywords: Climate policy, Greenhouse gases, Auctions, Emissions trading

Research Report 30

The future of renewable electricity in Australia

Greg Buckman and Mark Diesendorf
Research Report 30, May 2009

If long-term greenhouse gas emissions in Australia are to be reduced, renewable energy is likely to be critical. This is particularly so if deep cuts are eventually implemented. Current government policies (including emissions trading and electricity, the feed-in tariffs announced in 2008), are likely to have only modest impacts on renewable electricity generation in Australia at least until 2020. Australia's renewable electricity base will remain narrow with little solar technologies' contribution before 2020. This will not provide an adequate basis for delivering long-term deep cuts to Australia's greenhouse emissions nor for achieving major greenhouse gas emission reductions at least cost.

The future of Australia's renewable electricity rests mainly with the success, or otherwise, of its Mandatory Renewable Energy Target and expanded Renewable Energy Target. Their effectiveness may be eroded, however, by the long-term banking of tradable certificates used with both target mechanisms. Unless there is a change of policy mechanisms, Australia will probably fail to reach its renewable electricity target of 20 per cent by 2020. Australia will also fail to build up its solar and hot rock geothermal electricity generation capacity to make large supply contributions beyond 2020.

Keywords: Renewable electricity, energy, greenhouse emissions, emissions trading, renewable portfolio standard, feed-in tariff.

Research Report 31

Environmental economics of ethanol production – a brief introduction

**Jonathan Rhys Evers, Professor Tor
Hundloe and Dr Peter Daniels**
Research Report 31, June 2009

By treating organic wastes as a resource, and applying a different method of waste management, organic wastes could contribute significantly to global energy needs.

The ethanol distillation process waste product, stillage, is a soup-like waste stream that contains substantial organic content. By digesting this material three resources are recovered – biogas (80 per cent methane), biosolids (high in nutrients equivalent to high grade fertiliser) and recyclable water.

Current waste treatment in ethanol production focuses on drying the stillage waste and using the resultant material as mulch to be spread over crops. This is an energy intensive, low-benefit, process that increases production cost. If a waste treatment process could convert the waste into a recoverable resource, this would reduce the cost of ethanol production and would ensure all externalities are valued. For example, methane could be re-used as a source of energy in distillation and production.

Unless an economic advantage can be established, there is no true benefit of this type of waste treatment – this is how the economy currently works. All industry and business decisions relate to the bottom line and whether the project will make money (profitability). When a value is put on externalities, it is possible to show whether a project will be profitable. This is so even when considering the impact on the environment and society, not just the economy. Ultimately, when all externalities can be quantified, valued and shown to be positive, the project is sustainable.

This research has been carried out to establish the importance of valuing externalities in relation to the triple bottom line of ethanol production. By using waste treatment to recover resources in ethanol distillation, and using those resources directly in operation, process and production, while at the same time valuing foregone and used externalities, the cost of production should decrease

Values for the externalities can be derived from various references, such as current market value. Carbon now has a value per tonne of emissions established in several markets around the world – these values can be attributed directly to energy use. The value of water has been established through research and can also be attributed to water use

Research Report 32

Estimating non-market values under scenario and policy ambiguity: the case of climate change mitigation in Australia

Sonia Akter and Jeff Bennett

Research Report 32, February 2009

This report proposes an extension to existing models of non-expected utility (NEU) in the stated preference (SP) literature. The extension incorporates the impact of multiple sources of ambiguity in individual decision making behaviour. Empirical testing of the proposed decision model was carried out in Australia using a dichotomous choice contingent valuation study of a national carbon pollution reduction scheme (CPRS).

The results of the study demonstrate that subjective expectations of the context scenario and subjective policy expectations are important determinants of individual decision making in a stated preference framework. The results of the study also demonstrate that decision weight functions are non-linear (quadratic) in subjective scenario expectations and subjective policy expectation. Although evidence was found to link willingness to pay to scenario ambiguity, policy ambiguity was found to have no statistically significant influence on individual decision making.

Keywords: non-expected utility, scenario ambiguity, policy ambiguity, climate change, Australia

JEL codes: C93-D81

Research Report 33

Interfuel substitution: a meta-analysis

David I Stern

Research Report No. 33, June 2009

Interfuel substitutability has been of longstanding interest to energy economists and policy makers. However, there has been no quantitative meta-analysis of this literature.

This research report fills this gap by analysing a broad sample of studies of interfuel substitution in the industrial sector, manufacturing industry or sub-industries, and macro-economy of a variety of developed and developing economies. The primary study sample size has been included in the meta-regression to control for publication bias.

At the industrial level, results for the shadow elasticities of substitution between coal, oil, gas, and electricity for forty-six primary studies show that, except for gas-electricity and coal-electricity, there are easy substitution possibilities between all the fuel pairs. Substitution possibilities seem more constrained at the macro level and less constrained in sub-industries. Estimates also vary across countries.

Publication bias does not appear to be present, but model and data specification issues very significantly affect the estimates derived by each individual study. Estimates from cross-section regressions are generally largest, and fixed effects panel estimates are intermediate. Time-series estimates are mostly much smaller. Econometric research suggests that the fixed effects estimates, although biased downwards, are likely to be the best among the existing studies.

Keywords: Meta-analysis, energy, substitution, elasticity, interfuel

JEL codes: D24, Q40

Research Report 34

Between estimates of the environmental Kuznets curve

David I Stern

Research Report No. 34, July 2009

A recent paper in the *Journal of Environmental Economics and Management* points out that time effects are not uniquely identified in reduced-form models, such as the environmental Kuznets curve. This Research Report proposes a solution that assumes the time effect is common to each pair of most similar countries. The between estimator makes no *a priori* assumption about the nature of the time-effects and is likely to provide consistent estimates of long-run relationships in real-world data situations.

This research applies several common panel data estimators to the data set for carbon and sulfur emissions in the OECD collected by Vollebergh et al. and the global sulfur dataset compiled by Stern and Common. The between estimates of the sulfur-income elasticity are 0.732 in the OECD and 1.157 in the global data set. The estimated carbon-income elasticity is 1.612.

Keywords: carbon, sulfur, environmental Kuznets curve, between estimator

JEL codes: C23, Q53, Q56

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Research Report 35

Costing water quality improvements with auction mechanisms: case studies for the Great Barrier Reef in Australia

John Rolfe and Jill Windle

Research Report No. 35, August 2009

Australian governments continue to commit significant resources to the protection of the Great Barrier Reef. Funding for the Reef Rescue Programme is focused on reducing the impact of agricultural production on water quality.

Information about the costs and benefits of funding proposals is limited. As a result, the key challenge for policy makers is to identify where funding is most efficiently applied. While there is adequate information about the costs of various inputs for reducing water quality, the costs of achieving various outputs is much more limited.

Water quality tenders show the opportunity costs of changing agricultural practices. They allow policy makers to better understand the potential costs of misallocating public resources. It also helps them find better ways to improve water quality. Four pilot applications of tenders to improve water quality flowing into the Great Barrier Reef in Australia demonstrate how they can be used to reveal opportunity costs. The results demonstrate the potential for opportunity costs to vary substantially between agricultural producers, and across industries, catchments and pollutants.

Keywords: auctions, conservation tenders, market based instruments, water quality

Research Report 36

Price floors for emissions trading

Peter John Wood and Frank Jotzo

Research Report No. 36, October 2009

Price floors in greenhouse gas emissions trading schemes can have advantages for technological innovation, price volatility, and management of cost uncertainty. Implementing the schemes, however, has pitfalls.

This research report argues that requiring firms to pay an extra fee or tax is the best way to put a price floor in place. As well as providing budgetary advantages, the fee approach is more compatible with international permit trading than the alternative approaches currently dominating academic and policy debate. The fee approach can also be used for other emissions pricing schemes.

Keywords: price floor, price ceiling, carbon tax, emissions trading, carbon pricing, price and quality controls, Waxman-Markey Bill

Research Report 37

Adaptation to climate change in marine capture fisheries

R. Quentin Grafton

Research Report No. 37, November 2009

This Research Report responds to the challenge for marine capture fisheries of how and when to adapt to climate change. The report presents: (1) a set of fisheries climate change policy options (2) a risk and vulnerability assessment tool and management decision-making framework; and (3) ex ante and ex post climate adaptation possibilities in the marine environment.

The report also includes: (1) a discussion of how management objectives and instruments influence resilience and adaptation; (2) a decision-making process to assess vulnerabilities to climate change and to manage adaptation responses; (3) an inter-temporal framework to help decision-makers know when to adapt; (4) a risk and simulation approach to confront the uncertainties of the possible losses due to climate change and the net benefits of adaptation; (5) an explanation of how adaptive co-management can promote flexible adaptation responses and also strengthen adaptation capacity; and (6) a selection of possible 'win-win' management actions.

Keywords: climate adaptation, climate change, fisheries

Research Report 38

The integration of wind generation within the South Australian region of the Australian National Electricity Market

Nicholas Cutler, Iain MacGill, and Hugh Outhred

Research Report No. 38, November 2009

The analysis presented in this research report is intended to provide insights into likely outcomes of expanding wind generation in South Australia and other regions of the National Electricity Market (NEM). Under the recently legislated expanded renewable energy target, and to improve our understanding of wind integration, this report assesses the interaction between wind generation, electricity demand and regional spot prices.

Market data from current installed wind generation in South Australia over the most recent year were analysed. Our results suggest that electricity demand currently has the greatest influence on spot prices. Fluctuating South Australian wind generation levels, however, do have a significant secondary influence.

Research Report 39

Saving the world but saving too much? Pure time preference and saving rates in integrated assessment modelling

Kathryn Smith

Research Report No. 39, October 2009

There is a need for a rigorous presentation of the determinants of saving rates in models used to evaluate climate change policy. This report provides a detailed investigation of the implications of Stern's parameter choices for saving. This is done firstly in standard neoclassical growth theory and then in Nordhaus's dynamic integrated model of climate and the economy (DICE), a widely used climate policy model that is based on neoclassical growth theory.

In theory and practice, optimal saving rates in the presence of near-zero pure time preference are far from the near-100 per cent ones obtained from simpler models used by several critics of the Stern Review. This report shows that in DICE, for the utility function used in the Stern Review, optimal saving rates do not exceed 32 per cent. When using Stern's revised value for the elasticity of the marginal utility of consumption, this falls to 25 per cent.

Keywords: climate economics; integrated assessment models; economic models; social costs.

Research Report 40

Choice experiments: identifying preferences or production functions?

Fiona Gibson and Michael Burton

Research Report No. 40, November 2009

This report presents an alternative perspective on how respondents consider choice experiment options.

Building on the 'new' model of consumer demand by Stigler and Becker (1977), the report suggests that the attributes within choice experiments are not valued directly. Rather, they are used to generate higher-level improvement in the environment ('constructs'). This implies that to achieve the environmental outcome, what are currently viewed as marginal utilities of attributes are in fact marginal utilities mixed with (subjective) marginal productivity of the attribute.

The research report also proposes that hierarchical information integration methods may allow separate identification of the utility and production functions, and the individual heterogeneity therein.

Research Report 41

People versus planners: social preferences for adaptation to climate change

Leo Dobes

Research Report No. 41, December 2009

Adaptation of natural and human systems to climate change is receiving increased attention. The academic literature covers a wide spectrum of perspectives. Policy considerations, on the other hand, are largely driven by techno-scientific considerations. In particular, these include a risk-management approach. Climate change, however, is inherently uncertain – because the risks cannot be quantified, conventional risk-management approaches are inappropriate.

The 'real options' economic theory is used for least-cost adaptation strategies. Identifying individuals' preferences and priorities is a necessary pre-condition for estimating the benefits of adaptation strategies. Yet little has been done in this area.

As a first step towards estimating individuals' willingness to pay for adaptation measures, this research paper proposes to identify and compare priorities and preferences of planners, communities and individuals.

