A New Psychological Approach to Dichotomous Choice CVM.[1]

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Abstract

This paper considers an alternative approach dichotomous choice contingent valuation (DC), referred to as the dissonance minimising format (DM). This method seeks to reduce the extent of positive bias at the formulation stage of stated preference experiments known as "yea-saying", in order to gain a more accurate measure of respondent WTP. Both the DC and DM methodologies are applied to the case study of minesite rehabilitation within Victoria, with particular reference to the abandonment of open pits following small-scale gold mining operations. The results presented here indicate that the DM model has considerable promise for reducing yea-saying within dichotomous choice CV. The results also indicate that the community welfare loss associated with permanent alteration of the landscape from open cut mining is significant, and is far greater than the benefits of such operations to the mine administrators.

Introduction

Dichotomous choice CVM

Contingent valuation researchers have variety of methods for eliciting a respondent's maximum willingness to pay (WTP) for a given amenity, the most popular of which is the dichotomous-choice method (DC).

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Developed by Bishop and Heberlein (1979) the DC method asks each respondent for their response to a single WTP request, which they can either accept or reject. A mean WTP measure is then calculated from one of a number of statistical techniques (Cameron, 1987, Hanemann, 1984).

Several papers have pointed out that the DC method reflects a type of judgement which is performed routinely by consumers, and so should provide an efficient and familiar method for preference searching (Loomis, 1988, McCollum et al., 1990). The simplicity, and lack of interviewer interaction of this elicitation device also conveniently lends itself to surveying by mail. However, this can often cause one set of methodological problems to simply be exchanged for another with non-response a potential sticking point. However the most significant advantage of this technique is its potentially suppressing effect on strategic behaviour.

Strategic Behaviour

A dichotomous choice question can be constructed in a manner such that it is incentive-compatible, meaning that its rules provide respondents with incentives to truthfully and fully reveal their preferences (Cummings et al., 1996). Critics of stated preference techniques point out that there are two problems faced by a respondent in a revealed preference study: a value formation problem and a value statement problem. The first is a question of strict utility maximisation, usually performed in the face of time and resource constraints in the form of filling out a questionnaire. The accuracy of this process is clearly dependent on a variety of factors such as respondent familiarity, questionnaire design and elicitation method among others, which can be specifically fashioned to minimise the degree of bias in a respondents formulation of WTP, f(WTP).

The requirement of respondents to then *state* their formulated WTP, s(WTP) to the investigator however, creates the opportunity for strategic behaviour, where in order to maximise their perceived returns from a project, a respondent may over- or understate WTP. Hoehn and Randall (1987) described the likely outcomes of rational (and strategic) behaviour (seeking deliberate influence) under different policy

decision rules, and provided the conditions for an incentive-compatible honest response.[3]

As the dichotomous choice method of CV involves calculation of consumer surplus from binary responses, (yes or no) a qualitative choice model, specifically the logit model, is generally used in the analysis, with a variety of different 'bid values' used to determine mean and median WTP.

While the issue of strategic behaviour can be adequately addressed by careful construction of a WTP question, another class of response bias where respondents "over-formulate" their WTP by accepting a bid higher than their true WTP is of concern. This behaviour, where respondents don't follow strategic, but other psychological cues, is often referred to as 'yea-saying'.

Suspicion of yea-saying

Suspicion of yea-saying in DC contingent valuation studies was first raised in a number of major studies returning implausibly high positive response rates for upper bid values. Desvousges et al. (1992) in their investigation into the Exxon Valdez oil spill, found 34% of respondents across their national sample were willing to pay $1,000 in increased prices to reduce damage from oil spills. McFadden and Leonard (1992) found a similar phenomenon in their data, with a positive response rate of 15.4% for preserving a wilderness area at a bid value of $2,000 (when these responses were excluded from their dataset the estimated mean WTP decreased by 46.1% from $489 to $263).

In an exercise considering respondent insensitivity to bid values, Blamey et al (1997) found that 57% of their DC sample were willing to pay the maximum bid of $100 for engineering works to maintain a salt lake in Southern Australia, only a slight decrease from the 67% who were willing to pay $20 for the same project. Kanninen (1995) developed a test for what she termed 'positive response bias' seeking to determine whether there was a "fixed proportion of the population which

[3] These rules concern the type of payment vehicle employed (coercive) and the decision rule (simple majority rule).

are yea-sayers" (p.121). Her analysis of a double-bounded DC study indicated that 20% of her sample population were yea-sayers.[4]

Aside from the obvious concern that respondents who yea-say are not making a truly utility maximising choice and are thus biasing the results of the stated-preference exercise, cases such as these, where the probability of a positive response to a DC question appears largely insensitive to the magnitude of the bid amount, makes estimation of the logistical function difficult, if not impossible. This issue is known as the 'fat tail' problem, where the estimated distribution of maximum WTP attaches an unrealistically large proportion of the density to very high WTP bid amounts. If the study does not include WTP amounts which are higher than most respondents WTP, then little information will be generated about the size or shape of the right hand tail of the estimated cumulative distribution function (Ready and Hu, 1995). When the right hand tail of the estimated cumulative density function is unrealistically large or 'thick', resulting estimates of mean WTP will be extremely large, or even unbounded.

