Valuation framing and attribute scope variation in a choice experiment to assess the impacts of changing land use from agriculture to mining

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Abstract
Evaluating land use change in economic frameworks often requires non-market values to be assessed. However non-market valuation experiments can be sensitive to the way the tradeoffs are framed. The aim of the research reported in this paper was to examine the influence of varying the valuation scope and combination of attributes in a split sample choice experiment focused on assessing the impacts of increased mining activity (coal and coal seam gas) in the Surat Basin in southern Queensland, Australia. The region had traditionally been dominated by the agricultural sector. The survey was designed to assess the largely, but not exclusively, non-use values of a distant population (Brisbane (capital city) residents) for tradeoffs between positive and negative impacts, which incorporated economic, social and environmental issues. Four impact attributes were identified: A) local jobs in the mining sector; B) house prices in the non-mining sector; C) wage rates in the non-mining sector and, D) inspections and independent monitoring activity at coal seam gas mining sites (a proxy to address environmental concerns). The results indicate that varying the combination of attributes had a significant influence on preferences and welfare estimates, which varied across attributes and valuation formats.

Keywords: Choice experiment; valuation scope; choice attributes; mining; impact assessment

1. Introduction

Evaluating land use change in economic frameworks often requires non-market values to be assessed, as community values for social, environmental and other dimensions of land use options can be significant components of value estimates for alternate land uses. There is increasing application of stated preference techniques such as contingent valuation and choice modelling experiments to these issues, as they provide substantial flexibility for the analyst to focus on the key attributes of relevance as well as assessing both use and non-use values. In this paper we demonstrate an application of the choice modelling technique for assessing the impacts of shifting land uses from agriculture to mining, as well as testing the potential for those values to be sensitive to changing frames and contexts of the valuation experiment.

In Australia, mining, energy extraction and minerals processing makes a significant contribution to National, State and regional economies, creating new job opportunities and revenue flows (Lim et al., 2009). However, despite the economic contribution of the resources sector, questions are often raised about potential negative social, economic and

environmental impacts (Rolfe et al., 2007; Solomon et al., 2008; Petkova-Timmer et al. 2009). The development of energy resources in Australia such as coal and gas has been shown to involve substantial growth pressures on local economic frameworks, communities and environmental assets (Hajkowicz et al., 2011; Reeson et al., 2012), including in newly emerging areas such as the Surat Basin in southern Queensland (Rolfe, 2013; Fleming and Measham, 2014). To date there has been limited assessment of these impacts with stated preference techniques, with Gillespie Economics (2009), Ivanova and Rolfe (2011) and Gillespie and Kragt (2012) providing some limited examples in Australia.

The application of stated preference techniques such as choice modelling experiments can be challenging because of the discretion available over the selection of attributes and framing of the choice experiments in ways that reflect the policy issues to be addressed (Rolfe et al., 2000). Many studies have shown that the frame or context of the choice scenario as well as design dimensions can affect survey responses (e.g. Rolfe et al., 2002; Caussade et al., 2005; Hensher, 2006a; Rolfe and Windle, 2013). In most valuations about resource use and allocation policy, the decision about the number and type of attributes to include in the choice set becomes a balancing act between two opposing considerations of realism versus choice complexity. Ultimately, the decision about what attributes to include in a valuation exercise and how to describe them is likely to continue to be a multifarious task with tradeoffs being made between respondent comprehension, policy relevance and content validity (Johnston et al., 2012).

There has been limited attention in the literature to how varying the scope of issues to be covered in a non-market valuation exercise may impact on subsequent value estimates. This is particularly relevant to major land use change issues, where different elements and combinations of economic, social and environmental issues can be selected. The case study outlined in this paper is designed to address this gap and examines the effects of combining different valuation attributes in a split sample choice experiment. The study was conducted to assess the impacts of increased mining activity (coal and coal seam gas) in the Surat Basin in southern Queensland, Australia, where impacts can include both positive and negative economic and social impacts on local communities, as well as the risk of environmental losses. As well as assessing values for some major impacts on the region that were not available from market data, the experiments were also used to test if those values were sensitive to both framing dimensions and the complexity of the choice task.

The results indicate that varying the valuation scope and combination of attributes had a significant influence on preferences and welfare estimates, which varied across attributes and valuation formats. The paper is structured as follows. A brief review of the relevant literature and the methodological approach to explore the research questions is provided in the following section. The local case study details are outlined in section three followed by the results in section four and the discussion and conclusions in the final section.

2. Literature review and methodological approach

The complexity of resource allocation options often involves a range of potential social, economic and environmental impacts that can be included in a valuation scenario. For example, some valuations of ecosystem conservation include social attributes associated with recreational benefits in relation to river and waterways (e.g., Morrison and Bennett, 2004); forests (e.g., Turner et al., 2011) and nature areas (e.g. Liekens et al., 2013), or conflicts between recreational use, overcrowding and biodiversity benefits (e.g. Juutinen et al., 2011).

Other environmental valuations have included an economic attribute such as employment either as a benefit (job creation) of land use changes (e.g. Baskaran et al., 2013) or better land management practices (e.g. Colombo et al. 2005), or as a cost (employment losses) of environmental protection reducing potential for economic development (e.g. van Beuren and Bennett 2004). While increasing the scope of a valuation to include a broader range of impacts may be more realistic, it may also increase the complexity and cognitive burden placed on respondents, with subsequent impacts on the accuracy of estimated models.

Researchers have paid some attention to issues of choice set dimensions and application, concerned that presentational differences could affect subsequent value estimates. There is mixed evidence about the influence on respondent behaviour of the structure and dimensions of choice tasks. Increasing complexity has been shown to increase choice inconsistency (e.g., DeShazo and Fermo, 2002), the use of simplifying heuristics (e.g., Dhar and Simpson, 2003), the avoidance of choices (Dhar 1997), or increased selection of the status quo alternative (Boxall et al., 2009). In contrast, other studies have found that information relevancy is more important than information load (Hensher 2006b) and additional, relevant information may facilitate choice selection as respondents are more likely to find a choice profile that better matches their preferences (Rolfe and Bennett, 2009; Rolfe and Windle, 2012).