Research Report 42

Scale and scope effects on communities' values for environmental improvements in the Namoi catchment: a choice-modelling approach

Kasia Masur and Jeff Bennett

Research Report 42, December 2009

This report presents results of research designed to investigate variations in willingness to pay (WTP) estimates across different scales and scopes of environmental investments. The goal is to help catchment management authorities better prioritise their natural resource management actions at both catchment and farm levels.

Five split samples were used to test for scale and scope effects. A choice-modelling (CM) analysis was used to elicit household WTP for improvements in environmental quality attributes in the Namoi catchment. The approach was developed so that value estimates could be more accurately transferred between different action scopes.

Keywords: choice modelling, scale effect, scope effect, embedding, non-market valuation, catchment planning, environment.

Research Report 43

Comparing a best management practice scorecard with an auction metric to select proposals in a water quality tender

John Rolfe and Jill Windle

Research Report No. 43, December 2009

This report compares evaluation frameworks for selecting landholder proposals to improve water quality. A water quality tender performed in the Burdekin region in Northern Australia in 2007/2008 was used as a case study.

Tender bids can be assessed using an inputs-based best management practice scorecard or an outputs-based auction metric. Where landholder proposals are rated by inputs-based criteria, the scorecard approach, and other variants of multi-criteria analysis are commonly applied. Output-based approaches are typically applied in water quality and conservation tenders. This approach uses an environmental benefits index to summarise the cost-effectiveness of each proposal.

The case study evaluation reported in this paper shows how multi-criteria analysis-type assessments are flawed. It demonstrates how public funding efficiency can be more than doubled by using auction metrics to assess landholder water quality improvement proposals.

Keywords: water quality tender, auction metric, best management practice, input-based, output-based, Great Barrier Reef.

Research Report 44

Valuing the control of red imported fire ants in Australia using choice modelling

John Rolfe and Jill Windle

Research Report No. 44, December 2009

Invasive species create particular challenges for policy makers. Some deliberately introduced species contribute significantly to agricultural production and other purposes. However, many invasive weed and animal pests generate substantial costs through impacts on agricultural production, biodiversity, ecosystem services, infrastructure and communities.

An aggressive ant species, the red imported fire ant was introduced by accident to Australia. Infestations were found in Brisbane in February 2001. Modelling suggested that the pest could invade half of Australia within 35 years if it were not controlled. Control of the fire ant has reduced the rate of new discoveries but the ant was still not eradicated by 2009.

The benefits of controlling red imported fire ants are largely non-use. These include avoiding health and environmental impacts as well as maintaining lifestyle and amenity values. In this report, these benefits are assessed using choice modelling, a non-market valuation technique.

Keywords: invasive species, red imported fire ants, choice modelling experiments, non-market valuation.

Research Report 45

Comparing responses from web and paper-based collection modes in a choice-modelling experiment

John Rolfe and Jill Windle

Research Report No. 45, December 2009

To determine whether the collection mode affects sample characteristics and value estimates, paper-based (using drop-off/pick-up) and web-based (using an internet panel) modes were tested. The exercise elicited values from Brisbane respondents for future environmental improvement of the Great Barrier Reef.

The total per survey cost of the paper-based survey was approximately \$70 per survey. The survey took three months to complete. In contrast, the online survey cost approximately \$15 per survey and took two weeks to complete.

The results show there were no differences in gender, education and income levels between the two groups. In the internet group, however, there were more younger and fewer older people.

A comparison of the respondents' willingness to pay (WTP), as well as other model and behavioural indicators, does not indicate major differences between paper-based and web-based collection modes.

Keywords: web-based surveys, internet surveys, paper-based surveys, stated preference, collection mode, choice experiments.

Research Report 46

Testing construct validity of verbal versus numerical measures of preference uncertainty in contingent valuation

Sonia Akter and Jeff Bennett

Research Report 46, January 2010

The numerical certainty scale (NCS) and polychotomous choice (PC) methods are two widely used techniques for measuring preference uncertainty in contingent valuation (CV) studies. The NCS follows a numerical scale and the PC is based on a verbal scale. This report presents results of two experiments that use these preference uncertainty measurement techniques.

The first experiment was designed to compare and contrast the uncertainty scores obtained from the NCS and the PC method. The second experiment was conducted to test a preference uncertainty measurement scale that combines verbal expressions with numerical and graphical interpretations: a composite certainty scale (CCS). The construct validity of the certainty scores obtained from these three techniques was tested by estimating three separate ordered probit regression models.

The results of the study can be summarised in three key findings. First, the PC method generates a higher proportion of 'yes' responses than the conventional dichotomous choice elicitation format. Second, the CCS method generates a significantly higher proportion of certain responses than the NCS and the PC methods. Finally, the NCS method performs poorly in terms of construct validity.

Overall, the verbal measures perform better than the numerical measure. The CCS is a promising method to measure preference uncertainty in CV studies. To better understand its strengths and weaknesses however, further empirical applications are needed.

Keywords: preference uncertainty, contingent valuation, numerical certainty scale, polychotomous choice method, composite certainty scale, climate change, Australia.

JEL codes: Q51, Q54

Research Report 47

Water markets and scarcity: Australia's Murray-Darling Basin and the United States southwest

R. Quentin Grafton, Clay Landry, Gary D. Libecap and R.J. (Bob) O'Brien

Research Report No. 47, December 2009

Australia's Murray-Darling Basin and south western United States share: (1) climate variability resulting in the need for large water storage investment; (2) the need for internal and cross-border (state) water management; (3) an historical over-allocation of water to irrigators; and (4) increasing competition between agricultural and urban demand and in situ environmental and recreational uses.

The ability of water markets in these two regions to mitigate water scarcity is compared in this report. The evaluation suggests that on-going water market reform, along with processes to account for the public interest, can promote equity, environmental sustainability and economic efficiency.

Research Report 48

Additional Action Reserve: A proposed mechanism to facilitate additional voluntary and policy emission reduction efforts in emissions trading schemes

Paul Twomey, Regina Betz, Iain MacGill and Robert Passey

Research Report 48, January 2010

An additional action reserve (AAR) is proposed as a mechanism that allows government and voluntary private interests to make additional emission reductions beyond a national cap. A proportion of Australian emission units (AEUs) is set aside each year. The units can then be retired if state or local government, businesses or individuals take specific emission reduction measures that go beyond those expected from the Carbon Pollution Reduction Scheme (CPRS). AEUs allocated to the reserve that are not retired through additional activities would be made available to CPRS participants.

By providing an upper bound to such actions, the scheme would limit uncertainty about how many permits are available for emitters. The scheme would also provide a limit to the potential losses of auctioning revenue from AEU retirements. Compared with some other additional options (such as buying-and-retiring of permits or future national cap reductions) the scheme combines an open process with favourable accounting features for tangible, psychologically satisfying actions (such as installing a home solar PV system). These actions assure participants there is an immediate reduction in national emissions.

Elements of this approach have already been seen in the Regional Greenhouse Gas Initiative (RGGI), an interstate emissions trading scheme that began in the United States in 2009.

Research Report 49

The effects of a provision rule in choice modelling

Kasia Mazur and Jeff Bennett

Research Report 49, February 2010

This research report investigates the effects of including a provision rule in choice modelling non-market valuation studies. Split samples with and without a provision rule were used to test for differences in household willingness-to-pay for improvements in environmental quality in the Hawkesbury-Nepean catchment. Local/rural and distant/urban sub-samples of residents were selected.

The results of the study show that the inclusion of a provision rule had an effect on preferences in the distant/urban communities; however, the impact of a provision rule in the local/rural community sub-samples was negligible.

Keywords: Choice modelling, incentive comparability, provision rule, non-market valuation, environment

Research Report 50

The value of information in biosecurity risk-benefit assessment: an application to red imported fire ants

Michael Ward and Tom Kompas

Research Report 50, March 2010

Policy makers are confronted daily with uncertainty, especially in complex areas like biosecurity. One way to improve decision-making and reduce uncertainties is to collect more information. Information is costly – whether the value of improved decision-making justifies the cost is a fundamental question facing policy makers.

This paper addresses that question by making three practical contributions for binary choices (such as whether to implement or forego a particular policy). First, it analyses the determinants of the value of information, and how that value changes with features of the problem. Second, it uses this analysis to derive simple rules of thumb which provide upper bounds on the value of additional information. Third, it provides a practical application of the value of information in deciding whether to attempt eradication of the red imported fire ant.

Research Report 51

How ambitious are China and India's emissions intensity targets?

David I. Stern and Frank Jotzo

Research Report 51, March 2010

As part of the negotiating process for a post-Kyoto climate policy regime, several developing economies have announced carbon emission targets for 2020. China and India's commitments are framed as emissions intensity reductions by 40 to 45 per cent and 20 to 25 per cent respectively between 2005 and 2020. But how feasible are these proposed emissions intensity reductions, and how do they compare with the targeted reductions in the United States and the European Union?

In this research report we use a stochastic frontier model to explain the variation in countries' energy intensities. We use the model to produce emissions projections for China and India under a number of scenarios that consider various rates of technological change and changes in the share of non-fossil energy. We find that China is likely to need to adopt ambitious carbon mitigation policies in order to achieve its stated target, and that its targeted reductions in emissions intensity are on par with those implicit in the United States and European Union targets. India's target is less ambitious and might be met with only limited or even no dedicated mitigation policies.

Keywords: carbon emissions, climate change, developing countries, projections

JEL codes: O13, Q54, Q56, Q58

Research Report 52

Effects of alternative elicitation formats in discrete choice experiments

Gabriela Scheufele and Jeff Bennett

Research Report 52, March 2010

An elicitation format prevalently applied in discrete choice experiments (DCEs) offers each respondent a sequence of choice tasks. Each choice task contains more than two choice options. Empirical evidence shows, however, that repeated choice tasks influence choice behaviour through institutional learning, fatigue, value learning and strategic response.

The study reported in this paper uses a split sample approach. This approach was based on field surveys using a single binary elicitation format. To expand the research on effects of sequential binary DCE formats, a majority vote baseline was used. We present evidence for effects caused by institutional learning, and by either strategic behaviour or value learning, after respondents answered repeated choice questions. However, we did not find any indications for strategic behaviour in respondents caused by their awareness of having multiple choices.

The decision to use a sequential or a single elicitation format may therefore imply a trade-off between decreased choice accuracy and potentially increased strategic behaviour in respondents. This trade-off is due to an incentive incompatible mechanism. Further research is needed to explore strategic behaviour induced by incentive incompatible elicitation formats, using alternative approaches that are not compromised by a confounded baseline, that facilitate the differentiation between value learning and strategic behaviour, and that allow the use of less restrictive model specifications. Such research should also investigate the effects of varying incentives induced by the order in which choice questions are presented to respondents.

Keywords: discrete choice experiments, split sample approach, elicitation format, incentive compatibility, strategic behaviour, learning effects, panel mixed logit models

Research Report 53

An integrated assessment approach to linking biophysical modelling and economic valuation tools

Marit Kragt, Jeff Bennett and Tony Jakeman

Research Report 53, March 2010

Natural resource management (NRM) typically involves complex decisions that affect a variety of stakeholder values. Efficient NRM, which achieves the greatest net environmental, social and financial benefits, needs to integrate the assessment of environmental impacts with the costs and benefits of investment. Integrated assessment (IA) is one approach that incorporates the several dimensions of catchment NRM, by considering multiple issues and knowledge from various disciplines and stakeholders. Despite the need for IA, there are few studies that integrate biophysical modelling tools with economic valuation.