The presence of yea-saying thus presents a major problem for estimation of the c.d.f. as in some cases, a reasonable proportion of respondents will answer 'yes' to the highest bid offered, regardless of its magnitude and their respective budget constraints – and can preclude the use of mean estimates of wtp, often necessitating a variety of truncation techniques to limit the cumulative distribution function for the estimated WTP model.[5]

Approaches to dealing with Yea-Saying

Although many researchers have suggested a variety of statistical and mathematical for addressing the 'fat-tail' problem (Ready and Hu, 1995), an alternative solution is to treat it at the source – by identifying the root of the motivation for yea-saying and removing it from the WTP elicitation device.[6]

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[4] The extent of insensitivity to the bids presented was captured by the β coefficients in these studies. Kanninen (1995) found β values of –0.008 for single-bounded DC study of wetlands improvement, and Bennett et al. (1997) found β values of –0.01 for their DC study of salinity management both before and after trimming protest bids from their dataset.

[5] The emergence of this problem further highlights the care which must be taken when determining the appropriate bid-vector for use in such a study Duffield, and Patterson, (1991) Cooper and Loomis, (1992) , and Cooper, (1993)

[6] While this approach will not solve the problem where the bid vector is too low, it should address the problem of some respondents accepting the bid amounts regardless of their magnitude.

Causes of yea-saying

To use the parlance of the previous section, yea-saying, or WTP acceptance without true reflection of utility maximisation is not interpreted as a form of strategic behaviour, but as an issue at the value *formulation* stage of WTP reporting.

The intention of developers of the DC format was a less cognitively demanding format which would lead to more valid and reliable point estimates of respondent WTP. As mentioned earlier, one of the most attractive aspects of DC contingent valuation is the familiarity and simplicity with which a WTP decision is designed to appear to a respondent.

Despite these good intentions, however, some research indicates that the reverse may be occurring, and that prompting a respondent with a bid value may encourage a 'lazy' yes or no response which bears little resemblance to a 'true' equivalent variation measure, or may force a respondent to channel the product of a complex and unfamiliar preference ordering exercise into an over-simplistic "yes or no" answer.

Once a respondent is ambivalent about his or her answer, many studies suggest that they are more likely to provide a positive response. This is since most people will have *some* small, positive value for the good in question, but have not gone to the trouble of isolating it specifically. To answer "no" in such a case is in a sense more surely incorrect for a person who has determined that they have some positive value for a good. One of the most popular tests for yea-saying involves the comparison of OE and DC contingent valuation data. As part of their study of WTP for risk reduction, Ready et al (1996) asked respondents a DC question with a follow-up OE question and found 22% offered an open ended WTP amount *lower* than their accepted DC WTP, suggesting yea-saying was occurring extensively in the DC study, and that respondents had not carefully considered their response to the DC question before answering.[7]

A related cause of the yea-saying phenomenon in contingent valuation is described by Brown et al. (1996) who point out that respondents who wish to indicate support for the provision of the good have a much more direct vehicle when answering an OE question than a DC. This is since any positive amount offered

indicated support, whereas a respondent in a DC study can only signal support for the environment by answering affirmatively.[8] Thus providing respondents with the opportunity to express support for a proposal without a coupled monetary commitment should therefore lessen the degree to which they are compelled to "yea-say".

A further complicating factor is the difference between the clarity of the preference decision facing respondents in DC and OE contexts. In focus testing for this survey, respondents felt it was much easier to express a clear in-principle preference for environmental protection or enhancement than it was for a specific monetary amount they would be willing to pay. If the two decisions are bound together then there is a significantly greater chance that the respondent will overstate their *true* Hicksian surplus by merely following the simpler preference search. Opaluch and Segerson add to this idea in their discussion of ambivalence in decision making.[9] They suggest that ambivalence, which may be a quite common reaction to routine decisions, often arises from a conflict between tastes (which rank outcomes in terms of personal benefit) and values (which relate to long-held values, ethics and morals), forcing the individual to solve the impasse by "irrationally" overruling tastes by reference to value-based lexicographics or rules of thumb. This clash of tastes and preferences or seemingly irreconcilable internal conflict is referred to by psychologists as cognitive dissonance, and is used to justify a variety of seemingly irrational well-publicised public decisions (Aronson, 1992, Opaluch and Segerson, 1989). The potential for employment of this form of decision making for environmental protection is substantial, with acceptance of WTP bids appearing as yea-say responses rather than utility maximising.

There are a number of possible hypotheses in the literature relating to the variety of cognitive processes which occur when a respondent is presented with the

[7] Ready et al. (1996) found a much lower incidence (2.4%) of nay-saying, where respondents changed their positive DC bids to a lower amount under a subsequent OE WTP question.
[8] Thus a 'no' vote to a question asking for $500 to save an endangered animal species may cause considerable discomfort on the part of a respondent, even if the amount is outside of their budget constraint for such expenditure.
[9] Ambivalence here is defiend as the condition when an individual faces strongly opposing feelings when making a decision and finds the decision an extremely difficult one to resolve. Indifference, on the other hand, arises from an *absence* of a preference due to perceived irrelavance or similar of the decision.

opportunity/obligation to formulate and state their personal valuation for an unfamiliar good and the biases associated with them.

One of these is so-called 'social desirability bias' where respondents comply with a presumed expectation of a socially desired positive response (Mitchell and Carson, 1989, Arrow et al., 1993). Berrens et al. (1997) sought to prove the contribution of this bias to yea saying via a split-sample test involving a randomised-response model and standard dichotomous choice CV method to ensure anonymity of responses. Their preliminary results however were inconclusive, with the choice of functional form appearing to be considerably more influential than whether or not DC responses were socially 'invisible'.

This is one of the simple although significant digressions of the dissonance minimising format from the traditional DC model. Allowing respondents to express support for an environmental program without the pecuniary commitment is a major component of the DM elicitation format.