There has been little detailed research to explore the effects of varying the combination of different attributes. In environmental valuation, a wide range of different attributes have been applied to value the same ecological outcome such as a water quality or biodiversity improvement. For example, two Scandinavian valuations for marine water quality (Eggert and Olsson (2009) and Kosenius (2010)) applied two quite different sets of attributes, with the former using three attributes (coastal cod stock, bathing water quality, and biodiversity) and the latter applying four attributes (water clarity, abundance of coarse (non-attractive) fish, status of bladder wrack (a type of seaweed), and mass occurrences of blue-green algae blooms). Similarly, multiple indicators can be used to communicate the same or similar ecological outcomes. For example, the condition of a particular species might be represented using indicators of species abundance, frequency of successful breeding, habitat distribution, or classified status, etc. In one of the few evaluations of attribute composition, Zhao et al., 2013, applied different combinations of ecological indicators to assess values for migratory fish restoration in Rhode Island, USA, but found no significant difference in welfare estimates.

This study was designed to assess the largely, but not exclusively, non-use values of a distant population (Brisbane (capital city) residents) for tradeoffs between positive and negative impacts, which incorporated economic, social and environmental issues. Four impact attributes were identified: A) local jobs in the mining sector; B) house prices in the non-mining sector; C) wage rates in the non-mining sector and, D) inspections and independent monitoring activity at coal seam gas mining sites (a proxy to address environmental concerns). In this case study, a split sample experiment was designed to explore the influence of changing the combination of attributes in relation to the impacts of increased mining development. The baseline survey included four impact attributes, with one attribute omitted in each of the other two split samples. The aim of the research was to examine explore the effects of altering the valuation scope by changing the combination of valuation attributes.

This paper contributes to the literature by investigating the influence of attribute variation and the effects of including or excluding specific attributes. Three elements of valuation scope were examined. The first, referred to as increasing scope intensity, explored the effect of

including an additional employment-related attribute (C), i.e. attributes A, B, C & D versus attributes A, B & D. The second, referred to as increasing scope dimension, explored the effect of including an attribute to represent environmental issues (D), i.e. attributes A, B, C & D versus the economic and social attributes A, B & C. The third comparison was between a scope intensive valuation format (attributes A, B & C) and a scope extensive format (attributes A, B & D).

Four methodological approaches were applied to explore the influence of altering the scope of the valuation frame. First a comparison was made of the selection the status quo (no cost) option to determine if respondents found the improvement options more or less attractive in one of the survey formats. Second, mixed logit models were developed to examine respondents' preferences and to determine whether there was any difference in the significance of the different attributes across survey formats. The third approach was to compare the welfare or value estimates for the different attributes across the survey formats. The fourth methodological approach applied latent class models to examine the tradeoffs respondents made between the different attributes and how this varied across survey formats.

3. Case study details

3.1 Mining in the Surat Basin

The Surat Basin lies to the west of Brisbane, the capital of Queensland, and covers an area of approximately 110,000 square kilometres (Figure 1). Although a small number of coal mines have been operational in the region, agriculture has traditionally been the backbone of the regional economy. In the east, fertile soils support significant agricultural production. Further west, the landscape becomes drier and agriculture relies on grazing and dry land cropping. The region is sparsely populated (declining towards the west reflecting the smaller economic base), and until the recent increase in mining activity, employment opportunities in the smaller towns have generally been declining. Currently, there is some expansion in the coal mining sector and a rapidly developing liquefied natural gas industry (mainly associated with extracting coal seam gas). Growth projections based on a medium-level scenario for potential resource development in the Surat Basin estimate that by 2031:

- production of coal and coal seam gas is expected to increase ten-fold;
- the gross regional product will double;
- employment in the area will increase by an additional 12,500 full time equivalent positions; and
- population growth is projected to increase by 44 per cent.

(Queensland Government 2010)

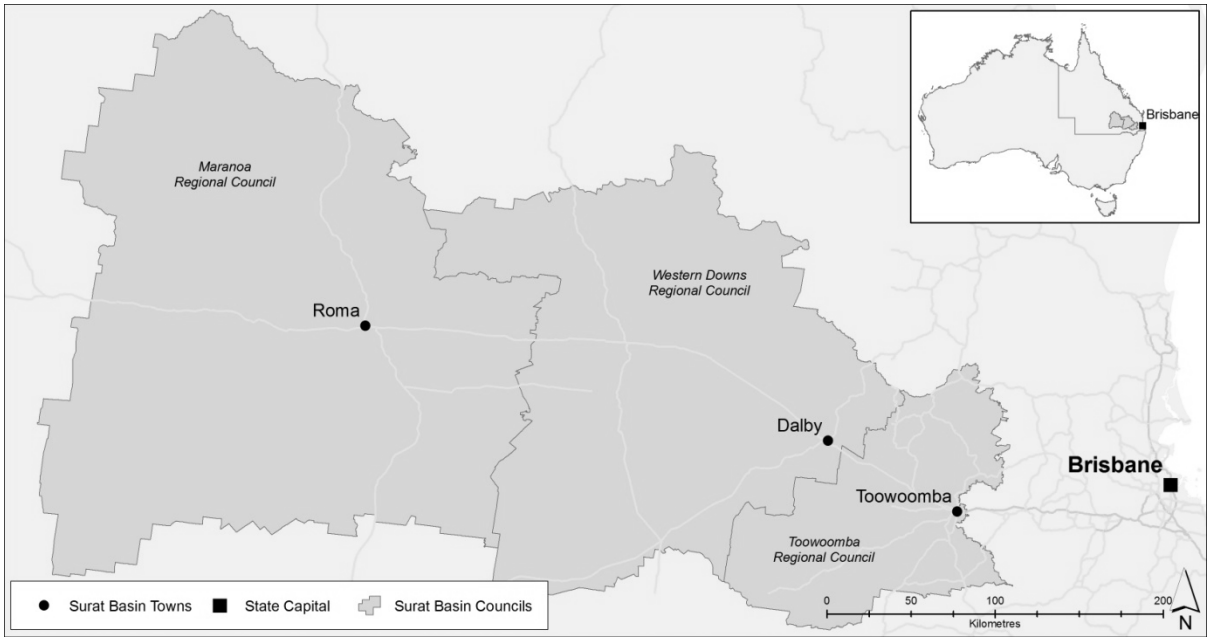


Figure 1. The Surat Basin in southern Queensland, Australia

While there are clear economic benefits, local residents are also concerned about other impacts indentified as:

- the loss of affordable housing;
- the lack of skilled local labour;
- the potential increase in social dysfunction; and
- the risk that the currently diverse economic base could be undermined if mining became the dominant economic activity.

(Schandl and Darbas, 2008)

Concerns about environmental impacts also exist, particularly in relation to coal seam gas extraction, attracting widespread media attention across the country, not just in Queensland. Concerns mainly relate to impacts on underground water aquifers (contamination and overuse). However, there is limited scientific knowledge about groundwater systems and the level of connectedness between aquifers which make it difficult to clearly identify the environmental risks or the likelihood of occurrence.