In this paper, we demonstrate how economic non-market valuation tools can be used to support an IA of catchment NRM changes. We develop a Bayesian Network model that integrates: a process-based water quality model; ecological assessments of native riparian vegetation; estimates of management costs; and non-market (intangible) values of changes in riparian vegetation. This modelling approach illustrates how information from different sources can be integrated in one framework to evaluate the environmental and economic impacts of NRM actions. It also shows the uncertainties associated with the estimated welfare effects. By estimating the marginal social costs and benefits, a cost-benefit analysis of alternative management intervention can be gained and provides more economic rationality to NRM decisions.

Keywords: Bayesian networks; bio-economic modelling; catchment management; cost-benefit analysis; environmental values; integrated assessment and modelling; non-market valuation; riparian vegetation

Research Report 54

Modelling international trends in energy efficiency and carbon emissions

David I. Stern

Research Report 54, March 2010

This study uses a stochastic production frontier to model energy efficiency trends, in 85 countries over a 37 year period. No structure is imposed on technological change over time, although differences in technology level across the countries are modelled as a stochastic function of explanatory variables. These variables are selected by a literature survey and a theoretical model of energy-efficient technology choice.

An improvement in a country's energy efficiency is measured as a reduction in energy intensity, while holding constant that economy's mix of inputs and outputs. All other things remaining constant, the country using the least energy per unit output is on the global best-practice frontier. The model is used to derive decompositions of energy intensity and carbon emissions. It also examines whether there is a convergence across countries.

The study shows that energy efficiency rises with increasing general total factor productivity. Energy efficiency is also higher in countries with undervalued currencies. Higher fossil fuel reserves are associated with lower energy efficiency.

Energy efficiency converges over time across countries. Technological change was the most important factor counteracting the effect of economic growth in increasing global energy- use increase and carbon emissions.

Keywords: Energy, efficiency, carbon, emissions, technological change, between estimator

JEL codes: O13, O33, O47, Q43, Q54, Q55, Q56

Research Report 55

Prerequisites and limits for economic modelling of climate change impacts and adaptation

Frank Jotzo

Research Report 55, March 2010

There is demand for qualitative and quantitative economic analysis on the optimum degree of climate change mitigation and adaptation, the optimal timing of such actions, and their optimum distribution between countries and sectors.

This paper discusses what is, as well as what is not, possible for economic modelling in this field. Specific reference is made to the paper by Bosello, Carraro and de Cian (2009), as well as Tol (2009).

Integrated assessment modelling can provide powerful qualitative insights (for example, about the need for both mitigation and adaptation and the interactions between the two, or the need for both individual and policy-driven adaptation). However, the more detailed quantitative results from such studies are extremely limited. In many cases, they are virtually irrelevant as a policy guide.

For these models to be useful representations of reality, economic climate change models need three important features: representation of uncertainty about impacts (in particular, the risk of abrupt climate change); fuller representation of economic impacts from climate change and inclusion of non-market impacts; and finally, modelling of equity dimensions. These features are absent in many models currently used. This leads to a tendency for quantitative results to be biased against mitigation as an option to address climate change and in favour of other adaptation.

Research Report 56

Restricted versus unrestricted choice in labelled choice experiments: Exploring the trade-offs in expanding choice dimensions

Jill Windle and John Rolfe

Research Report 56, March 2010

The main objective of this study was to examine how the inclusion of an additional labelled alternative – to provide respondents with more choice in a stated preference survey – impacted on choice complexity. The valuation context was to elicit preferences for improvements in the future condition of the Great Barrier Reef, in Australia.

A split-sample experiment was implemented in which one survey included four labelled alternatives: a status quo option and three specific policy management options (restricted choice). The other survey provided respondents with an unrestricted choice set, by including a fifth option labelled 'a combination of management options'. While the additional option improved opportunities to find an attractive choice profile, adding an extra alternative increased the complexity of the survey. The trade-off between choice flexibility and complexity is examined in terms of changes in the choice behaviour of respondents and the performance of the different models.

The results provide some evidence that adding a combination policy alternative did change the ways that respondents viewed trade-offs, but that choice behaviour and subsequent value estimates were consistent across the two survey formats.

Keywords: Choice complexity, choice modelling experiments; labelled alternatives; policy management options; multiple alternatives.

Research Report 57

Measuring the value of protecting the Great Barrier Reef with choice modelling by management policy options

John Rolfe and Jill Windle

Research Report 57, January 2010

This paper reports on the results of a choice-modelling experiment to value increased protection of the Great Barrier Reef in Australia. There are very few previous studies that identify protection values for the Great Barrier Reef. This makes it difficult to evaluate whether community benefits from future additional protection are greater than the costs involved.

The valuation experiment tests whether the improvements mechanisms are important to respondents. The experiment is unique in two important ways. First, different management policies to increase protection have been included as choice experiment labels. Second, the level of certainty associated with predicted reef health has been included as an attribute in the choice profiles, helping to distinguish between the management policy outcomes.

The results show that protection values vary with the policy scope of the considered improvements. Values are sensitive to whether protection will be generated by improving water quality entering the reef, increasing conservation zones or reducing greenhouse gas emissions. They are also sensitive to how certain the outcomes are.

The average household's willingness-to-pay for five years, for each additional one per cent of protection, is approximately \$26.37 (when the broad management options to generate improvements were included in the choice sets). These results can be extrapolated to a total value held by Queensland households of \$132.8 to \$171.5 million per one per cent improvement, depending on assumptions about the discount rate.

Research Report 58

Tradeable green certificates as a policy instrument? A discussion on the case of Poland

Christoph Heinzl and Thomas Winkler

Research Report 58, March 2010

Quota obligation schemes based on tradeable green certificates to expand power generation from renewable energy sources (RES) have become popular. However, applying these policies cannot be justified as a first-best response to a market failure. If there is an emissions trading scheme (ETS) that fully covers the energy industry, these policies can also not be justified as a second-best response to mitigate the distorting effects of the emissions externality,.

Overcoming barriers for RES use and establishing beneficial side effects (such as industry development, energy security and abatement of pollutants not covered under the ETS) are ancillary reasons we studied in the recently-introduced scheme in Poland. While setting substantial expansion incentives (an advantage for local industry), job-market development or energy security can hardly be seen.

We expect a negative impact on social acceptance for RES and RES-deployment support policies. This is a result of rising power prices for end-consumers and awareness that the extra rents from the schemes mostly accrue to foreign investors, and renewable and polluting generators.

Keywords: tradeable green certificates, environmental policy, Poland

Research Report 59

Initial allocation effects in permit markets with Bertrand output oligopoly

Evan M. Calford, Christoph Heinzl and Regina Betz

Research Report 59, March 2010

This research report analyses the efficiency effects of the initial permit allocation given to firms that have market power in both permit and output markets. We examine two models: a long-run model with endogenous technology and capacity choice, and a short-run model with fixed technology and capacity.

In the long-run, quantity pre-commitment with Bertrand competition can yield Cournot outcomes. This is also the case under emissions trading. In the short-run, Bertrand output competition reproduces the effects derived under Cournot competition, but displays higher pass-through profits. In a second-best setting of over-allocation, a tighter emissions target tends to improve permit-market efficiency in the short-run.

Keywords: Emissions trading, initial permit allocation, Bertrand competition, EU ETS, endogenous technology choice, Kreps and Scheinkman

JEL codes: L13, Q28, D43

Research Report 60

The value of tropical waterways and wetlands: does an increase in knowledge change community preferences?

Abbie McCartney, Jonelle Cleland and Michael Burton

Research Report 60, May 2010

Choice modelling was used to investigate how information and understanding influences the public's preferences for conserving the natural environment. For this study respondents were asked to make conservation choices about the tropical waterways and wetlands of the Kimberley region in Western Australia. This paper is part of a larger study investigating preference divergence for environmental systems between experts and non-experts. By giving the public information about complex environmental problems, it might be expected respondents would form preferences similar to those of experts. A preliminary analysis of public low and high information samples found that, when bird and plant species are the focus of tropical waterway conservation, increased information does not significantly impact preferences. When fish species conservation is considered, however, significant differences were found. By placing higher values on fish species conservation, individuals appear to have reacted favourably to the additional information. This indicates a recognition that rare species need more protection than widespread iconic species. Over all of the attributes considered, respondents generally preferred high levels of conservation improvements rather than lower incremental improvements.

These results should be interpreted with care, however. The alternative specific constant needs to be further investigated, as well as the inclusion of individual characteristics to explain sample heterogeneity.

Research Report 61

Inducing strategic bias: implications for choice-modelling design

Michael Burton

Research Report 61, May 2010

It has been suggested that the task of responding within a multi-attribute multi-alternative choice experiment may be complex enough to make it difficult for individuals to give responses that strategically bias their answers

Our experiment tested that hypothesis by setting conditions to give incentives for strategic bias. By changing design parameters it is possible to investigate whether the strategic bias can be reduced.

The answer is 'No'. Under most circumstances, respondents could find a strategy that achieved significant bias in inferred preferences. The circumstances where this did *not* occur, involved ranking of alternatives, rather than selecting a single preferred alternative. With ranked alternatives, the inferred preferences reflected neither the intended bias, nor their original preferences. This made the answers useless to both respondent and researcher.

Keywords: Strategic bias, choice modeling, complexity

JEL codes: Q51, C91

Research Report 62

Climate change and game theory

Peter John Wood

Research Report 62, May 2010

This survey paper examines the problem of achieving global cooperation to reduce greenhouse gas emissions. Contributions to this problem are reviewed from non-cooperative game theory, cooperative game theory, and implementation theory.

Solutions to games where players have a continuous choice about how much to pollute, games where players make decisions about treaty participation, and games where players make decisions about treaty ratification, are examined. The implications of linking cooperation on climate change with cooperation on other issues (such as trade) is investigated. To examine the behaviour of coalitions that cooperate on climate change, we investigate cooperative and non-cooperative approaches to coalition formation.

One way to achieve cooperation is to design a game (known as a mechanism) whose equilibrium corresponds to an optimal outcome. This paper examines some mechanisms based on conditional commitments that could lead to substantial cooperation.

Keywords: Climate change negotiations, game theory, implementation theory, coalition formation, subgame perfect equilibrium

Research Report 63

Where is it cheapest to cut carbon emissions?

David I Stern and N Ross Lambie
Research Report 63, June 2010

The relative cost of carbon emissions reductions across regions depends on whether we measure cost by marginal or total cost, or private or economy-wide cost. It also depends on whether we use market or purchasing power parity exchange rates. If all countries are on the same marginal carbon abatement cost curve, then lower marginal costs of abatement are associated with higher energy intensities and higher total costs of abatement.

We test this conjecture using the results of the GTEM computable general equilibrium model as presented in the Australian Treasury Department's climate change economics review. Rankings of countries by costs do differ depending on whether marginal or total cost is used. But some regions, including OPEC and the former USSR, have high marginal costs and high emissions intensities and, therefore, high total costs. Others, like the EU, have relatively low marginal and total costs.

Under a global emissions trading regime, real economy-wide abatement costs are higher in those developing economies that have currencies valued below purchasing power parity. There are also large differences between private and economy-wide costs, in countries such as in India, which contribute to the high GDP losses experienced in those countries.

Keywords: Climate change, costs, developing countries, computable general equilibrium

JEL codes: Q52, Q54

Research Report 64

A systems approach to liveability and sustainability: defining terms and mapping relationships to link desires with ecological opportunities and constraints

Jacqueline de Chazal
Research Report 64, June 2010

This research report offers a protocol for assessing the sustainability of liveability. Drawing on a framework that assesses vulnerability, the protocol offers two key features. The first is a capacity to incorporate multiple and shifting stakeholder values. The second is a means of moving from expressions of liveability to underlying ecological attributes that deliver or constrain system change.

I have used ecological and social data collected from a study site in the French Alps to show how these features apply to liveability and sustainability. This research report also presents a reappraisal of both of these terms as a result of system change.