The Dissonance Minimising Choice format

This format, related to similar work by Blamey et al. (1997) is designed to avoid many of the identified and suspected factors which encourage yea-saying.

It enables respondents to express their support (or lack of) for a proposed change to the status quo through an initial question, without monetary commitment, and then allows them to declare their unacceptance or support for monetary contribution for the same proposal through a choice from a number of alternative response categories provided (developed on the basis of focus group and pilot survey feedback). Both of these stages are integral to the success of the method. The thought process which respondents face in a DM framework is described below.

The separation between expression of support for the project and commitment of funds is clear, and appreciated by respondents (see results). Respondents are also provided with a series of outcomes to choose from, all of which reduce to dichotomous yes or no decision. The transparency of the choices is important, with each respondent fully aware of the budgetary implications of their choice.

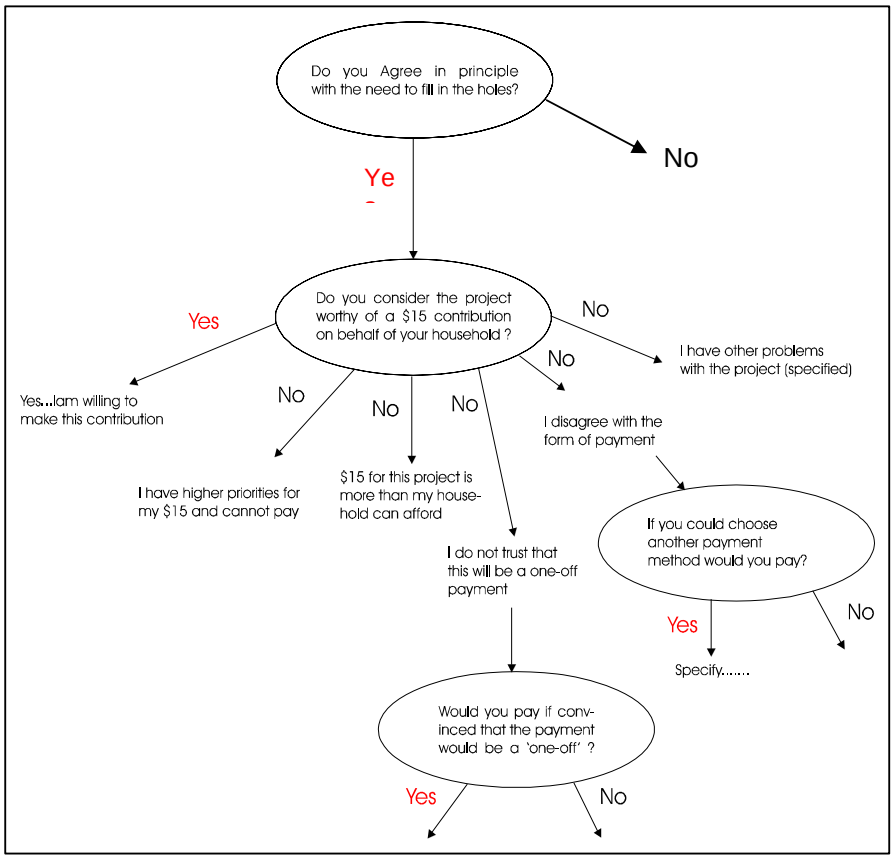

Fig 1. Figurative Representation of DM process

The hypothetical scenario in which Victorian residents are asked to estimate their willingness to pay for this project is a difficult one. The reluctance of some respondents to bear responsibility for the project was quite apparent from feedback received throughout the development process. As a result, the DM response categories were careful to avoid response categories which could be interpreted as legitimising (encouraging) this form of protest response. Further, rather than a continuous list of choices, the transparency of the process was enhanced with the explicit separation of the positive from the negative responses on the answer sheet. Respondents were encouraged to contemplate their choice carefully by scanning the entire list of alternatives presented on the page, however once the choice had been made, it would be clear on which side they had 'voted'.

An additional benefit of this approach is the targeted use of follow-up questions. Respondents who refused to pay due to particular difficulty with the proposed payment vehicle could identify themselves, and possibly provide another more suitable vehicle. A cynical respondent who would have answered positively but

for their suspicions about the duration of the one-off payment could also remain in the sample by virtue of follow-up questions. The identification and removal of protest responses is therefore approached more systematically. Rather than sending back a blank questionnaire, or a partially completed one in defiance of the questions which had been asked, respondents were encouraged to express their motives as well as their preferences within the body of the questionnaire as well as in an additional 'comments page' added to the end of the document. The occurrence of protest responses is an important issue when dealing with contingent valuation responses, and particularly so when responses are gather by mail and the response rate is not entirely controlled by the investigator.

The DM method is more attune to the psychological requirements of the average respondent to a CV questionnaire, and was expected to provide more accurate results with fewer protest responses than either the DC or continuous stated preference measurement Results and comparisons with DC and OE results are presented in the following section.

Logistics of the Survey

Primary data collection was undertaken in two stages. The first involved sending 500 open ended questions to a random selection of Victorian residents on February 1998 with responses closing in March 1998. This subsection was split between a 'large' and 'small' scopes of environmental impact in order to facilitate an external (independent) test for sensitivity to scope. The second data collection exercise involved sending 2,000 discrete choice questionnaires to a random selection of Victorian households, split into 5 bid levels, two scope levels and two elicitation methods (the DC and DM) for a total of 20 groups of 100.

The experiment was designed to investigate the significance of the scope effect upon the different elicitation mechanisms, and the extent of sensitivity within the bid vectors as between the DM and DC groups.