3.2 Previous non market valuation studies

Assessing the impacts of increased mining activity is challenging because of the complex range of potential impacts involved and there are only a limited number of studies where non-market valuation experiments have been applied. Spyce et al. (2012) report the use of a choice experiment in the Yukon in northern Canada to assess community preferences for different land use tradeoffs, as recent increases in mining and energy projects are transforming the region. Respondents were asked to indicate their preferences for different development scenarios that had varying impacts on jobs, moose populations, fish catch rates and the population of the regional area.

In New South Wales, Australia, two choice modelling valuations have been conducted to estimate the non-market impacts associated with an expansion in underground coal mining activity (Gillespie Economics, 2009; Gillespie and Kragt, 2012). In both studies respondents were selected from the local region where the mine was located as well as from the broader

state-wide community. Respondents were faced with tradeoffs between positive and negative impacts, as well as between social, environmental and economic impacts. The results indicated that both local and non-local respondents were willing to pay (WTP) to avoid adverse environmental impacts (on waterways and vegetation) as well as adverse social impacts on Aboriginal cultural heritage sites (Gillespie Economics, 2009; Gillespie and Kragt, 2012). Respondents were also WTP to ensure the flow of employment benefits. In the Gillespie Economics (2009) study, values were also elicited to avoid rural families being displaced due to mine proximity and increased noise and dust.

Ivanova and Rolfe (2011) report the application of a choice experiment in Moranbah, a coal mining town in the Bowen Basin in central Queensland, Australia. In that study, local residents were asked about the expansion of coal mining in their area and their preferences for future development options for the town. The results revealed that local residents were WTP to:

- avoid an increase in housing and rental prices;
- reduce the level of water restrictions in the community;
- to increase the buffer between the mine and the town to reduce the level of noise, vibration and dust; and
- reduce the proportion of the workforce living in work camps.

Little is known about how the broader (Queensland) community views the tradeoffs of mining development in the Surat Basin. However, previous valuation studies have shown people may hold non-market values for better social outcomes in regional areas, even if they do not live in the region. For example, people living in urban centres have been shown to have significant values to maintain viable rural communities through employment opportunities and regional incomes (Bennett et al., 2004), and for more environmental protection in terms of mine site rehabilitation (Burton et al., 2012).

3.3 Survey design and development

The focus of this study was to identify how the largest population group in Queensland, Brisbane residents, viewed the potential economic, social and environmental impacts of rapid resource developments in the Surat Basin. Although the economic benefits of increased mining activity will also flow to Brisbane (Rolfe et al., 2011)[1], it is very unclear how Brisbane residents feel about the negative aspects of mining that might impact on local communities. Furthermore it is not clear whether Brisbane residents are prepared to sacrifice some of the wealth from resource developments to reduce negative impacts and if so, how they would make the tradeoffs.

Focus groups were held with Brisbane residents to identify the main impacts that were important to them; that they were willing-to-pay (WTP) to ameliorate, and that were suitable to include as attributes in a choice experiment. For example, an impact attribute needed to have a clear causal link to increased mining activity, and could realistically be presented with different quantitative levels of provision. A range of issues were discussed and considerable variation in community views was identified with some people favouring mining developments because of the benefits, while others viewed mining developments as a

[1] It has been estimated that the employment multiplier effect means that for each new job created locally, there will be 2.3 new jobs generated in local communities; 3.3 extra jobs for the whole region (including Toowoomba, the regional centre) and 4.0 extra jobs in Brisbane and southeast Queensland (adapted from Rolfe et al., 2011).

negative because of the costs involved. However, in the interests of brevity further details are not provided in this paper.

Four particularly important issues were identified that were suitable for inclusion in the valuation survey.

- JOBS: increased employment opportunities in local communities (and by inference the flow-on effects in Brisbane);
- HOUSING: higher housing prices (and housing shortages) in local communities;
- BUSINESSS WAGE: pressures on local businesses in the non-mining sector (rising wage rates and labour shortages); and
- ENV MONITORING: potential environmental impacts.

These issues were adapted to be included as attributes in the choice experiment. There were some challenges associated with converting concerns about environmental issues into a choice attribute. Environmental concerns were primarily focused on water quality issues, but there was considerable uncertainty both about the potential impacts that might occur, as well as the likelihood of occurrence. Consequently, the attribute was described in terms of "More independent monitoring activity and inspections" which would help in early detection if any environmental issues did occur, as well as ensure industry compliance.

A fifth attribute representing cost was included, with the payment vehicle described in general terms as potentially an increase in either taxes, rates or prices, to avoid possible payment vehicle bias that might be associated with a more specific description. Background information in the survey had explained how people in Brisbane would receive a larger share of some benefits of mining in the Surat Basin compared to people in small rural communities through flow-on employment benefits. This provided the rationale for asking Brisbane residents if they were WTP to change the level of impact on the local community, and the extent they were prepared to tradeoff the benefits of increased employment and income opportunities. The different outcomes were predicted to occur in five years time (2016) with the term of the annual payment limited to the same period. Details of the background information presented to respondents are provided as a supplementary file.

Three split sample surveys were created with a baseline survey which included all four impacts attributes (Survey1: JHWE). The other two splits contained only three impact attributes with JOBS, HOUSING and BUSINESSS WAGE (JHW) in Survey 2 and JOBS, HOUSING and ENV MONITORING (JHE) in Survey 3. This meant there were two common attributes across all three survey splits; one with a positive impact, with higher levels preferred (JOBS) and the other with a negative impact, with lower levels preferred (HOUSING). The three comparisons were between Survey 1 and Survey 3, to examine the effect of increasing scope intensity with the inclusion of an additional employment-related attribute (BUSINESSS WAGE), and between Survey 1 and survey 2, to examine the effect of increasing scope dimension, with the inclusion of an environment-related attribute (ENV MONITORING). The third comparison was between the scope intensive survey (Survey 2) and the scope extensive survey (survey 3).

Three separate D-efficient experimental designs were created using ©Ngene software with a Bayesian design strategy used to create 24 choices sets. These were blocked into four versions so that each respondent was assigned a random block of six choice sets. An example choice set for the baseline survey with all attributes (and underlying descriptions) is

shown in Figure 2 and attribute details are outlined in Table 1. The status quo or no cost option described a situation where there would be maximum employment opportunities, but this would be associated with higher housing prices, higher wages and low levels of environmental monitoring. The improvement alternatives represented options with different levels of impact, but had an associated cost.