To complicate the situation, the central place of values intrudes into liveability and sustainability. Even so, the protocol presented here is able to ground the abstractions and equivocations in open and explicit announcements. The openness of the study allows for consistency of comparison and replication without artificially removing the labile flexibility necessarily embedded in liveability and sustainability.

Research Report 65

Do values for protecting iconic assets vary across populations? A Great Barrier Reef case study

John Rolfe and Jill Windle

Research Report 65, May 2010

The effects of distance decay, and the influence it might have on both use and non-use values, have been examined in a number of studies. However, the relationship between environmental values and distance effects is less clear-cut when iconic or special assets are involved. Using two split-sample choice experiments, the effects of distance decay on protection values of Australia's Great Barrier Reef are explored in this report. The results suggest that the Townsville (local) population has larger use values than the Brisbane (distant) population. However, for iconic resources where perceptions of responsibility, substitutes and information are reasonably consistent across population groups, non-use values remain constant across spatially different populations.

Keywords: Choice-modelling experiment, distance decay, population effects, iconic assets, Great Barrier Reef, use values, non-use values

Research Report 66

Valuing environmental improvements in the Great Barrier Reef: Ecological and preference heterogeneity in local area case studies

John Rolfe and Jill Windle

Research Report 66, May 2010

Protection values at a particular Great Barrier Reef (GBR) site were tested to find out if the values could be easily transferred to other sites in the region. Three local case studies in the GBR were valued and tested for consistency across site and population characteristics. The sites were chosen to reflect substantial heterogeneity in extent, ecological composition and condition. Values were assessed for both local and distant populations.

The results are encouraging. Significant heterogeneity was identified with the mixed logit models and values were robust to various site and population differences. No significant difference in protection values between the three local case studies could be identified. There was also no significant difference in values between the local population and the Brisbane population. However, some evidence for distance effects was identified for the Brisbane population, with closer sites valued more highly. As well, potential losses were valued more highly (in absolute terms) than potential gains. These results imply that protection values are likely to be higher for closer reef areas at risk of loss than those with opportunity for improvement.

Keywords: Choice modelling, benefit transfer, population effects, Great Barrier Reef, willingness-to-pay, willingness-to-accept

Research Report 67

Using choice modelling to assess the willingness to pay of Queensland households to reduce greenhouse emissions

Galina Ivanova, John Rolfe and Gail Tucker

Research Report No. 67, May 2010

This paper presents the results of a choice-modeling survey of households in Queensland to assess values for national greenhouse emissions reductions by 2020. The study is novel in two main ways. First, labeled alternatives were used to assess whether the types of broad management options for reducing net emissions (green power, alternative technologies or carbon capture) are significant in understanding preferences for emissions reduction. Second, the importance of the level and type of uncertainty involved in reductions was tested. They include (1) the uncertainty of achieving emissions reduction and (2) the uncertainty about international participation (delivering greater control and emission reductions through international agreements). The results of this survey identified that choice responses vary when the level of uncertainty associated with emissions reduction options are included within choice alternatives.

Research Report 68

Tax-Versus-Trading and Free Emission Shares as Issues for Climate Policy Design

John C.V. Pezzey and Frank Jotzo

Research Report No. 68, September 2010

We give empirical welfare results for global greenhouse gas emission control, using the first multi-party model to combine tax-versus-trading under uncertainties with revenue recycling. Including multiple parties greatly reduces the welfare advantage of an emissions tax over emissions (permit) trading in handling abatement-cost uncertainties, from that shown by existing, single-party literature. But a tax has a different, much bigger advantage, from better handling uncertainties in business-as-usual emissions. Either mechanism's free emissions share, from tax thresholds or free permits, which lowers its possible welfare gain from revenue recycling, may however dominate any tax-versus-trading advantage. Moreover, political and practical constraints, such as the political unacceptability of no free emissions, the institutional unavailability of efficient emissions tax thresholds, and the unpopularity of recycling revenue as conventional tax cuts, make ideal welfare maximisation a poor guide for mechanism choice; and at optimal prices, trading currently tends to outperform taxation.

Keywords: climate policy, emission pricing, tax vs. trading, uncertainties, revenue recycling, political economy

JEL codes: D810, H230, Q580

Research Report 69

Testing for geographic scope and scale effects with choice modelling: Application to the Great Barrier Reef

John Rolfe and Jill Windle

Research Report No. 69, September 2010

Choice modelling experiments testing the consistency of values across differently scoped dimensions of an environmental asset are reported. Identifying whether protection values for one part of the Great Barrier Reef (GBR) in Australia can be transferred to different sections was the key policy question of this case study. Twelve split-samples in three choice-modelling experiments were used to assess values for the whole GBR; a regional section of the GBR; and a local reef area. Variations were controlled across populations, the scope of the choice tasks, and survey formats.

The results demonstrate that geographic scope and scale issues remain challenging in choice-modelling experiments. Contrary to expectations, the proportional values for different regions of the GBR remained consistent when geographic scope and scale increased, while absolute values declined. This was despite substantial efforts to define the amenity of interest to respondents through design and presentation of the survey. The results indicate that it is difficult to identify single-unit values for an environmental amenity that can be easily transferred and extrapolated across geographic regions and scales. However, there may be good theoretical reasons why marginal values for specific areas of interest in the GBR have much higher protection values. These marginal values then decline as larger and more general areas are considered.

Research Report 70

A Rule of Thumb for Controlling Invasive Weeds: An Application to Hawkweed in Australia

Tom Kompas and Long Chu

Research Report No. 70, September 2010

To derive a rule of thumb for optimal invasive weeds management, in terms of marginal benefits and costs, we use a bang-bang optimal control model. Instead of determining the size of infestation under an optimal surveillance measure, the rule specifies the types of land where establishment of an invasive weed should be first prevented. It also specifies under what conditions control should be initiated. The types of land are modelled via the heterogeneous vulnerability of land to the weed and likely infestation.

This easy-to-use rule is applied to determine how hawkweed should be controlled in Australia, across three potential control strategies: containment, eradication and no action. We investigate this rule-of-thumb in both deterministic and stochastic settings. When calculating the threshold of when and how to act, we take into account that delaying control action will incur not only greater damage and a potentially larger spread, but also a higher cost from uncertainty in the spread of the weed itself. The land value threshold is thus given by the unit cost of keeping a weed off a parcel of land, multiplied by the difference between the interest rate and the current weed-spread rate, plus the uncertainty effect.

An application to hawkweed in Australia is provided. The rule specifies that hawkweed should be immediately eradicated in all types of agricultural lands the weed currently occupies where the potential damage is larger than 15AUD per hectare per year. This generates a full eradication strategy under broad parameter values. Although the cost of removing hawkweed is significant, it is overwhelmed by the damage if hawkweed spreads to higher value agricultural land.

Keywords: Stochastic optimal control, biosecurity, invasive weed management, hawkweed

Research Report 71

A Comparison of Parametric Approximation Techniques to Continuous-Time Stochastic Dynamic Programming Problems

Tom Kompas and Long Chu

Research Report No. 71, September 2010

We compare three parametric techniques to approximate Hamilton-Jacobi-Bellman equations via uni-dimensional and multi-dimensional problems. The linear programming technique is very efficient for uni-dimensional problems and offers a balance of speed and accuracy for multidimensional problems. A comparable projection technique is shown to be slow, but has stable accuracy. A perturbation technique has the least accuracy although its speed suffers least from the curse of dimensionality. The linear programming technique is also shown to be suitable for resource management problems, including biosecurity and marine reserve design applications.

Keywords: stochastic dynamic programming, parametric approximation, perturbation, projection, linear programming, optimal fishing, marine reserves.

JEL codes: C61, C63, Q22

Research Report 72

Assessing national values to protect the health of the Great Barrier Reef

John Rolfe and Jill Windle

Research Report No. 72, October 2010

The Great Barrier Reef (GBR) is a vast iconic environmental asset covering an area of approximately 35 million hectares. It is valued by people all over Australia, as well as overseas. Non-market values for the GBR will comprise both use and non-use values. The values of people who live closer to the GBR and who can visit it more frequently are likely to be higher than those who live further away.

The aim of this study was to estimate the values to protect the health of the GBR at the national level and to examine the effects of distance decay on valuation estimates. A split-sample choice-modelling experiment was conducted in six locations: a regional town within the GBR catchment area (Townsville); Brisbane, the state capital approximately 450 km from the southern limit of the GBR; and four other capital cities (Sydney, Melbourne, Adelaide and Perth) ranging from 730 km to over 3600 km from Brisbane.

The results indicate that the total national value for a 1 per cent improvement in the health of the GBR ranges from between a low of approximately \$433.6 million to a high of \$811.3 million, depending on the underlying assumptions made. There was some evidence of distance decay in values. Most decline occurred once outside the home state, and little further decline once away from the east coast. There was no evidence to suggest any difference in patterns of use and non-use values. The values of the potential future users were most influential in determining WTP estimates.

Research Report 73

Valuing Ecosystem Services to Agricultural Production to Inform Policy Design: An Introduction

Emma Aisbett and Marit Kragt
Research Report No. 73, October 2010

There is an ongoing policy debate regarding both how much government intervention there should be to protect ecosystems affected by agriculture, and how the costs of these interventions should be distributed across different interest groups. In accordance with the policy focus in most countries, the majority of the valuation literature on ecosystem services and agriculture estimates the benefits that managed agricultural landscapes can provide to the rest of society. We argue, however, that the efficiency and equity of policies for ecosystem services related to agriculture can be further enhanced by understanding the value and sources of ecosystem services that agricultural production *receives*. With this in mind, we survey studies and techniques for estimating the value of ecosystem services to agricultural production.

Research Report 74

B_{MEY} without apologies

R. Quentin Grafton, Tom Kompas, Nhu Che, Long Chu and Ray Hilborn
Research Report No. 74, October 2010

Recent re-examination of the economics of overexploitation has shown in four fisheries that under reasonable discount rates, the fish biomass that maximizes the present value of the net profits from harvesting (denoted by dynamic B_{MEY}), exceeds the biomass that maximises the sustained yield (B_{MSY}). In fisheries this finding has prompted a biomass targets debate. It has been claimed that adopting dynamic B_{MEY} as a target: (1) promotes private interests in fisheries at the expense of the public good; (2) may increase the risk of biological overfishing; and (3) is incomplete in that it ignores the processing sector and other legitimate fisheries management objectives (such as maximising employment).

This paper responds to these criticisms by providing a comprehensive overview and new results in terms of dynamic B_{MEY} that accounts for both the harvesting and processing sectors as well as the interests of consumers and fish producers. To better understand the possible profit-employment trade-offs from adopting a dynamic B_{MEY} target, the present value of increased profits at dynamic B_{MEY} is compared with the losses in permanent employment in the Western and Central Pacific tuna fisheries.

Keywords: fisheries, maximum economic yield, maximum sustainable yield, employment, fish processing

Research Report 75

Applying Real Options to Climate Change Adaptation Measures, with examples from Vietnam

Leo Dobes

Research Report No. 75, November 2010

Uncertainty is the hallmark of climate change and a common factor in all adaptation measures. The timing, intensity and location of climate change impact is not precisely known. Because most deterministic analyses and policy prescriptions ignore this uncertainty, their recommendations are likely to waste community resources. Except by chance, adaptation measures will either be over-engineered, or they will be inadequate. The result will be a waste of community resources.

Real options thinking, however, is an incremental and flexible approach. Adaptation measures are implemented only as better knowledge becomes available. In this paper, several examples are given of real options in the Mekong Delta comparing net present values of two housing alternatives. To ensure that the value of any option is weighed against other costs and benefits, net present value calculations are essential when comparing different projects

Acknowledgements

Leo Dobes is grateful to Professor Stephen Howes for comments on an earlier version, and to Ross Lambie for very useful discussions on the pricing of real options and for comments on various drafts. Special thanks are due to Nguyen Van Kien for his generosity in sharing his knowledge of rural life in the Mekong Delta as well as his photographs.