The large and small scope scenarios were developed during the final three focus groups. In order for a scope test to be valid, the two different scopes should be neither so similar in the minds of most respondents that they confound do not discriminate between the two with respect to willingness to pay, nor should they be so 'obviously' heterogeneous that the test is meaningless

An alternative scope test which was considered involved variation of the level of environmental degradation associated with the mining pit with the quantity of holes kept constant. Although a similar exercise to the one above was undertaken and provided a successful indication of scope sensitivity, it was not pursued due to the falseness of the claim to which some well-informed respondents may object, and a lack of suitable substitute with which to frame a contaminated site.

Gold mining and quarrying

Although this experiment was applied to the case of environmental degradation associated with gold mining, there are obvious extensions to the extractive industries (quarries) which operate under similar legislative requirements within Victoria. Accurate and unbiased framing of the good being valued is an important part of contextualising the study for respondents. It would have been misleading to claim to Victorians receiving the questionnaire that the only open pit holes in the State were those created by the minerals industry while there are many more quarry pits across the state.

Results

The overall raw response rate achieved was 53.1%. This was relatively high for a mail survey of non-use values, especially since less than 20% of the sample admitted to being aware of the issue presented in the questionnaire before reading it. The *valid* response rate of 41.6%, (including only non-protest responses which include valid responses to the willingness to pay question) was relatively high by general contingent valuation standards, and sufficient for the purposes of statistical investigation of results. The response rate for the DM version was also significantly higher than the DC and OE methods ($p < 0.01$) for both the raw and valid samples.

Analysis

The DM version was designed to minimise the extent of yea-saying bias associated with discrete-choice contingent valuation and hence elicit a more accurate and truthful representation of a respondent's WTP. The first part of this approach, which asked for a non-financial expression of support, was found to be strongly independent of respondent's final WTP choice, indicating that respondents considered

it independently from the actual payment question (χ^2 = 55.3 and 39.6 at 1df for DM small and large scopes respectively, p<0.005 for each).

Regression analysis

The dependent variable for all of the following models was WTP, the yes or no response provided by survey respondents. The framing of this WTP question varied on the basis of bid amount ($2, 5, 10, 20, 50) and across two scenarios, each involving both a 'large' and small project scale.

The explanatory variables contained in the models included both attitudinal and demographic variables collected prior to and following the main WTP question in the questionnaire. Several dummy variables were also included in the models, described here:

Variable	Interpretation
BID	dollar amount presented to respondents
SCOPE	Dummy variable for scale/scope of project 1 for large scale, 0 for small
INCOME	Respondents' gross household income
ENV_SCORE	Respondents' score for public funding of environmental protection
EDU_SCORE	Respondents' score for public funding of education (proxy for education)
REHAB	Respondents' score for public funding for rehabilitation of damaged lands
EDUCATION	Categorical measure of educational attainment
SHOPPING	scale of environmental sensitivity of respondents' shopping habits
AWARE	Respondent was aware of issue raised in questionnaire prior to study
RURAL	Dummy variable 1 for rural resident, 0 for metropolitan (by postcode)
LOCAL	Dummy variable 1 for local resident, 0 for non-local (by distance, postcode)

Nine logistical regression models were developed, two each of the two different combinations of DC and DM questionnaire formats, two each of the small and large scale questionnaire versions (DC and DM combined), and one of all of the dichotomous questionnaires combined.

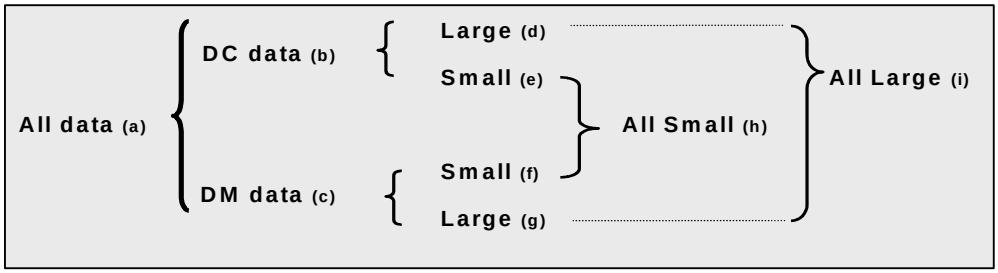

Fig 2 Map of sub-splits in data for modeling.

Logistical regression results for the linear utility model were as follows:

Model/ Variables	DM Large	DM Small	DM All	DC Large	DC Small	All discrete data	DC All
Bid amount	-0.037	-0.058	-0.042	-0.02	-0.055	-0.037	-0.032
Scope						0.673	1.04
Income				0.236	0.133	0.083	0.201
Env Score		-0.392	-0.289			-0.165	
Rehab Score	-0.204					-0.159	-0.248
Rural resident			-0.562			-0.5063	
Local resident					-1.03		-0.754
Awareness			0.718				
Env Org			-0.109				
Shopping habits						0.19	
Education	0.275						
% predicted	**64.8**	**71.5**	**67.9**	**69.7**	**66.85**	**68.5**	**70.3**

Table 1 Results of Logistical Regression (All coefficients significant p< 0.05)

All of the parameters presented here were signed as predicted. The statistical significance of the BID amount variable and its magnitude throughout all of the models showed the sensitivity of responses to the amount presented, providing good indication of the validity of the economic choice made by respondents. The significance of both the ENV_SCORE and REHAB parameters is also as expected, (with scores closer to 1 indicating a higher preference for both, hence the negative signs on the coefficients). The relationship between income and WTP and environmentally sensitive shopping habits and WTP also met apriori expectations although the effect was not widespread[10].