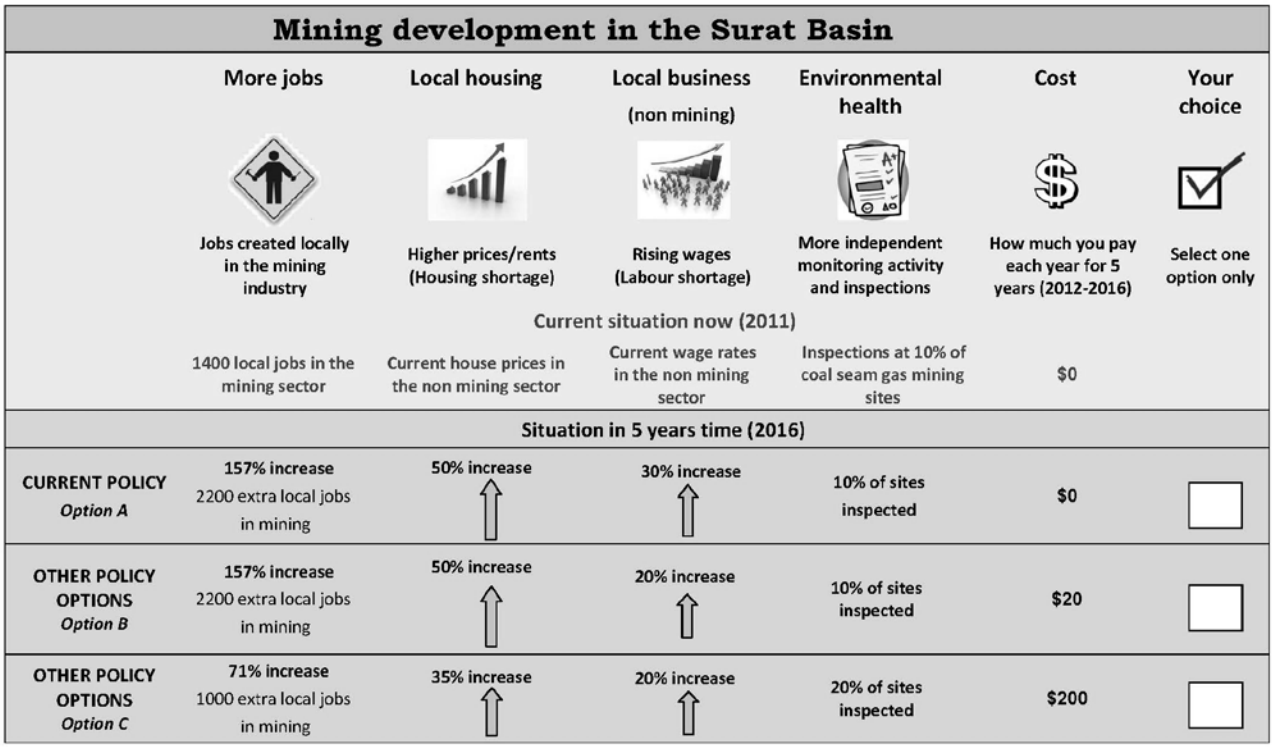


Figure 2. Example choice set for the baseline survey with all attributes

Table 1. Choice set attribute descriptions and levels

Title	Description	Current levels (2011)	Levels in 5 years time (2016)	
			Status quo option	Alternative options
More jobs (JOBS)	Number of jobs created locally (in the Surat Basin) in the mining industry	1400 jobs	2220 extra jobs	2220, 1600, 1000 extra jobs
Local housing (HOUSING)	Higher housing prices (housing shortages)	Current prices	50% increase	50%, 35%, 20% increase
Local business (BUSINESS WAGE)	Rising wage costs (labour shortages) in the non mining sector	Current wage rates	30% increase	30%, 20%, 10% increase
Environmental Monitoring (ENV MONITORING)	More independent monitoring activity and inspections	Inspections at 10% of coal seam gas mining sites	10% of sites inspected	10%, 20%, 30% of sites inspected
Cost (COST)	How much you pay each year for 5 years (2012-2016)	$0	$0	$20, $50, $100, $200

The valuation surveys were conducted in 2012, in an online format with access to an internet panel provided through a commercial service provider. The details reported in this paper are a component of a larger research study and the details from only a proportion of the total

sample (522 respondents) are analysed here. This included 178, 168 and 176 responses for surveys one two and three respectively. The socio-demographic characteristics of survey respondents are presented in Table 2. There were more females and the average age was higher in the sample compared to the population. There were more people with a tertiary degree in the sample, but not more with post school education. In most income categories, the sample matched that of the population.

Table 2. Sample characteristics of Brisbane respondents

n=522		**Sample**	**Population**[1]
Gender	Female	56%[*b]	51%
Age	Average (yrs)	45.4 yrs[*t]	43.7 yrs
Education	Post school qualification	70%[b]	66%
	Tertiary degree	39%[*b]	29%
Income	Less than $25,999 per year	17%[b]	17%
(gross)	$26,000 – $41,599 per year	18%[b]	18%
	$41,600 – $62,399 per year	19%[b]	21%
	$62,400 – $88,399 per year	18%[b]	17%
	$88,400 – $103,999 per year	11%[*b]	8%
	$104,000 – $155,999 per year	12%[*b]	15%
	$156,000 or more per year	5%[b]	6%

[1] Australian Bureau of Statistics 2011 Census, apart from 'Income' with 2006 Census categories and details applied.
[*] Indicates a statistical difference between the sample and the population when applying: b= the normal approximation to the bionomial test or t= independent samples T-test.