Research Report 76

Choice experiment framing and incentive compatibility: observations from public focus groups

Abbie McCartney and Jonelle Cleland

Research Report No. 76, November 2010

The hypothetical nature of choice modelling surveys makes it difficult to enforce incentive compatible properties. Given that the hypothetical choice scenarios and payment structure are not binding, it is thought that bias may result from strategic behaviour and untruthful responses.

This study examines three methods of addressing incentive compatibility through survey framing: (1) a statement of consequence; (2) use of an 'honesty' script that openly explains how the data are to be analysed and used; and (3) use of a provision rule that defines how survey outcomes relate to actual implementation.

Focus groups were held with members of the public to investigate participants' reactions to the three framing treatments. The provision rule emerged as the preferred more realistic treatment. The rule did not need to be 100 per cent binding to have the desired effect of inducing realism. However, the participants did not believe that their responses to the choice scenarios would have changed between framing treatments. Empirical testing is needed to find out if this is actually the case.

How participants interpreted the general choice scenario instructions (particularly in terms of answering questions independently and as an individual consumer) was reassuring. This provides evidence that respondents make choices in response to the questions as they are intended by the researcher.

Research Report 77

Putting the Spotlight on Attribute Definition: Divergence Between Experts and the Public,

Jonelle Cleland and Abbie McCartney
Research Report No. 77, December 2010

One of the key stages of designing a choice experiment is to define the attributes of interest. The attributes chosen essentially influence all subsequent activities carried out in a choice study. Surprisingly, the process of attribute definition is not the subject of critical and ongoing inquiry.

In the context of informing policy, the choice modelling literature suggests that a given set of attributes should (1) reflect public interests, (2) have a sound scientific basis, and (3) provide useful information to end-users. Fulfilling all criteria presents a challenging task to researchers. Conflicts between criteria are possible, and there are currently no guidelines to assist researchers in negotiating their way through potentially competing sets of information and viewpoints.

We investigated the potential for divergence between members of the public and scientific experts. The investigation was carried out across three environmental systems which differed according to their scale and institutional setting. The results showed that attribute definitions do indeed diverge. Critical points of divergence observed across all case studies included: the way in which the public and experts defined attributes that represented the biodiversity of the system; the public's inclusion of attributes that represented the terrestrial/marine interface; and the public's inclination to aggregate attributes when asked to choose their top picks. A number of additional points of divergence were observed, but these were case specific.

Research Report 78

Comparing the Copenhagen emissions targets

Frank Jotzo

Research Report No. 78, November 2010

Following the Copenhagen climate Accord, developed and developing countries have pledged to cut their greenhouse gas emissions, emissions intensity or emissions relative to baseline. This analysis puts the targets for the major countries on a common footing, and compares them across different metrics. Targeted changes in absolute emissions differ markedly between countries, with continued strong increases in some developing countries but significant decreases in others including Indonesia, Brazil and South Africa, provided reasonable baseline projections are used. Differences are smaller when emissions are expressed in per capita terms. Reductions in emissions intensity of economies implicit in the targets are remarkably similar across developed and developing countries, with China's emissions intensity target spanning almost the same range as the implicit intensity reductions in the United States, EU, Japan, Australia and Canada. Targeted deviations from business-as-usual are also remarkably similar across countries, and the majority of total global reductions relative to baselines may originate from China and other developing countries. The findings suggest that targets for most major countries are broadly compatible in important metrics, and that while the overall global ambition falls short of a two degree trajectory, the targets by key developing countries including China can be considered commensurate in the context of what developed countries have pledged.

Keywords: Copenhagen Accord, emissions targets, emissions intensity, business-as-usual, cross-country comparison.

Acknowledgements

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Research Report 79

Putting the Spotlight on Attribute Definition: a Knowledge Base Approach

Jonelle Cleland and Abbie Rogers
Research Report No. 79, December 2010

Attributes definition is a crucial, yet neglected topic of critical inquiry in the choice modeling literature. In a policy context, attributes should reflect public interests. However, guidance on how to go about achieving this criterion is lacking. To address this concern, we offer a novel approach to attribute definition – the knowledge base approach. A knowledge base is the particular 'lens' through which a shared understanding of a topic is gained (i.e. different groups of people view the world in different ways). Knowledge bases have been used in evidence-based policy to account for different sources of information and perspectives in complex policy settings, with the intention of improving policy and program development. The knowledge base approach was applied to the design of a choice experiment, specifically looking at conservation priorities for the waterways and wetlands in the Kimberley region of Western Australia. We conclude that the approach is both comprehensive and expedient, and could improve the selection of attributes for choice experiments that value policy or program change.

Research Report 80

Comparing Scientist and Public Preferences for Conserving Environmental Systems: A Case of the Kimberley's Tropical Waterways and Wetlands

Abbie Rogers and Jonelle Cleland
Research Report No. 80, December 2010

This study uses choice modelling to investigate public and expert preference divergence through a valuation of the Kimberley's tropical waterways and wetlands in Western Australia. A sample of Australian tropical river scientists participated in an identical survey to the West Australian public. Within the public sample, a split survey design is utilised to examine the effects of information on preferences – a low information version provided sufficient information for respondents to participate in the survey, while a high information version provided a more thorough and detailed description of the attributes. Divergent preferences are apparent between the public and scientist samples. This is illustrated through two key results: first, an attempt to merge the data for each of the samples is rejected; and second, there are differences in conservation preferences. The scientists had stronger preferences to protect system based attributes and threatened species, and were generally not willing to pay to protect iconic attributes. The public, on the other hand, held positive and more evenly spread values for all attributes. Information had an impact on public preferences, particularly through the rejection of a combined low/high information model, but also with respect to the iconic species attribute, where there is a pattern of decreasing willingness to pay as information level increases.

Research Report 81

Revegetation of Regent Honeyeater habitat in the Capertee Valley: a Cost-Benefit Analysis

Tertius Greyling and Jeff Bennett

Research Report No. 81, December 2010

This study considers the costs and benefit of the Regent Honeyeater Project in the Capertee Valley over the past 10 years. The benefits are estimated using choice modelling and the costs are based on project expenditure and forgone agricultural production. A comparison of the benefits and costs yields a benefit-cost ratio (BCR) of 4.45, which implies that the benefits outweigh the costs. However, variation in the underlying assumptions reveal significant sensitivity to the uncertainty associated with the maturation of native tree plantings and the successful establishment of a significant population of birds within the native vegetation. The Cost Benefit Analysis (CBA) is dominated by the benefit derived from protection of the native species (i.e. the Regent Honeyeater) which in turn depends on these two uncertainties. By expanding the total area of land being revegetated and reducing the fragmentation amongst individual plantings these uncertainties can be reduced. This should deliver larger benefits and further improve the BCR.

Keywords: Cost-benefit analysis, Benefit-cost ratio, Choice modelling, Regent Honeyeater, Capertee Valley

Research Report 82

Examining resilience and vulnerability as concepts conditional upon human values: a review

Jacqueline de Chazal

Research Report No. 82, December 2010

Whilst there has been progress in understanding the role that values play in determinations of vulnerability and resilience, I suggest some key points continue to be overlooked. I offer three propositions to describe how values underpin such concepts, summarised as 'no fixed characterization', 'no fixed relationships' and 'no fixed trends'. These propositions are not new and have been made in other contexts. Based on a literature review of vulnerability and resilience in the global environmental change area, I elaborate on how these propositions are not adequately accommodated, in particular in relation to ideas of biophysical and social vulnerability, specified versus general resilience, and assignments of desired trend direction (increasing resilience or decreasing vulnerability). I conclude that irrespective of the concept label, characterisations and assessments of ecosystems and their attendant change are inescapably dependent on values.

Research Report 83

Non Use Economic Values of Marine Protected Areas in the South-West Marine Region

Robert Gillespie and Jeff Bennett

Research Report No. 83, December 2010,
Revised March 2011

Australian governments are committed to the expansion of marine protected areas (MPAs) in Australian waters and have already established over 200 MPAs. However, this policy direction has a range of costs and benefits for the community which have largely remained unquantified. One of the main benefits of establishing MPAs are the non use values that the community for the protection of marine biodiversity. This study uses a dichotomous choice contingent valuation format with follow-up open-ended willingness to pay question to estimate these non use values for the establishment of MPAs in South-west Marine Region of Australia.

It was found that on average Australian households would be WTP \$104 for the establishment of MPAs that cover 10% of the South-west Marine Region. Aggregating this mean WTP estimate to 50% of the population of Australian households gives an aggregate WTP of \$400M.

However, whether the establishment of MPAs in the South-west Marine Region is economically efficient requires a consideration of all the potential costs and benefits. Other relevant costs and benefits for inclusion in a benefit cost analysis would include those associated with displacement of commercial and non-commercial uses, additional planning, compliance and monitoring costs as well as any predicted increases in commercial and non-commercial use values.

If the net costs of establishing MPA over 10% of the South-west Marine Region are less than \$400M, then the non-use benefits of establishing MPAs would exceed the other net costs and it would be considered to

be economically efficient and desirable from a community welfare perspective.

Given the difficulties of estimating precise WTP values from dichotomous choice data, any BCA of MPAs in the South-west Marine Region, incorporating the results of this study, should undertake sensitivity testing that includes the range of values reported including dichotomous choice and open-ended means to determine the robustness of BCA results to variations in the welfare estimate

Research Report 84

Assessing community values for reducing agricultural emissions to improve water quality and protect coral health in the Great Barrier Reef

Jill Windle and John Rolfe

Research Report No. 84, November 2010

Key policy issues relating to protection of the Great Barrier Reef from pollutants generated by agriculture are to identify when measures to improve water quality generate benefits to society that outweigh the costs of reducing pollutants. The research reported in this paper makes a key contribution in several key ways. First, it uses the improved science understanding about the links between management changes and reef health to bring together the analysis of costs and benefits of marginal changes, helping to demonstrate the appropriate way of addressing policy questions relating to reef protection. Second, it uses the scientific relationships to frame a choice experiment to value the benefits of improved reef health, and links improvements explicitly to changes in 'water quality units'. Third, the research demonstrates how protection values are consistent across a broader population, with some limited evidence of distance effects. Fourth, the information on marginal costs and benefits that are reported provide policy makers with key information to help improve management decisions. The results indicate that while there is potential for water quality improvements to generate net benefits, high cost water quality improvements are generally uneconomic. One implication for policy makers is that cost thresholds for key pollutants should be set to avoid more expensive water quality proposals being selected.

Research Report 85

Measuring the Economic and Cultural Values of Historic Heritage Places

David Throsby, Vinita Deodhar, Bronwyn Hanna, Bronwyn Jewell, Zena O'Connor, Anita Zednik

Research Report No. 85, November 2010

This research project on the valuation of cultural heritage is developing a methodology for a quantitative valuation study of the use and non-use values of historic heritage places. The methodology developed in this project will provide a template for subsequent empirical applications to generate data of use in the formulation of heritage policies and programs. The initial stages in reaching this larger objective have involved determining how historic heritage places are to be categorised for measurement, establishing the process by which heritage attributes will be determined for valuation, and developing and trialling an effective measurement framework. The principal techniques being developed for valuation assessment in the project are derived from choice-modelling (CM) and contingent-valuation methods (CVM). A particular focus of the project is on the systematic integration of cultural and economic value assessments within a consistent theoretical framework, reflecting the need for an economic perspective on the significance criteria currently in use in heritage policy in Australia.