An interesting outcome was the negative sign on both the RURAL and LOCAL coefficients, indicating that both categories of residents were less willing to accept the bid presented to them than their metropolitan counterparts. This may be

[10] The DM dataset exhibited a significant correlation between Income and protest responses. This association was largely responsible for the lack of association between income and WTP response for the DM data.

due to lower income levels in rural areas, or a concern that other projects, such as local infrastructure should receive funding priority.[11]

These models do not contravene any reasonable hypotheses regarding the log-likelihood of a respondent accepting a request for a donation and any of the independent variables. All of the significant parameters were expected to have an impact upon the dependent variable.

Scope effects

The SCOPE dummy variable was significant, both across the discrete data overall and across the DC dataset, indicating that respondents to the dichotomous choice questionnaires were receptive to the scale of the environmental rehabilitation project presented to them. The DM data were responsive to scope at the 8% level when the lower two bid levels were trimmed from the dataset. The OE dataset exhibited no sensitivity to the scale of the project, and is therefore considered inferior to the discrete choice results.

The first impression from this result is that the DC was a superior method since the scope test was passed in a more comprehensive fashion. However consideration of the implications of this result suggests that an alternative conclusion is also possible.

Insensitivity to the scope of the project at the $2 and $5 levels can be explained in the sense that it is reasonable to assume a respondent who rejected a $2 request for help would refuse regardless of the scale of the project, since $2 is small and quite 'disposable' amount of money. Phrased differently, for the DM sample the increase in project scale was not enough to make the 'nay-sayers' change their minds and accept the low bids.

This raises the question of the suitability of the DC version, which found more people accepting the $2 bid at the large project version than the small.

[11] Correlation results found that rural residents were in lower income categories, and placed a higher preference in infrastructure and road spending (at the expense of environmental spending) than their metropolitan counterparts. Please contact the author for discussion of these results.

In order to illustrate the results, the data were split into a 2x2x2 table, with overall acceptance rates as follows:

Methodology	**Small Project**		**Large Project**	
Bid amount	$2 and $5	$20 and $50	$2 and $5	$20 and $50
DM	0.60 (1)	0.23 (2)	0.68 (3)	0.36 (4)
DC	0.56 (5)	0.30 (6)	0.74 (7)	0.51 (8)
Mean	**0.59** (9)	**0.26** (10)	**0.71** (11)	**0.44** (12)

Table 2. Acceptance rates across different sub samples. (cell number).

The overall scope effect in the data is indicated by the comparison of cells (9) with (11) and (10) with (12). The specific scope tests between the versions are most illustrative. While the acceptance rate for the DM version only increases slightly for the small bid levels, (0.6 to 0.68) the corresponding difference for the DC is much greater (0.56 to 0.74).

The affordability constraint effect is also noticeable in the above table, as acceptance rates decrease with the increase in bid amount both for the large and small project scales.

The suitability of scope sensitivity at very small bid amounts has not received very much attention in the contingent valuation literature. An interpretation offered here is that there is a body of DC respondents who feel encouraged by the large scale of the project to accept a bid value, despite their general disapproval or lack of agreement with the project. This subsample of respondents express their disapproval in the small project case, but are tempted to change their minds in the large case. An illustration of this hypothesis is provided here.

The data splits the respondents into two attitudinal categories: those who support the project in general (at either scale) and those who do not. The approximate ratios are derived from responses provided in the survey itself. As mentioned earlier, prior to the WTP question respondents to the DM questionnaires were asked whether they supported the project in principle (standard DC respondents were not). Approximately 20% of respondents expressed in principle disapproval with the project.

The following is a demonstration of the data for a sample of 100 respondents. Cells contain the frequency of positive responses.

			Small Project		Large project	
Count		Type	$2 and $5	$20 and $50	$2 and $5	$20 and $50
Don't Support	10	DM	0	0	0	0
	10	DC	0	0	7.5 - 3.5	0
Support	40	DM	30.5	11.3	34	19.05
	40	DC	28.5	14.7	29.5 - 33.5	24.95
Total			**59**	**26**	**71**	**44**

Table 3. Expected frequency table according to DC yea-saying hypothesis

According to this interpretation of the data, there is group of DC respondents who against the principle of the project, although willing to donate a small amount to the large scale of the project (shaded cell in the table above). The DM respondents are prevented from taking this course of action by a preceding question asking for their principle support. After acknowledging their in-principle disapproval with some aspect of the project, none of these respondents offered a positive response to the WTP question.

This interpretation amounts to a classic case of yea-saying in the DC dataset at the lower bid values, where respondents are replying positively to a request for funds as a result of influences other than utility maximisation, i.e. DC is only sensitive to scope at the $2 level *because of yea-saying*.

This analysis supposes that in actuality, neither the DM nor the DC methods were very sensitive to scope at the $2 levels, though both methods exhibited much greater sensitivity at higher bid levels.

Implication of this result

This result has potentially important implications for the interpretation of WTP motivations in general, and sensitivity to scope in particular. If yea-saying is potentially socially motivated as suggested by Mitchell and Carson (1989) and the degree of social motivation increases with the scale of the good, then rather than WTP reflecting an function of the change in utility from differences in scale, a scope test may rather be merely collecting the artifacts of a flawed mechanism for utility

expression. In other words, the presence of yea-saying helps an experiment pass the scope test.