4. Results

The first approach to examine the influence of attribute variation was to compare respondents' selection of the status quo (no cost) alternative. It is expected that respondents will select this option if the valuation scenario is not important to them or they are not WTP for the other alternatives on offer. Some people might think the issues are important, but budgetary limitations mean they cannot afford to pay. Other people may find it too hard to make a choice, because they do not know their preferences for the different tradeoffs involved, and select the status quo as a way of opting-out. Higher levels of status quo selection maybe an indication of the increased difficulty in finding a choice profile that matched the respondents' preferences. Higher levels of serial status quo selection, where the option is always selected, might be more of a protest and an indication that the valuation scenario is unrealistic. The incidence of status quo selection is detailed in Table 3

Table 3. Section of the status quo option across survey formats

	Survey 1: JHWE n=178	**Survey 2: JHW n=168**	**Survey 3: JHE n=176**
Proportion of status quo responses* (n*6 choice sets)	34.6%	48.3%	31.5%
Proportion of serial (all) status quo responses*	17.4%	25%	12.5%

* Significant difference (Pearson's chi-square crosstab) between surveys – but not between Survey 1 and 3

The survey format with the highest level of non-participation was Survey 2, suggesting that respondents found greater value (were less likely to select the no cost option) when the ENV MONITORING attribute was included in the choice profile. Increasing attribute scope intensity through inclusion of the WAGE attribute (Survey 1 vs Survey 3) did not have a significant influence on status quo selection. In contrast, increasing attribute scope dimension through inclusion of the ENV MONITORING attribute (Survey 1 vs Survey 2) significantly reduced the incidence of status quo selection. Similarly, the scope extensive format (Survey 3) with ENV MONITORING provided respondents with more attractive payment options compared to the scope intensive format (Survey 2) with WAGE as the third attribute.

Next, mixed logit models were developed using ©Nlogit5 software to compare choice selection and preferences across survey formats. All attributes were included as random parameters with a normal distribution. The same socio-economic variables used to compare the characteristics of the sample with that of the population, were included in the model to determine the relative importance of sampling biases. These were interacted with the ASC and modelled to explain the selection of the status quo alternative. Details of the model variables are provided in Table 4 and the results are presented in Table 5.

Table 4. Model variables

Main variables	**Description**
Main attributes	
JOBS	More jobs (# ('00s) of jobs)
HOUSING	Local housing – higher prices (% increase)
BUSINESS WAGE	Local business – rising wage costs (% increase)
ENV MONITORING	Independent water / environmental monitoring activity (% increase in sites monitored)
COST	Annual household payment for 5 years ($)
ASC + Socio-demographic variables	
ASC	Alternative specific constant = 1 for the status quo alternative
AGE	Age in years.
GENDER	Male = 1; Female = 0
EDUCATION	Dummy coded 1 = tertiary education
INCOME	Information collected in a seven category format representing different ranges in annual income (Table 2). The midpoint of each category was applied in the analysis as follows: 1=$13,000; 2=$33,800; 3=$52,000; 4=$75,400; 5=$96,200; 6=$130,000; 7=$171,600

Table 5. Mixed logit models for the three survey formats

	Survey 1: JHWE			**Survey 2: JHW**			**Survey 3: JHE**		
	Coefficient		*St Err*	*Coefficient*		*St Err*	*Coefficient*		*St Err*
Random parameter means									
COST	-0.011	***	0.002	-0.021	***	0.004	-0.021	***	0.003
JOBS	0.026	*	0.015	0.040	*	0.021	0.058	***	0.019
HOUSING	-0.036	***	0.009	-0.064	***	0.011	-0.027	***	0.010
BUSINESS WAGE	0.024	***	0.009	0.041	***	0.014			
ENV MONITORING	0.074	***	0.014				0.071	***	0.014
Random parameter standard deviations									
COST	0.012	***	0.002	0.021	***	0.004	0.019	***	0.003
JOBS	0.066	**	0.026	0.098	***	0.035	0.154	***	0.029
HOUSING	0.061	***	0.013	0.076	***	0.016	0.055	***	0.012
BUSINESS WAGE	0.045	**	0.018	0.068	***	0.022			
ENV MONITORING	0.121	***	0.018				0.117	***	0.018
Non random parameters									
ASC	1.095		1.277	0.934		1.417	0.850		1.311
AGE	-0.027		0.021	-0.035		0.021	-0.054	**	0.022
GENDER	0.973		0.657	1.211	*	0.645	1.175	*	0.639
EDUCTION	-0.648		0.705	0.529		0.683	-0.276		0.647
INCOME	-6.9E6		7.9E-6	-4.1E6		9.1E6	-3.8E6		8.7E6
Standard deviation of latent random effects									
SigmaE01	3.162	***	0.440	3.152	***	0.452	3.030	***	0.407
Model Statistics									
Sample (n)	178			168			176		
Observations	1068			1008			1056		
Log Likelihood	-860			-728			-836		
AIC	1.640			1.473			1.610		
McFadden R sqrd	0.267			0.342			0.279		
Chi sqrd	628			758			648		

Significance levels are *10%. **5% and *** 1%

All impact attributes were significant in all three models, (although JOBS was less significant in Surveys 1 and 2) with significant standard deviations highlighting the heterogeneity in preferences. All attributes were signed as expected, apart from BUSINESSS WAGE which was positive in all three models, indicating higher levels were preferred. This suggests that most respondents were considering the employees rather than the employers and higher wages were seen as a positive impact. There was some difference in the significant of socio-demographic variables, with none significant in the baseline model. GENDER was weakly significant in the three attribute formats (males were more likely to select the status quo option) and AGE was significant in Survey 3 (without BUSINESSS WAGE) with older people being more likely to select an improvement option.

The most notable difference between surveys in terms of attribute significance related to the JOBS attribute. Significance levels were higher (at the 1% level) in the scope extensive format (Survey 3) compared to both the other surveys, where it was only significant at the 10% level. Preferences for JOBS were less significant (preferences were diluted) when it was accompanied with another employment related attribute. More distinct differences between surveys are apparent in the strength of preferences (coefficient values) for the attributes in the different models and these are given further consideration in the third methodological approach by examining the welfare estimates or WTP values. The WTP estimates (Table 6) were calculated as the negative of the ratio of each attribute coefficient to the price coefficient with confidence intervals estimated from 1000 draws using the Krinsky and Robb

(1986) procedure. A Poe et al. (2005) test, estimating the proportion of differences greater than zero, was applied to determine whether there was a significant different in values estimates across the survey formats.