Research Report 86

A Theoretical Model of Optimal Compliance Decisions under Different Penalty Designs in Emissions Trading Markets

Phillia Restiani and Regina Betz

Research Report No. 86, December 2010

This paper employs a theoretical model to examine compliance incentives and market efficiency under three penalty types: the fixed penalty rate, which uses a constant marginal financial penalty; the make-good provision (quantity penalty), where each missing permit in the current period is to be offset with a ratio (restoration rate) in the following period; and a mixed penalty, which combines the two penalty types. Using a simple two-period model of firm's profit maximisation, we analyse compliance decisions and the efficient penalty level under each penalty type. Firms' compliance strategies are modelled as an irreversible investment in abatement measures and permit buying in the market. Our findings indicate that the penalty type does not affect compliance decisions provided that the efficient penalty level is applied. Market efficiency is retained regardless of penalty types. Nevertheless, the mixed penalty design provides the strongest compliance incentives. Hence this finding supports the practice in which this penalty design is widely used in the existing and the proposed trading schemes. Furthermore, we discuss the policy implications of the findings with regard to permit price discovery process and the Australian proposal of tying the penalty level to the permit price.

Keywords: Emissions trading, penalty design, compliance

Research Report 87

The Effects of Penalty Design on Market Performance: Experimental Evidence from an Emissions Trading Scheme with Auctioned Permits

Phillia Restiani and Regina Betz

Research Report No. 87, December 2010

This paper investigates the behavioural implications of penalty designs on market performance using an experimental method. Three penalty types and two penalty levels are enforced in a laboratory permit market with auctioning, including the Australian Carbon Pollution Reduction Scheme proposed design of tying the penalty rate to the auction price. Compliance strategies are limited to undertaking irreversible abatement investment decisions or buying permits. We aim to assess how penalty design under the presence of subjects' risk preferences might affect compliance incentives, permit price discovery, and efficiency. In contrast to theory, we find that penalty levels serve as a focal point that indicates compliance costs and affects compliance strategies. The make-good provision penalty provides stronger compliance incentives than the other penalty types. However, the theory holds with regard to permit price discovery, as we find no evidence of the effect of penalty design on auction price. Interestingly, risk preference does not directly affect compliance decision, but it does influence price discovery, which evidently is a significant factor in compliance decisions as well as efficiency. Most importantly, a trade-off between investment incentives and efficiency is observed.

Keywords: Emissions trading, penalty design, experiment, auction, irreversible investment, abatement, compliance

Research Report 88

Renewable energy integration into the Australian National Electricity Market: Characterising the energy value of wind and solar generation

Nicholas Boerema, Merlinde Kay and Iain MacGill

Research Report No. 88, September 2010

This paper examines how key characteristics of the underlying wind and solar resources may impact on their energy value within the Australian National Electricity Market (NEM). Analysis has been performed for wind generation using half hour NEM data for South Australia over the 2008-9 financial year. The potential integration of large scale solar generation has been modelled using direct normal solar radiant energy measurements from the Bureau of Meteorology for six sites across the NEM.

For wind energy, the level and variability of actual wind farm outputs in South Australia is analysed. High levels of wind generation in that State have been found to have a strong secondary effect on spot prices. Wind generation's low operating costs will see it displacing higher operating cost fossil-fuel plant at times of high wind. At the same time, the increased variability of wind may impose additional challenges and costs on conventional plant which will also be reflected in wholesale spot market prices. It is shown that this is proving particularly important during high wind penetration periods, which are contributing to an increased frequency of low or even negative prices.

The solar resource in South Australia is shown to be highly variable; however, as seen with wind power, geographical dispersion of generators can significantly reduce power variability, even with as few as six sites. The correlation of the solar

resource with spot prices also appears to be superior to wind generation. Modelling using the Adelaide solar resource showed that, for electricity sold into the spot market, two-axis tracking solar generators would achieve an average price that is over twice that received by wind generators over the year 2008-9 analysed. Of course, significant solar generation deployment might drive similar price impacts as seen with wind generation, thereby reducing this advantage. Considering the potential implications of both major wind and solar generation within South Australia, the solar and wind resources within the State appear, on average, to be non-correlated for the magnitude, and the change in magnitude, across half an hour.

The analysis shows that solar and wind resources within the NEM have key characteristics that can markedly impact on their energy value within the wholesale electricity market. High levels of renewable electricity are already affecting spot prices, highlighting the need for low bidding renewable generators to attain power purchase contracts and for developers to consider this effect when choosing a site location for renewable generators. Other generators within the NEM may also be significantly impacted by major renewable energy deployment. The long-term success of renewable generation will likely depend on maximising the energy value that it contributes to the electricity industry.

Keywords: Energy value, Integration, NEM, Solar, Variability, Wind

Research Report 89

The economics of transmission constraints on wind farms: some evidence from South Australia

Nicholas Boerema and Ian MacGill
Research Report No. 89, September 2010

The impacts of transmission congestion and network investment on the development of the Australian wind energy industry have received growing attention from wind farm developers as well as relevant policy stakeholders such as the Australian Energy Market Commission (AEMC).

There are many potential wind farm sites across the country with excellent wind regimes yet only limited transmission capacity. At least one wind farm in South Australia has spent a period following construction where its output was curtailed by transmission constraints (NEMMCO, 2009). Current market rules do not guarantee dispatch to an existing wind farm as more wind generation connects to the same transmission. Given the expense of transmission network extension and augmentation, there are interesting questions of what economic impacts such constraints might have for wind farm operators.

This paper examines this issue in the context of the South Australian region of the Australian National Electricity Market (NEM). The State currently hosts almost half of total Australian wind generation capacity and has significant transmission capacity limitations for further development. Half hour wholesale electricity spot prices were used along with generation data from nine South Australian wind farms over the 2008-9 and 2009-10 financial years to assess the potential impact that transmission constraints might have had on wind farm revenue.

Results showed that a number of the wind farms would have suffered only very limited revenue reductions from having significantly greater wind farm capacity than the rating of their transmission connection to the NEM. Importantly, some wind farms could be limited to a maximum power output of half

their rated capacity and still achieve higher capacity factors than other already existing unconstrained wind farms.

The key reasons for this are that wind farms do not generate at rated capacity for a great deal of the time over the year, periods of high wind generation appear to be associated with lower wholesale prices and there is significant variance between the wind farms capacity factors. Our findings suggest that there may be circumstances where wind farm developers might benefit from installing more wind turbines than the capacity of their transmission connection.

Keywords: [Integration](#), [Market Price](#), [NEM](#), [South Australia](#), [Wind](#)

Research Report 90

Projected impacts of salinity on dryland property values in South West Australia

Michael Ward and Jared Dent

Research Report No. 90, December 2010

The goal of this analysis is to predict the impacts of salinity on property values in the unirrigated, predominately cropping land in the south-west agricultural region of Western Australia. The method applied is statistical analysis of the relationship between salinity and property values in data from the recent past. Estimates suggest that if we can avoid salinisation of salt free cropping land holding other factors constant, we can avoid a reduction in land values of anywhere between 30% and 95%. In terms of dollar values and relative to the average land value per hectare in this study of approximately \$1500, that amounts to savings of between \$450 and \$1425 per hectare.

Research Report 91

Conserving biodiversity in the southwest Australia ecoregion: the policy implications of scientist and community values

Abbie Rogers and Jonelle Cleland

Research Report No. 91, August 2010

Research Report 92

How Robust to model uncertainty are optimal investment plans?

Christopher White and Michael Ward
Research Report No. 92, August 2011

This paper looks at the impact of uncertainty over the choice of parameters in the biodiversity reserve site selection analyses based on the species-area curve ecological model. The impact of uncertainty is estimated on the allocation of resources within and towards conservation budgets using a simulation model. Using this model, the impact of uncertainty is estimated by finding the optimal allocation of land for protected areas under different conditions. Firstly, homogeneous land costs are assumed to look at the effect of uncertainty when the allocation decision is determined by species richness. Secondly, the model is extended to include fixed heterogeneous land costs in order to look at the effect of uncertainty when opportunity costs are included. Finally, the model is extended to include land costs as a function of land supply in order to get a more accurate estimation of the impact of uncertainty on land allocation. The paper finds that, within the Australian context, uncertainty over the ecological model has little impact on the cost-effective allocation of resources within conservation budgets, but can have significant impact on the efficient allocation of total resources towards conservation budgets.

Research Report 93

Ordering effects and strategic response in discrete choice experiments

Gabriela Scheufele and Jeff Bennett
Research Report No. 93, March 2010

This study explores ordering effects and response strategies in repeated binary discrete choice experiments (DCE). Mechanism design theory and empirical evidence suggest that repeated choice tasks per respondent introduce strategic behavior. We find evidence that the order in which choice sets are presented to respondents may provide strategic opportunities that affect choice decisions ('strategic response'). The findings propose that the 'strategic response' does not follow strong cost-minimization but other strategies such as weak cost-minimization or good deal/ bad deal heuristics. Evidence further suggests that participants, as they answer more choice questions, not only make more accurate choices ('institutional learning') but may also become increasingly aware of and learn to take advantage of the order in which choice sets are presented to them ('strategic learning').

Keywords: Discrete Choice Experiments, Incentive Compatibility, Mixed Logit Models, Ordering Effects, Repeated Binary Choice Task, Response Strategies

Research Report 94

Assessing the total economic value for protecting the Great Barrier Reef

John Rolfe

Research Report No. 94

Abstract to be provided

Research Report 95

Testing for value stability with a meta-analysis of choice experiments: River health in Australia

John Rolfe and Roy Brouwer

Research Report No. 95, March 2011

While meta-analysis is typically used to identify value estimates for benefit transfer, applications also provide insights into the potential influence of design, study and methodological factors on results of non-market valuation experiments. In this paper, a meta-analysis of sixteen separate choice modelling studies in Australia with 130 individual value estimates relating to river health are reported. The studies involved different measures and scales of river health, so consistency was generated by transforming implicit prices from each study into a common standard of WTP per kilometer of river in good health. Tobit models have been used to identify the relationships between the dependent variable (WTP/km) and a number of variables.

The results demonstrate that values are sensitive to marginal effects, with lower WTP/km for larger catchments, and higher WTP/km when river health is in decline. Values are also lower when river health has been defined by a subset of benefit types, such as recreation uses, vegetation health, fish health or bird populations. While there is evidence that the framing of the choice sets and descriptions of attributes have systematic impacts on values, there is very little evidence that choice dimensions, collection methods, sample sizes, response rates, statistical methods or publication status have influenced value estimates. Tests of apparent author effects show that these become insignificant when other explanatory variables are included in the models.

Keywords: Non-Market Valuation, Choice Modelling, Meta Analysis, River Health

Research Report 96

Willingness to pay for recycling food waste in the Brisbane Region

Robert Gillespie and Jeff Bennett
Research Report No. 96, March 2011

Kerbside recycling in Australia has focused on paper, cardboard, plastics and bottles and in some areas green waste. Another area for potential kerbside recycling is organic waste. This study uses a dichotomous choice contingent valuation format with follow-up open-ended willingness to pay question to estimate the household willingness to pay for the introduction of a kerbside recycling scheme for kitchen waste. Two provision rules were used. The first sample split contained a majority decision rule while the second sample split contained a provision rule where participation is voluntary.

Households across the Brisbane statistical sub-division currently pay in the order of \$250 per annum for their kerbside waste collection scheme. This study indicates that on average Brisbane households would be WTP an additional \$32 to \$35 per year for a general waste bin where food waste is split from general waste. There was no significant difference in results between sample splits with majority or voluntary provision rules.

Whether the provision of a food waste recycling scheme is economically efficient requires a consideration of all the potential costs and benefits. Other relevant costs and benefits for inclusion in a benefit cost analysis would include those associated with bin replacement, any additional collection and transport costs, composting costs, revenues from compost sales and avoided landfill costs.

If a compulsory food waste recycling scheme could be provided to all households for less than \$32 to \$35 per household per annum then the benefits of the scheme would exceed the costs and would be considered to be economically efficient and desirable from a community welfare perspective. Given the difficulties of estimating precise WTP values from

dichotomous choice data, any BCA of a compulsory scheme incorporating the results of this study should undertake sensitivity testing that includes the range of values reported including dichotomous choice and open-ended means to determine the robustness of BCA results to variations in the welfare estimate.