The research implication of this result is that there must be a clear indication of both the likely marginal utility change experienced by respondents with different changes of magnitude in the project for the purposes of constructing a scope test. If there is insufficient evidence that the change is likely to elicit a significant difference in WTP then the responses will not be expected to pass a scope test. In this scenario, failure to provide evidence of a change is a realistic and valid result, while the presence of scope sensitivity may merely indicate the presence of yea-saying in large-scale scenarios relative to small-scale.

Calculation of mean WTP

The above models were used to calculate the means and medians of household WTP by integrating the area bounded by the distribution functions, truncated to various ranges:

Model		Mean		Mean/ Median
		0 to $^{+}\infty$	*0 to Max Bid ($50)*	$-\infty$ to ∞^{+}
Large	**DM**	31.98	23.73	22.24
	DC	66.04	31.44	53.14
	Pooled	42.27	28.29	34.19
Small	**DM**	20.41	18.4	14.24
	DC	19.11	16.86	10.33
	Pooled	19.55	17.29	11.33

Table 4. Mean and Median measurement s of respondent WTP.

The models are presented graphically below. The marked difference between the average WTP of the two project sizes is demonstrated here, with the larger project pushed out to the right on the model with the data pooled from the large DC and large DM models.

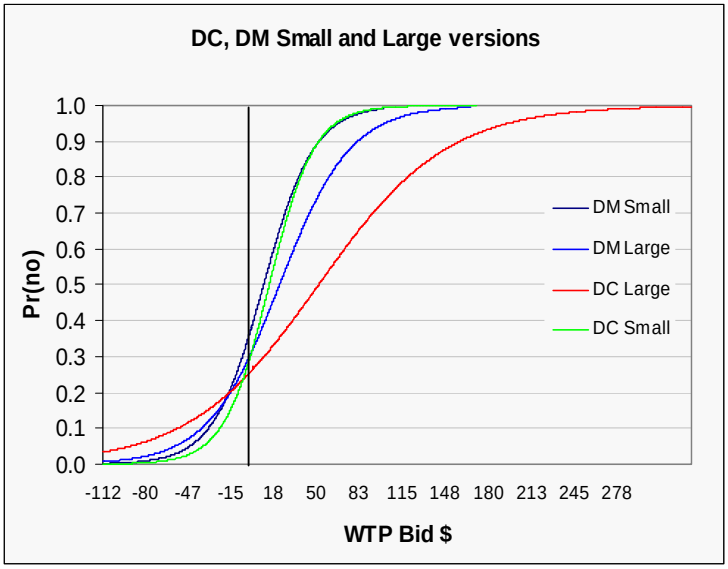

Fig 2 Estimated WTP functions for small and large versions –linear-logistic form.

Preliminary evidence of yea-saying from the linear analysis

As mentioned above, one of the main indicators of yea-saying in discrete choice CV is a lack of sensitivity to the bid variable, indicated by either a lack of statistical significance, or a very small coefficient value. All of the bid coefficients presented here were strongly significant, with relatively strong coefficients.

Further, the bid coefficients were larger for the DM data than for the DC, particularly for the large-scale project to repair multiple minesites.

In order to remove the influence of other explanatory variables from the bid variable, the analysis was also conducted with the bid amounts as the only explanatory variable for respondent WTP. Results were as follows:

Model	β	S.E	95% Upper value	95% Lower Value	% predicted
DM Large	-.0352	0.0084	-0.0548	-0.0186	62.11
DC Large	-.0238	0.0083	-0.0400	-0.0074	62.21
DM Small	-.0535	0.0109	-0.0749	-0.0321	70.37
DC Small	-.0436	0.0113	-.06817	-.02339	62.32

Table 5 Comparison of Bid coefficients, DM versus DC formats.

While the overall results indicate overall responsiveness to the bid vector (which had been chosen on via extensive pretesting) the DM formats consistently showed higher bid coefficients than the DC. The coefficients for the large scale project were also lower than for the small scenario presented to respondents – a result consistent with expectations. The goodness of fit measure reported here suggests the small DM model outperforming the others, which are all roughly equal. These goodness of fit measures are all at least 2% below the full models, suggesting that a significant proportion of information in the full (linear) models comes from the other explanatory variables.

DC and DM results compared

The difference between the DC and DM versions, while significant at some bid amounts were found to not be significant when all of the data were pooled together. The overall statistics were as follows:

Comparison DC and DM		
	χ^2 statistic	*p*
Small/Small	4.11	0.391
Large/Large	4.2	0.379
Cutoff:	*P=0.05*	*9.488*
	P=0.1	*7.77*

Table 6 overall χ2 comparison, DC and DM versions

The two elicitation devices were found to be significantly different at the $5 and $20 bid levels for the small scope projects, otherwise the χ^2 statistics for independence were not found to be significant.

Validity of the Data

The validity of the data is generally assessed by the extent to which it meets the expectations of consumer demand theory that in answering the WTP question put to them, respondents are acting to maximise their utility subject to a given set of constraints, the most dominant of which is income.

Comparison of acceptance rates between the DC and DM methods across different project sizes and WTP amounts illuminates the pattern of behaviour across these groups and indicates the extent to which the results obtained conform to the

expectations of economic theory, with implications for the choice of methodology adopted.

As shown above, the two different discrete elicitation methods gave different results with respect to scope. The DC method was sensitive to scope over the entire bid vector, while the DM version only appeared sensitive over the range \$10-\$50 (p <0.08).

Choice of the welfare measure for cost benefit analysis

The inevitable outcome of the preceding statistical analysis is the rigorous choice of a measure of welfare for the purpose of comparison within a cost-benefit framework. Although a sensitivity analysis will be applied to this figure, the choice of base number from the many possible approaches nevertheless carries important implications for the interpretation of conclusions.