Table 6. Household WTP for marginal changes in impact attributes

	JOBS ('00s)	**HOUSING (%)**	**BUSINESS WAGE (%)**	**ENV MONITORING (%)**	**Total value**
Unit of measurement	Per 100 extra local jobs in mining	To avoid a 1% increase in house prices in the non-mining sector	For a 1% increase in wages in non-mining sector	For a 1% increase in inspections at coal seam gas mining sites	WTP per year for 5 years
Survey 1: JHWE	$2.40	$3.40	$2.27	$6.93	$15
95% CI	(-$0.39 to $5.55)	($1.82 to $5.52)	($0.53 to $4.42)	($4.43 to $10.76)	
Survey 2: JHW	$1.90	$3.04	$1.95		$6.89
95% CI	(-$0.08 to $4.34)	($1.86 to$4.68)	($0.74 to $3.71)		
Survey 3: JHE	$2.84	$1.29		$3.46	$7.59
95% CI	($0.93 to $5.02)	($0.43 to $2.31)		($2.05 to $5.10)	
Poe statistic = proportion of differences greater than zero (Statistical difference)					
Survey 1 Vs Survey 2	0.39	0.63	0.38		
Survey 1 Vs Survey 3	0.61	0.01**		0.01**	
Survey 2 Vs Survey 3	0.74	0.02**			

In the baseline survey the total WTP is double that for the three attribute surveys providing evidence of theoretical consistency, as respondents were WTP more for a wider range of outcomes. However, varying the attribute combination had a significant influences for values on two of the four attributes (HOUSING and ENV MONITORING), but the effect was only apparent with an increase in scope intensity and not with scope dimension. The addition of a second employment attribute (WAGES) had a significant influence and effectively doubled the value for marginal improvements in both HOUSING and ENV MONITORING (Survey 1 vs Survey 3). Household WTP (per year for five years) to avoid a one percent rise in housing costs, increased from $1.29 (Survey 3) to $3.40 (Survey 1) and WTP for a one percent increase in environmental inspections rose from $3.46 to $6.93. In contrast, an increase in scope dimension and the inclusion of an environment related attribute (Survey 1 vs Survey 2), did not have a significant influence on WTP for any attributes.

A comparison between the intensive scope and extensive scope formats (Survey2 vs Survey 3) indicates a significant impact on HOUSING (WTP being reduced by half in Survey 3) but not on JOBS. The value estimates to reduce the impacts of increased housing costs were significantly higher in both survey formats which included the WAGES attribute, suggesting the increased focus on employment impacts acted to increase the relative importance of the other, non-employment related socio-economic impact on the community (HOUSING). However, it did not affect values for the primary employment related attribute (JOBS), with values unaffected by the combination of other attributes included in the choice profile.

The fourth methodological approach was to compare the tradeoffs respondents made between attributes with the use of latent class models, where individuals are statistically assigned into behavioural groups or latent segments. Comparing differences across survey formats is most clearly illustrated with two-class models. More classes would have provided further information about the preference heterogeneity within each survey format, but would have confounded the cross survey comparison. Full details of the models are provided in Table 7.

Table 7. Latent class model results

	Survey 1: JHWE	Survey 2: JHW	Survey 3: JHE
Class 1: Membership probability	75%	57%	67%
COST	-0.0047 (0.0008)***	-0.0050 (0.0012)***	-0.0061 (0.0009)***
JOBS ('00s)	-0.0004 (0.0082)	-1.1E-05 (0.0001)	-0.0040 (0.0098)
HOUSING (%)	-0.0336 (0.0042)***	-0.0584 (0.0050)***	-0.0440 (0.0047)***
BUSINESS WAGE (%)	0.0011 (0.0051)	0.0113 (0.0081)	
ENV MONITORING (%)	0.0617 (0.0056)***		0.0812 (0.0067)***
Class 2: Membership probability	25%	43%	33%
COST	-0.0891 (0.0226)***	-0.0377 (0.0063)***	-0.0216 (0.0036) ***
JOBS ('00s)	0.0006 (0.0006)	0.0010 (0.0004)**	0.0010 (0.0003)***
HOUSING (%)	-0.0185 (0.0229)	-0.0149 (0.0112)	0.0069 (0.0091)
BUSINESS WAGE (%)	0.0307 (0.0271)	0.0445 (0.0177)**	
ENV MONITORING (%)	0.0383 (0.0282)		0.0023 (0.0123)
Model statistics			
Sample (n)	178	168	176
Observations	1068	1008	1056
Log Likelihood	-934	-793	-930
AIC	1.770	1.592	1.779
McFadden R sqrd	0.204	0.284	0.198
Chi Sqrd	478	628	460

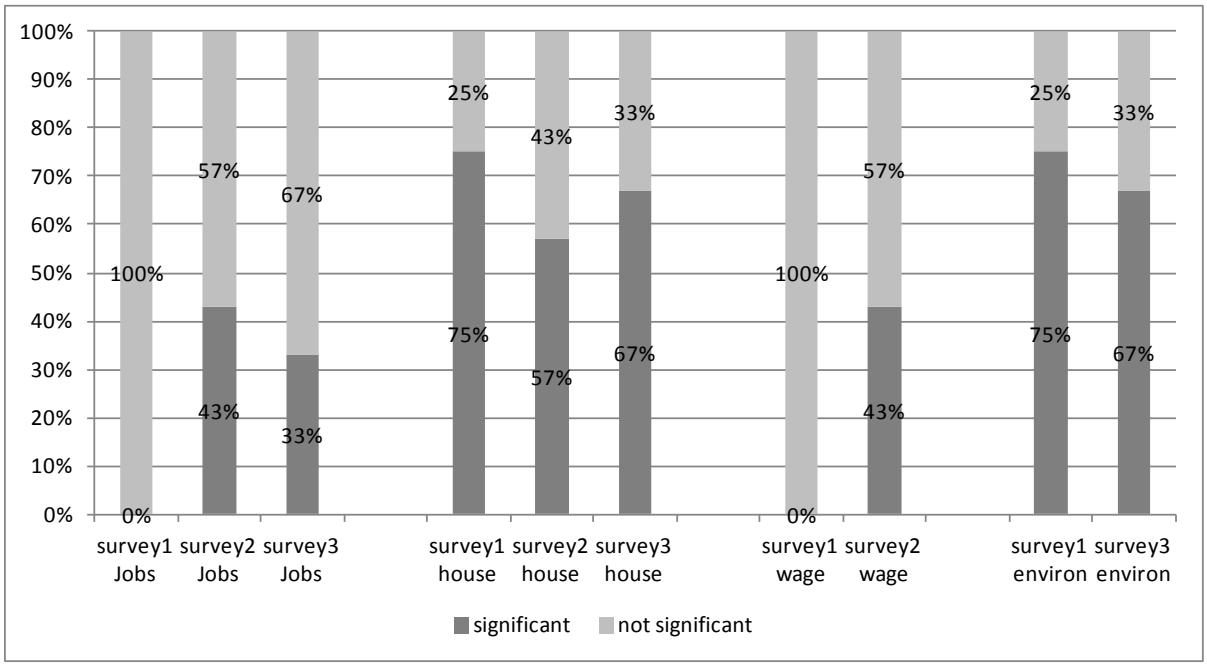
Note: Standard errors are in parentheses

The majority of respondents were represented in the first class and preferences tradeoffs were similar across all survey formats. Preferences for COST and HOUSING were all significant and negative (higher levels were not preferred); preferences for JOBS and BUSINESS WAGE were not significant, and preferences for ENV MONITORING were strong (high coefficient values) and significant, with higher levels preferred. The effect of varying attribute combinations is illustrated in Class 2 membership. Respondents were most cost conscious (coefficient values were the highest) in Survey 1, maybe with too many tradeoffs to consider because preferences for none of the other attributes were significant. In Survey 2 (three attributes without ENV MONITORING), 43% of respondents had significant and positive preferences for both JOBS and WAGES, but HOUSING was not significant. In Survey 3, 33% of respondents had significant preferences for JOBS, but not for HOUSING or ENV MONITORING. It would appear that respondents in this class in both the three attribute format surveys were more focused on the economic, employment related benefits.