Notwithstanding, the results of any BCA, decision-makers also need to be cognisant of the high proportion of respondents who did not support a kerbside food waste recycling scheme. The data from the study could also be used to undertake a BCA of a voluntary scheme.

Research Report 97

Willingness to pay for kerbside recycling the Brisbane Region

Robert Gillespie and Jeff Bennett
Research Report No. 97, March 2011

Waste policy in Australia has a strong focus on kerbside recycling. This has a range of costs and benefits to the community, including non-market benefits. However, in Australia, there has been little investigation of household willingness to pay for kerbside recycling. This paper used mixed logit choice modelling to estimate the willingness to pay of households in Brisbane, Australia for kerbside waste collection services including kerbside recycling. It was found that households in Brisbane have a positive and significant willingness to pay of \$131.49 per annum for fortnightly kerbside recycling and would be willing to pay an additional \$18.30 to increase the frequency of this service to weekly. The utility of respondents was, however, found to decline by \$34.18 per year if general waste collection increased from weekly to twice a week. Based on the assumptions used in this study it would appear that the willingness to pay for kerbside recycling exceeds the net financial costs of this service, suggesting that the scheme is economically efficient. However, the reported economic values for recycling may overstate the community's true willingness to pay if household responses to the choice questions were confounded by their underlying perceptions about the environmental and resource sustainability benefits of recycling.

Research Report 98

Valuing ecosystem resilience

Gabriela Scheufele and Jeff Bennett
Research Report No. 98, April 2011

The concept of ecosystem resilience is being increasingly discussed as a driver of biodiversity values. It implies that marginal deteriorations in ecosystem conditions can abruptly result in non-marginal and irreversible changes in ecosystem functioning and the economic values that the ecosystem generates. This challenges the traditional approach to the valuation of biodiversity, which has focused on quantifying values attached to individual species or other elements of ecosystems. As yet, little is known about the value society attaches to changes in ecosystem resilience. This paper investigates this value. A discrete choice experiment is used to estimate implicit prices for attributes used to describe ecosystem resilience using the Border Ranges rainforests in Australia as an example. We find evidence that implicit prices for the attributes describing ecosystem resilience are positive and statistically significantly different from zero.

Keywords: Ecosystem resilience, Discrete Choice Experiments, Implicit Prices, Willingness to Pay Space

Research Report 99

Cost-Benefit Analysis of the Protection of Malleefowl in the Lachlan Catchment

Tertius Greyling and Jeff Bennet
Research Report No. 99, March 2011

A cost-benefit analysis (CBA) of an investment in the protection of malleefowl and associated native vegetation in the Lachlan Catchment's central-west yielded a benefit-cost ratio of 1.4. The CBA is based on project expenditures over the past four years coupled with benefit estimates from a recent Choice Modelling study in the Lachlan Catchment. The project targets the protection of malleefowl on private land which has not yet been surveyed but where the species is known to be present. The CBA is subject to significant uncertainty due to a lack of available data. Nonetheless, sensitivity analysis indicates that the BCR is consistently larger than unity, if marginal in some cases. This suggests that the project is a worthwhile investment at this early stage. Furthermore, greater gains may be achieved by addressing the numerous threats facing the species and its habitat. The increased cost of such an investment may be more than offset by the gains in benefits due to relatively conservative assumptions associated with the benefit calculations in the BCA.

Keywords: Cost-benefit analysis, Benefit-cost ratio, Choice modelling, Malleefowl, Lachlan Catchment

Research Report 100

Does anybody give a dam? The importance of public awareness for urban water conservation during drought

Emma Aisbett and Ralf Steinhauser
Research Report No. 100, March 2011

Demand management has been of interest in dry climates such as Australia, Spain and the Western United States for decades. It is particularly important to understand policy options during drought conditions, as drought periods have a disproportionate effect on supply infrastructure decisions. While water-conservation campaigns aimed at inducing voluntary consumption reductions are almost universally employed by water managers in times of supply constraint, voluntary measures are generally dismissed in the economics literature as ineffective. We argue that the robust positive correlation between dam levels and consumption after controlling for policy changes suggests that there is a significant component of voluntary conservation. Furthermore, omitting dam levels from regressions may bias estimated impacts of policy changes.

Keywords: Water Use, Demand Management, Pricing, Behavioral Aspects

Research Report 101

Protecting the Booroolong Frog in the Namoi Catchment: A Cost-Benefit Analysis

Tertius Greyling and Jeff Bennett
Research Report No. 101, March 2011

The Booroolong frog project in the Namoi Catchment represents an environmental investment to protect the species and around 10.7 kilometres of its habitat in the catchment. The project's benefit-cost ratio (BCR) of 8.6 indicates that the benefits outweigh the costs by a significant margin. The measures introduced by landholders, at relatively low cost, should therefore result in a significant return on investment upon project completion in 10 years time. The benefits are estimated using a choice modelling study which was recently developed for the valuation of investment in natural resource management in the Namoi Catchment. As this is a largely ex ante cost-benefit analysis, the BCR is subject to uncertainty associated with assumptions which had to be made for some variables. However, sensitivity analysis indicates that the project benefits outweigh the costs by a significant margin even under conservative conditions.

Keywords: Cost- benefit analysis, Benefit-Cost Ratio, Choice Modelling, Booroolong Frog, Namoi Catchment

Research Report 102

Valuing recreation of communities in the Great Barrier Reef

John Rolfe and Daniel Gregg and Gail Tucker

Research Report No. 102, August 2011

The aim of this research is to identify local and recreational use values for recreation in and adjacent to the Great Barrier Reef Marine Park (GBRMP) using the travel cost methodology, focusing on beach, island, and fishing, boating and sailing trips. Of the 1051 responses to the survey, drawn randomly from households between Bundaberg and Cairns, 87% indicated they had taken a trip to one beach ("most preferred beach"), 73% undertook a trip to a second beach ("second most preferred beach"), 30% undertook a trip to an island, and 42% undertook a fishing/boating/sailing trip over the last two years. Probit models were used to represent the choice to take a recreation activity, while count data models (zero truncated negative binomial models) were used to model the zero truncated positive integer count data.

Average values per person per trip per day were estimated at \$35 for beaches, \$331 for Islands, and \$183 for fishing, boating and sailing activities (although the value for the latter group is not significant). Additional information about how variation within population groups may affect the demand for recreation activities has been gained by trailing the use of quantile regression models to estimate recreation values as well as the more standard count data models. The results are likely to represent the lower value of recreation activities because travel time and location investment costs have not been included in analysis.

Research Report 103

Non Use Economic Values of Marine Protected Areas in the South-West Marine Area

Robert Gillespie and Jeff Bennett
Research Report No. 103, March 2011

Australian governments are committed to the expansion of marine protected areas (MPAs) in Australian waters and have already established over 200 MPAs. However, this policy direction has a range of costs and benefits for the community which have largely remained unquantified. One of the main benefits of establishing MPAs are the non use values that the community for the protection of marine biodiversity. This study uses a dichotomous choice contingent valuation format with follow-up open-ended willingness to pay question to estimate these non use values for the establishment of MPAs in South-west Marine Region of Australia.

It was found that on average Australian households would be WTP \$104 for the establishment of MPAs that cover 10% of the South-west Marine Region. Aggregating this mean WTP estimate to 50% of the population of Australian households gives an aggregate WTP of \$400M.

However, whether the establishment of MPAs in the South-west Marine Region is economically efficient requires a consideration of all the potential costs and benefits. Other relevant costs and benefits for inclusion in a benefit cost analysis would include those associated with displacement of commercial and non-commercial uses, additional planning, compliance and monitoring costs as well as any predicted increases in commercial and non-commercial use values.

If the net costs of establishing MPA over 10% of the South-west Marine Region are less than \$400M, then the non-use benefits of establishing MPAs would exceed the

other net costs and it would be considered to be economically efficient and desirable from a community welfare perspective.

Given the difficulties of estimating precise WTP values from dichotomous choice data, any BCA of MPAs in the South-west Marine Region, incorporating the results of this study, should undertake sensitivity testing that includes the range of values reported including dichotomous choice and open-ended means to determine the robustness of BCA results to variations in the welfare estimate.

Research Report 104

Public perceptions and preferences for environmental biosecurity in Southeast Queensland

Sonia Akter, Tom Kompas, and Michael Ward

Research Report No. 104, April 2011

The aim of the study was to understand public understanding of biosecurity and provide an estimate of the non-consumptive use and non-use benefits to be derived from enhanced biosecurity measures in the Southeast Queensland region. A public survey was conducted there during January 2011 using the choice experiment (CE) technique of nonmarket environmental valuation where 400 households were interviewed using fully structured survey questionnaire. Apart from increased household expenditure, three environmental attributes, namely, the number of threatened plant and animal species, area of landscape and water bodies covered by weeds and chances of invasive biting insects in the backyard and outdoor recreation areas, were included in the choice questions.

About a quarter of our sample never heard of the terms 'invasive species' and 'biosecurity' before the survey and they attached relatively low levels of importance to invasive species threat in comparison to other competing environmental threats facing the region. However, the majority of the respondents believed that the threat posed by invasive species to the environment will increase over the next 50 years and they were willing to sacrifice a proportion of their income to promote corresponding biosecurity management actions to reduce the threat. Respondents were willing to spend A\$21 per year to save one native plant or animal species from the threat of non-native invasive species. Respondents' willingness to pay to eliminate weed cover from one percent of landscape and water bodies is A\$6 per year. Respondents' average willingness to pay to reduce the chances of invasive biting insects being established in their backyard and outdoor recreation area was found to be increasing at a decreasing rate. They were

willing to sacrifice A\$110 per year to reduce the chances from high to medium. Their willingness to pay declines significantly (A\$45) to reduce the chances from medium to low. On average, sampled households were willing to bear between A\$72 to A\$147 per year to support changes to the existing biosecurity measures. As economic theory predicts, household support for the changes in biosecurity policy varied negatively with its potential cost. At a relatively lower level of cost, more households were supportive of the policy. The support for the policy declined as cost increased.

Research Report 105

Economic consequences of biological invasions: the impacts of invasive species threats on Queensland's bioregional attributes,

Sonia Akter, Tom Kompas and Michael Ward

Research Report No. 105, April 2011

This study aims to provide an estimate of non-consumptive use and non-use values for controlling invasive pest species in Queensland's bioregions. Bioregions are geologically and ecologically distinct land areas. Bioregion specific values are estimated to assist the development of landscape specific biosecurity management plans that are consistent with the interim Biogeographic Regionalisation for Australia (IBRA) framework. Six out of 13 bioregions of Queensland, namely Cape York Peninsula, Wet Tropics, Bringalow Belt North, Central Queensland Coast, Southeast Queensland, Gulf Plain bioregion, were selected for this study. A public survey was conducted in January 2011 where about 600 households living in these six bioregions were interviewed using the choice experiment (CE) technique of nonmarket valuation. Three bioregional attributes were included in the CE study: (1) native plant and animal species, (2) landscape and water bodies and (3) backyard and outdoor recreation areas. Respondents were asked for their willingness to pay for enhanced biosecurity measures that aim to (1) save native plant and animal species from the threat posed by invasive species, (2) reduce the percentage of landscape and water bodies covered by invasive weeds and (3) reduce the chance of invasive ants and other biting insects being established in the backyard and outdoor recreation areas. Our results show that the sampled households have positive willingness to pay for the three bioregional attributes included in the choice experiment. The average implicit price to save

native plant and animal species varied between A\$22 and A\$34. Average willingness to pay to eliminate weed cover from landscape and water bodies was A\$7. Household willingness to pay to reduce the chances of ants and other biting insects ranged from A\$232 to A\$93. The standard Poe et al. (1994) test was employed to examine if the differences between the implicit prices obtained from all of Queensland sample and bioregion specific samples are statistically significant. The test results fail to provide sufficient evidence to reject the null hypothesis of equality between implicit prices. Compensating surplus welfare measures were estimated for three alternative biosecurity policies. The measures were obtained by subtracting indirect utility of the status quo from indirect utility to be obtained from a changed policy measure. On average, sampled households were willing to bear between A\$100 to A\$235 per year to support changes to the existing biosecurity measures. This is about 0.15 to 0.35 percent of the average yearly income of the sampled households. This result suggests that enhanced biosecurity measure is likely to improve household welfare by better protecting the bioregional attributes.