The following chart illustrates the range of estimates of mean and median WTP as obtained from the survey data according to a variety of parametric nonparametric methods.

Model			Dichotomous Choice ("DC)		Dissonance Minimising Choice ("DM")	
Measure	Model	Range	Small	Large	Small	Large
Mean	Linear Parametric	0-50	31.44	16.86	23.73	18.40
		$0 - \infty^+$	66.04	20.41	31.98	19.11
Mean/ Median		$-\infty - \infty^+$	53.14	16.86	22.24	14.24
Mean	Log-logistical	0-50	26.50	19.40	26.50	16.70
		0-100	45.71	28.51	43.75	22.49
	Non Parametric	0-50	25.93	17.230	23.30	17.74
		0-100	52.47	27.90	33.05	18.48
Median	Log-Logistical	Na	15.20	6.50	15.00	8.80
	Non-Parametric	Na	32.00	10.00	16.00	4.50

Table 7 Summary of results from data analysis (mean in \$Aus)

The mean value of the once-only WTP for the small project, representing rehabilitation of the single mining operation ranges from of \$9.94 to \$28.51 according to the specific methodology employed.

As there are no established rules for the preference of any particular methodology over another, the choice of the appropriate mean measure of WTP is made on logical grounds. The sensitivity of the log-logistical models to the range of integration suggests that they do not serve as robust measures of community welfare. The nonparametric approach, while more appealing due to the absence of any distributional assumptions about the error term or the overall WTP function, is sensitive to the method used to interpolate between the data points, and not considered a first-best answer.

Following the example provided by Hanemann (1986, 1990) the linear model which involves integration of the WTP function from the bounds $^{-}\infty$ - ∞^{+} will be used here representing the mean/median WTP amounts.

As the results of the preceding analysis did not produce a clearly preferable methodology from the choice of DM and DC, the average of the two mean WTP measures is be taken as the valid measure.

The mean WTP result from the continuous data is also provided in this analysis, although not directly comparable with the DM and DC results since the continuous result is bounded to be greater than zero.

According to the discrete data, the mean welfare loss associated with a level of minesite/quarrysite rehabilitation as described in the survey questionnaire was $15.55 for the sample surveyed. Using the same method, the mean welfare loss associated with the larger scale of project, to rehabilitate 21 sites was $37.69.

Using the continuous data, which did not show sensitivity to scope, gave a mean of $10.36 for the single site, and $16.09 for the multiple sites.

Aggregation of the mean WTP data

As described to survey respondents in all versions of the questionnaire, the mean WTP figures calculated above are taken to be representative of entire households, rather than individual contributions. Despite the clarity of what the mean WTP measure represents, extrapolation of these results to reflect the aggregate preferences of a population involves a choice of how to represent the proportion of nonrepondents within the overall survey.

The total number of responses to the survey was 1207, with a further 227 questionnaires considered undeliverable and returned unopened. A conservative estimate of aggregate WTP would be to consider the unopened responses as behaving in the same manner as those which were delivered, but all delivered and unreturned (i.e. non-responding) members of the sample considered to offer a zero WTP bid. This assumes a non-negligible cost to the respondent of returning the questionnaire document, whereby a respondent with zero WTP would be less likely to return their questionnaire than a respondent with a positive WTP seeking to make their contribution. Despite the return postage provided to respondents, there was still an implicit price involved in returning the questionnaires, and hence this is a reasonable assumption.

In this scenario, the household WTP for the single mine case is was $8.91. Multiplied by the 1.6 million independent households in Victoria the total comes to $14.9 million.

Application to the Case Study: Bailieston Open Pit.

The mine site

The contingent valuation exercise concerns a single open-pit mine operated in Central Victoria. The site was chosen by virtue of a number of factors. First, the land upon which the pit was constructed was semi-forested Crown Land, and abutted a State Forest. At the time of the commencement of this study, the mine was approximately 2/3 through its planned operational phase, and was expected to have entered decommission phase by the time the contingent valuation study was underway. This would enable accurate measurement of the financial costs and benefits associated with the project to compare with non-financial costs and benefits.

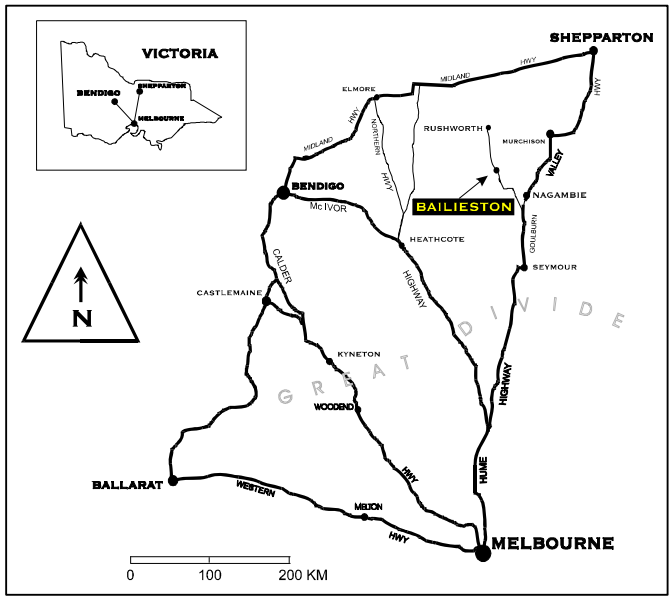

Fig 3 Bailieston and surrounds from Melbourne. Source: VICMAP

The operation is located 120 kilometres north of Melbourne and abuts the Rushworth State Forest. The mine itself occupies a small proportion of the lease area, while a larger area is taken up by an overburden heap and a heap-leach operation.