More specifically, the main impact on respondents' preferences and tradeoffs occurred in Survey 1, where there were no significant preferences for either employment related attribute across the two class model (Figure 3). This provides a new perspective not revealed in the mixed logit models. The result suggests that the combined influence of increases in both scope intensity and scope dimension has the strongest impact on both the scope related attributes (JOBS and WAGES). The same effect is not apparent in Survey 2 or Survey 3. The survey format did not have such a strong influence on the preference significance for either the HOUSING or the ENV MONITORING attributes (Figure 3).

Although the inclusion of WAGES (Survey 1 and 2) had affected (increased) the WTP for HOUSING improvements, it did not have such a strong impact on preference significance in the latent class models, as apparent for JOBS and WAGES.

Figure 3. Attribute significance across classes and survey formats



Note: The COST attribute was significant in all three survey formats

Discussion and conclusion

The non-market valuation experiment reported in this case study demonstrates that land use changes associated with a developing energy sector in a traditional agricultural region can have significant non-use values associated with economic, social and environmental impacts. The study also demonstrates some of the challenges involved in valuation experiments for multi-dimensional policy issues, with the split-sample experiment results identifying that the selection and combination of attributes can have significant effects on subsequent policy estimates. The results of this case study allow three important conclusions to be drawn.

First, the valuation formats which included the environment-related attribute provided more attractive improvement options, compared to the situation where it was omitted. The results confirm the findings of Hensher (2006b) and others which suggest information relevancy is more important than information load, and increasing the valuation scope dimension does not appear to make the choice task more difficult.

Second, changing the combination of attributes can impact on welfare estimates, although the impacts were shown to be largest for changes in scope intensity compared to scope extension. The inclusion of WAGES significantly increased (doubled) the value of the non employment-related attributes. In contrast, increasing the scope dimension and including the environment-related attribute did not impact on the welfare estimates for the other attributes in the choice profile.

The third key finding is that values may be biased in studies where there are potential interactions (non-independence) between scope-intensive attributes. When there was a scope-related interaction between two attributes within a choice profile, it affected the value estimates, but only for the other accompanying variables. The inclusion of WAGES had no significant impact on the value estimate for the other employment related attribute (JOBS).

For this study, these results indicate that the lower value estimates recorded in Survey 3 were more accurate than Survey 1, as they had not been influenced by the combination of other attributes in the choice profile.

The other information provided by the choice models is an indication of the significance (relative importance rather than relative value) of the different attributes. The most obvious difference between attribute significance and attribute value is apparent in relation to the JOBS attribute. The results of the mixed logit models indicate the values for this attribute were stable across survey formats, but the relative importance or significance of the attribute was weakest in Surveys 1 and 2 (where WAGES was also present). However, the latent class models revealed that there were no significant preferences for JOBS in Survey 1 nor were there for WAGES, something that was not revealed in the mixed logit models. This result suggests that another, different interaction occurred which influenced the relative importance of the attributes. The inclusion of JOBS and WAGES did not overtly impact on the significance of preferences for HOUSING (Figure 3: Survey 2) and nor did the combination of JOBS and EVN MONITORING (Figure 3: Survey 3). It was the combination of JOBS, WAGES and EVN MONITORING that caused an interaction to divert preferences away from both WAGES and JOBS.

These results have important implications for choice modelling analyst, particularly if a variation in the combination of attributes has such a strong impact on welfare estimates. However, there are two important caveats to note. It is not clear from these results if it was the effect of attribute scope intensity that was having the impact or whether it more about the type of attribute. It is possible that an environment or employment attribute evokes a certain response or interaction, and if the same effects of scope intensity would have occurred in relation to an environment attribute. In addition, it is important to remember that the survey was designed to elicit values from a distant population sample so that welfare estimates comprised primarily of non use values, with some component of use value. What the effects might be in a local population sample remains an important topic for future research.

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References

Baskaran, R., Colombo, S., Cullen, R., 2013. Public preferences in irrigation and conservation development projects: Does simultaneous consideration of substitutes in choice sets matter? Land Use Policy 33, 214– 226.

Bateman, I.J., Day, B.H., Jones, A.P., Jude, S., 2009. Reducing gain-loss asymmetry: a virtual reality choice experiment valuing land use change. Journal of Environmental Economics and Management 58(1), 106–118.

Bennett, J., van Bueren, M., Whitten, S., 2004. Estimating society's willingness to pay to maintain viable rural communities. Australian Journal of Agricultural and Resource Economics 48 (3), 487-512.

Boxall, P., Adamowicz, W.L. & Moon, A. (2009). Complexity in choice experiments: choice of the status quo alternative and implications for welfare measurement. Australian Journal of Agricultural and Resource Economics 53, 503-519.

Burton, M., Zahedi, S., White, B., 2012. Public preferences for timeliness and quality of mine site rehabilitation. The case of bauxite mining in Western Australia. Resources Policy 37(1), 1-9.

Carson, R.T., Louviere, J., Anderson, D., Arabie, P., Bunch, D., Hensher, D., Johson, R., Kuhfeld, S., Steinberg, D., Swait, J., Timmermans, H., Wiley, J., 1994. Experimental analysis of choice. Marketing Letters 5 (4), 351–368.

Caussade, S., Ortuzar, J., Rizzi, L., Hensher, D., 2005. Assessing the influence of design dimensions on stated choice experiment estimates. Transportation Research 39(7), 621-640.

Colombo, S., Hanley, N., Calatrava-Requena, J., 2005. Designing policy for reducing the off-farm effects of soil erosion using choice experiments. Journal of Agricultural Economics 56(1), 81–95.

DeShazo, J.R., Fermo, G., 2002. Designing choice sets for stated preference methods: the effects of complexity on choice consistency. Journal of Environmental Economics and Management 44, 123-143.