Research Report 106

Stability of environmental values in the event of natural disasters: the case of biosecurity and a catastrophic flooding in Southeast Queensland

Sonia Akter, Michael B. Ward and Tom Kompas

Research Report No. 106, April 2011

This paper presents the results of the first natural experiment in the stated preference literature that tests for the stability of environmental values in the event of a catastrophic natural disaster. Two subsequent choice experiment surveys were conducted in Southeast Queensland, a region of the state of Queensland in Australia. The objective of the choice experiment study was to estimate households' willingness to pay for environmental biosecurity measures. The time interval between the two surveys was about six weeks. The second survey was launched two weeks after one of the worst flood events recorded in the state's history. The results of the experiment can be summarized into three key points. First, no statistically significant differences were observed in the proportions of choices made by respondents during the first and second survey in 16 out of 20 choice questions. Second, the dummy variable representing the order of the survey was not statistically different than zero in the scale-parameter adjusted pooled regression model. Finally, no statistically significant difference was observed between the mean implicit prices of the three environmental attributes included in the choice questions. We conclude that household preferences for biosecurity in Southeast Queensland are disasterproof.

Keywords: Natural Disaster, Stated Preference, Preference Stability, Australia, Biosecurity, Invasive Species

Research Report 107

The Implications of Risk and Uncertainty Aversions in Public Goods Games

Veronika Nemes and Lata Gangadharan

Research Report No. 107, June 2011

In this paper we examine how individuals behave in situations of risk and uncertainty in public and private goods context. We find that subjects are willing to pay a much higher amount to find out information relating to the probabilities of providing the private good than information relating to the public good even if this information has greater consequences for the individual in the public goods context. We find strong support for the free-rider hypothesis and extend it to cases when risk and uncertainty are present. We find that subjects treat risks and uncertainties associated with the provision of private good and public good differently.

Keywords: Experimental Economics, Public Goods, Risk Aversion, Uncertainty Aversion, Decision Making

Research Report 108

Adapting to climate change for water resource management: Issues for northern Australia

William Nikolakis, Aimee Nygaard and R. Quentin Grafton

Research Report No. 108, April 2011

There are two aims of this work focused across northern Australia (north of the tropic of Capricorn). First is to identify adaptive strategies to deal with climate change in each jurisdiction. Second the work identifies issues for adaptation in water resource management across the region in light of potential impacts and local conditions. Over half of Australia's annual runoff occurs in the north Australian region from November to April. The region is relatively undeveloped and sparsely populated compared to southern Australia. Almost 30% of the land base is owned under Indigenous tenure. Drought and over-allocation of water resources in southern Australia has focused attention on the potential for expanding irrigated agriculture in the north. With an outlook for increased drought in southern Australia the pressure to look north is likely to increase. While rainfall projections in northern Australia are identified as stable to increasing, our research highlights that the outlook for water availability remains uncertain under climate change scenarios across the north.

Work by CSIRO and BOM (2007a) and CSIRO (2009a) predict that to 2030 and 2070, northern Australia is likely to experience hotter temperatures, more intense rainfall and more intense cyclonic events. It must be stated that climate change impacts are likely to vary across the region and impacts may be highly localized. There may be an increased risk of saltwater inundation and erosion in coastal areas. While inland areas may experience more extreme high temperatures, drought, flooding, dust storms and bushfires (CSIRO, 2009a; Green, 2006). Although northern Australia produces over half of Australia's runoff, it is considered to be water limited for

two main reasons. First there is high evaporation and evapotranspiration for most of the year (CSIRO, 2009a). Second the potential for water storages is constrained (NAWLT, 2009; Petheram et al, 2008). There may be consequences for water resources from climate change (as well as infrastructure) which combined with increased population growth (especially in Darwin, NT) could make water stress more acute, particularly during the dry season. As water stress increases the need for a robust and adaptive framework to manage water becomes more important. Climate models may allow policy makers to anticipate particular events in setting design standards for water infrastructure (Hallegatte, 2009).

Reference has been made in water plans to climate change in each jurisdiction. There is also recognition in climate adaptation strategies that water resources will be impacted by climate change. Adaptation for water resource managers and policy makers is not new. But the effects from climate change may impose new and perhaps unforeseen challenges on water management regimes. This is particularly true across tropical northern Australia, a region already difficult to manage and deliver services to because of its size, remoteness and relatively poor infrastructure base. It is recommended in literature that adaptation for water resources should consider basins in an integrated way and address issues such as flood and drought protection, managing water demand, and maintaining and protecting infrastructure. Water markets are a demand side strategy to adapt to climate change. Markets have enabled irrigators in southern Australia the flexibility to cope with drought and maintain productivity during water shortages. Water markets may enable adaptation to the effects of climate change by allowing re-allocation among users and flexibility to users through trading. Markets can also encourage water use efficiency which is important where climate change reduces water availability. The use of water markets are at a formative stage across the north Australian region, with little to no trading at the time of writing. Despite no trading, northern jurisdictions generally allow water trading to occur in areas subject to a water plan (competition for water tends to be higher in these areas and necessitates a plan).

Water plans seek to identify a sustainable level of consumptive extraction by using best available science and community

consultation to support economic, ecological and social outcomes. It is acknowledged across the north that data relating to water resources and climate is limited. This is particularly true for groundwater resources for which there is a strong reliance across much of the north. There is considerable risk for the extraction on groundwater resources on groundwater dependent ecosystems, and on the customary values of Indigenous Australians. The Northern Territory has in place one water allocation plan in the region, the Tindall aquifer plan. Queensland has the Gulf and Mitchell resource operation plans. Western Australia has the Ord River water management plan. The Tindall plan in the NT is the only groundwater plan completed in the region. In Queensland and the NT plans are enshrined in statute and last 10 years (though in the NT the plan is reviewed within 5 years). While in WA the Ord plan is for 3 years.

An important tool for adapting to climate change in water plans is the ability to reduce water allocations to entitlement holders in line with reductions in water availability. This is often done according to the level of security provided to an entitlement holder (high, medium and low security). The economic value of entitlements is linked to its level of security. In the Northern Territory, the Tindall aquifer water allocation plan provides that all water licenses may have their allocation reduced to zero in serious drought (commencing with low then up to high security). In times of critical water shortage the Water Controller in the NT has the power to impose restrictions on stock and domestic use as well. In the Ord there is greater security afforded to users because of the storage capacity in Lake Argyle (101 GL). Allocations in the Ord are determined based on water storage levels in the dam, and restrictions can be imposed on allocations if water reaches 'critical levels'. It is expected that in only 5 years out of every 100 will water reach 'critical levels' and allocations be reduced. Hence entitlement holders will get their full allocation 95% of the time. Plans are reviewed and new information may be integrated and entitlements amended to reflect any changes in water availability.

Most work on climate change and hydrology research has been focused on metropolitan centres in WA and Queensland. There has been relatively little work across the north to understand the effect of climate change on water resources. Uncertainty and lack of knowledge serve to constrain planning

efforts. Adapting to climate change in water resource management requires an integrated approach, coordinating efforts across government and collaborating with stakeholders to be effective- it will be important to support socio-economic outcomes over the long term. The impacts from climate change will not be distributed equitably and will have implications for Indigenous groups (who are disadvantaged), with consequences for health, wellbeing and livelihoods (Green, 2006). Industry will be affected by the impacts of climate change in northern Australia. For example, the pastoral industry which covers almost 90% of land use could be negatively affected by reduced feed quality and water availability. These impacts can be mitigated by proactive planning, as well as collaborative and stakeholder focused planning activities. Planning will require particular effort to include and engage Indigenous groups, where consultation efforts have in the past fallen short of expectations in water management.

Research Report 109

Are there incentives to integrate to land and water management across northern Australia?

William Nikolakis and R. Quentin Grafton

Research Report No. 109, June 2011

The aim of this work is to understand what incentives exist to encourage integration in land and water management across northern Australia. Integration is seen as important in improving planning and management of resources in the context of climate change and development pressure. The north Australian region is made up of three jurisdictions, the two states of Queensland and Western Australia, and the Northern Territory. It is a sparsely populated region, with over a quarter of the Australian estate and only 2% of the nation's population. However, the region makes a significant contribution to national exports and is recognized for its ecological values, and its prominent Indigenous population who have customary rights to land and water. The region produces over half the nation's annual runoff during the wet season.

Increasingly there is a focus on northern Australia as the next frontier for irrigation development. A report by the North Australian Land and Water Taskforce in 2009 suggested irrigation could expand by up to 200% in the region, though in a form that is distinct from southern Australia given soil, hydrological and biophysical characteristics of the region. Population is increasing and climate change projections point to increased temperatures and evapotranspiration, as well as more intense rainfall and cyclonic events, and in coastal areas storm surges and erosion, while in inland areas there is predicted greater incidence of drought and bushfire (CSIRO, BOM and BRS 2010a, b). The linear and non linear forces that may shape northern Australia's landscape highlight the need for integrated land and water management as a tool for adaptation. Integration can improve the coordination of government adaptation programs, as well as efforts between government and non government actors (vertical integration), and encourage coordination between sectors (horizontal integration).

Integration is both a process and an objective, to more closely align the policies and structures of institutions responsible for natural resources management (including water planning and land management). The aspiration is to provide a holistic perspective which takes account of the inter-dependencies between resources, ecosystems and humans in natural resource management. Traditionally in the interests of specialization and transparency, different departments were responsible for managing resources independently (so for example, water, forestry and land were managed separately).

However, increasingly it is realized that encouraging coordination to improve efficiency in service delivery, collaborating with stakeholders and addressing environmental problems through multi-disciplinary efforts, offers the promise of improved outcomes and dealing with greater complexity. It is argued that to encourage integration there must be a change in structural arrangements (such as legislative change, creation of a written agreement between agencies and non government actors) and the creation of processes and rules to support integration (such as whether any decisions are binding) (Margerum and Born 2000). Implementing integration is challenging, there are barriers such as departments defending their territory, short term planning, and encouraging integration in practices at the individual level (such as reducing practices that cause salinity or eutrophication, or reducing land clearing to improve biodiversity). Often the individual may bear the costs of broader land and water objectives, and this may prevent integration from taking full effect. Encouraging integration through incentives may overcome this barrier and support efforts to manage land and water holistically.

In northern Australia there are few market based incentives to encourage integration of land and water management. Most attempts at integration have been formal structural or policy efforts to encourage coordination between governments. For example, the Federal Government has sought to improve vertical integration between levels of government in program and service delivery through the creation of regional Natural Resource Management (NRM) bodies, and there have been national efforts to create consistent policies on salinity, (the National Action Plan for Salinity and Water Quality) and promote water reform (the National Water Initiative 2004). In Queensland the *Sustainable Planning Act 2009* has established a uniform process for development assessment; and in the Northern Territory there is a private agreement between indigenous land owners and

ConocoPhillips to promote traditional fire management that reduces carbon emissions. The use of incentives to better align land and water use among farmers and landholders is mostly informal across the north. The use of Payment for Ecosystem Services and Tradable Rights Allocation System may offer ways to successfully implement integration and improve natural resource management in light of increased development and climate change.