Dhar, R., 1997. Context and task effect on choice deferral. Marketing Letters 8, 119-130.

Dhar, R., Simpson, I., 2003**.** The effect of forced choice on choice. Journal of Marketing Research 40, 146-160.

Eggert, H., Olsson, B., 2009. Valuing multi-attribute marine water quality. Marine Policy 33, 201-206.

Fleming, D., Measham, T., 2014. Local economic impacts of an unconventional energy boom: The coal seam gas in Australia. Australian Journal of Agricultural and Resource Economics, forthcoming.

Gillespie Economics, 2009. Proposed Warkworth Extension. Choice Modelling Study of Environmental, Cultural and Social Impacts. Report prepared for Warkworth Mining Ltd.

Gillespie, R., Kragt, M., 2012. Accounting for nonmarket impacts in a benefit-cost analysis of underground coal mining in New South Wales, Australia. Journal of Benefit-Cost Analysis 3**,** article 4.

Hajkowicz, S., Heyenga, S., Moffatt, K., 2011. The relationship between mining and socio-economic well-being in Australia's regions. Resources Policy 36(1), 30-38.

Hensher, D. A. 2006a. Revealing differences in willingness to pay due to the dimensionalities of stated choice designs, an initial assessment. Environmental and Resource Economics 34, 7-44.

Hensher, D.A., 2006b. How do respondents process stated choice experiments? Attribute consideration under varying information load. Journal of Applied Econometrics 21(6), 861–878.

Ivanova, G., Rolfe, J., 2011. Assessing development options in mining communities using stated preference techniques. Resources Policy 36(3), 255-264.

Johnston, R. J., Schultz, E.T., Segerson, K., Besedin, E.Y., Ramachandran, M., 2012. Enhancing the content validity of stated preference valuation: the structure and function of ecological indicators. Land Economics 88, 102-120.

Juutinen, A., Mitani, Y., Mäntymaa, E., Shoji, Y., Siikamäki, P., Svento R., 2011. Combining ecological and recreational aspects in national park management: A choice experiment application. Ecological Economics 70, 1231–1239.

Kosenius, A., 2010. Heterogeneous preferences for water quality attributes: The Case of eutrophication in the Gulf of Finland, the Baltic Sea. Ecological Economics 69, 528-538.
Krinskey, I., Robb, A., 1986. On approximating the statistical properties of elasticities. Review of Economics and Statistics 68, 715-719.
Liekens, I., Schaafsma, M., De Nocker, L., Broekx, S., Staes, J., Aertsens, J., Brouwer, R., 2013. Developing a value function for nature development and land use policy in Flanders, Belgium. Land Use Policy 30 (1), 549-59.
Lim, G.C., Chua, C.L., Claus, E., Tsiaplias, S., 2009. Review of the Australian economy 2008-09: Recessions, retrenchments and risks. The Australian Economic Record 42, 1-11.
Morrison, M., Bennett, J., 2004. Valuing NSW rivers using benefit transfer. Australian Journal of Agricultural and Resource Economics 48(1), 591-612.
Petkova-Timmer, V., Lockie, S., Rolfe, J., Ivanova, G., 2009. Mining developments and social impacts on communities: Bowen Basin case studies. Rural Society 19 (3), 211-228.
Poe, G.L., Giraud, K.L., Loomis, J.B., 2005. Computational methods for measuring the differences of empirical distribution. American Journal of Agricultural Economics 87(2), 353-365.
Queensland Government, 2010. Surat Basin Future Directions Statement. Queensland Government, Brisbane.
Reeson, A., Measham, T. Hosking, K., 2012. Mining activity, income inequality and gender in regional Australia. Australian Journal of Agricultural and Resource Economics 56(2), 302-313.
Rolfe, J., 2013. Predicting the economic and demographic impacts of long distance commuting in the resources sector: a Surat Basin case study. Resources Policy 38(4), 723-732.
Rolfe, J., Bennett, J., 2009. The impact of offering two versus three alternatives in choice modelling experiments. Ecological Economics 68, 1140-1148.
Rolfe, J., Windle, J., 2012. Restricted versus unrestricted choice in labelled choice experiments: exploring the tradeoffs of expanding choice dimensions. Canadian Journal of Agricultural Economics 60(1), 53-70.
Rolfe, J., Windle, J., 2013. Including management policy options in discrete choice experiments: a case study of the Great Barrier Reef. Canadian Journal of Agricultural Economics 61, 197-215.
Rolfe, J., Bennett, J., Louviere, J., 2000. Choice modelling and its potential application to tropical rainforest preservation. Ecological Economics 35, 289-302.
Rolfe, J., Bennett, J., Louviere, J., 2002 Stated values and reminders of substitute goods: Testing for framing effects with choice modelling. Australian Journal of Agricultural and Resource Economics 46(1), 1-20.
Rolfe, J., Miles, B., Lockie, S., Ivanova, G., 2007. Lessons from the social and economic impacts of the mining boom in the Bowen Basin 2004–2006. Australasian Journal of Regional Studies 13(2), 134–153.
Rolfe , J., Gregg, D., Ivanova, G., Lawrence, R., and Rynne, D., 2011. The economic contribution of the resources sector by regional areas in Queensland. Economic Analysis and Policy 41 (1), 15-36.
Schandl, H., Darbas, T., 2008. Surat Basin Scoping Study. Enhancing regional and community capacity for mining and energy driven regional economic development. Report to the Southern Inland Queensland Area Consultative Committee and

Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. CSIRO Sustainable Ecosystems, Canberra.
Solomon, F., Katz, E., Lovel, R., 2008. Social dimensions of mining: Research, policy and practice challenges for the minerals industry in Australia. Resources Policy 33, 142-149.
Spyce, A., Weber, M., Adamowicz, V., 2012. Cumulative effects planning: Finding the balance using choice experiments. Ecology and Society 17(1), article 22.
Turner, J.A., Dhakal, B., Yao, R., Barnard, T., Maunder, C., 2011. Non-timber values from planted forests: recreation in Whakarewarewa forest. New Zealand Journal of Forestry 55(4), 24-31.
van Bueren, M., Bennett, J., 2004. Towards the development of a transferable set of value estimates for environmental attributes. Australian Journal of Agricultural and Resource Economics 48, 1-32.
Zhao, M., Johnston, R.J., Schultz, E.T., 2013. What to value and how? Ecological indicator choices in stated preference valuation. Environmental and Resource Economics 56, 3-25.