According to the tenement information lodged at the Victorian Department of Minerals and Energy, the mining lease, which was granted in June 1996, covers an area of 225.7 hectares. A rehabilitation bond of $100,000 was lodged in October 1995 prior to the commencement of work in January 1996.

The Bailieston Open Cut Mine

The modern mine project began in late 1992, with approval granted for a program of exploratory drilling at the Bailieston site. Although the site appeared to be a low grade deposit with ore grades of between 0.7 and 0.8g of gold per tonne, its proximity to another of the company's refining sites suggested the project would still return a profit. Authority to commence work was granted in January 1996, with the first ounces of gold poured by the end of the following quarter.

Though falling short of productivity expectations, the project was anticipated to provide an after-tax profit of $1.1 million from production of 15,000 ounces of gold, with mining ceasing in the September quarter of 1997 and final gold extraction to take place in June 1999.

The company involved prides itself upon its record of environmental compliance. It is one of only six Victorian mining companies to make a formal voluntary commitment to the Minerals Council of Australia's voluntary Code for Environmental Management, which requires public reporting of all environmental aspects and impacts associated with mining operations as well as a commitment to continual improvement of environmental performance.

The rehabilitation plan for the Bailieston pit, fully detailed and costed prior to the commencement of work, involved stockpiling of all soil cover from the pit area to facilitate rehabilitation of the waste dump area, and the contouring of the waste dump to match existing landforms (Sprague, 1994).

An intensive program of tree-planting was also undertaken progressively throughout the life of the project, with seeding and tubestock planting using seed collected from the local area over the waste dump as well as around the pit itself.

The mine operators also constructed a 'bund' earth wall around the pit and erected a safety fence to ensure that any onlookers would be prevented from entering the pit.

As a further goodwill gesture, the mine owners purchased a block of scrubland adjacent to the license area equal in size to the pit area and donated it to the State Government with the intention of that area being incorporated into an existing flora reserve. The overall cost of these operations was $165,000, with the bulk of these costs incurred from earthworks associated with contouring the waste dump to reflect the local landscape features.

Due to the small size of the Bailieston pit, the only method of backfill considered for feasibility testing was at the completion of mining, rather than a progressive operation concurrent with production. With almost all backfilling operations, the main cost associated with is the earthworks involved, with the total cost coming to $1.35 million and taking 37 weeks, or 2,000 hours and employing 6 pit technicians full-time.

Cost benefit analyses of the alternative scenarios are presented here.

Unbackfilled pits ('do nothing') scenario

		Millions ($Aus)
Financial Benefits	Gross Operating profit from Gold production[12]	$1.100
Financial Costs	*less* Rehabilitation expenditure (land contouring, tree planting)	$0.156
	Net Financial Benefit / Loss	+ $0.944
Social Benefits	Generation of employment[13]	$2.010
	Existence value of mine (4% of environmental existence value)	$0.600
Social Costs	*less* Environmental damage	$14.900
	Net Social Benefit/Loss	- $12.290
	Net Total Benefit/Loss	*- $11.360*

Table 8 Net total benefit of the Bailieston mining operation with rehabilitation as completed.

[12] Anticipated, not realised profits.
[13] Social benefits are calculated based on fiancial and social costs associated with employment. Social costs derived from Morrison, et al., 1998 and Lockwood, 1994. Please see the author for more information.

Backfilling scenario

		Millions ($Aus)
Financial Benefits	Gross Operating profit from Gold production	$1.100
Financial Costs	*less* Backfilling operation (900,000m^3 @ $1.50)	$1.350
	less Rehabilitation expenditure (land contouring, planting)	$0.156
	Net Financial Benefit/Loss	- $0.094
Social Benefits	Generation of employment	$2.010
	Generation of employment (backfilling operation)	$0.428 [14]
	Existence value of mine (4% of environmental existence value)	$0.600
Social Costs	*less* Environmental Damage	$0.000
	Net Social Benefit/Loss	$3.038
	Net Total Benefit/Loss	*$ 2.944*

Table 9. Net total benefit from Bailieston mining operation if pit is backfilled and site rehabilitated.

As shown in the above table, due to the marginal expected financial return from the mining operation, backfilling was technically straightforward, though not considered to be an economically viable option, although once backfilled, the impact of the operation from a social standpoint becomes strongly positive (and would be moreso with a mining operation employing more people and being more profitable).

The two cost-benefit comparisons above indicate the extent of loss associated with minesite rehabilitation as undertaken under the MRDA legislation. The negative externality associated with failure to backfill open pits overwhelms the financial benefit to the company, while from the social perspective, the cost of rehabilitation is considerably smaller than the overall gain. The magnitude of the social cost identified through the contingent valuation exercise, indicates the substantial market failure which occurs with the case of minesite rehabilitation. Private companies receive no price signals to indicate the extent of the cost borne by the community by these practices aside from sporadic public demonstrations against specific projects.

Conclusions

[14] Assuming two of the 5 workers on the backfill operation is prevented from otherwise becoming unemployed for the duration (37 weeks). Uses the average of the annual weekly per household costs for unemployment avoidance (17.54 ¢)

The study serves to highlight the overwhelming welfare costs associated with incomplete minesite rehabilitation when compared with the financial returns from such operations. Before the concerns of the community are fully incorporated into rehabilitation guidelines, and in particular the prerequisites for backfilling open pit mines, external costs such as those investigated in this study will continue to be levied upon members of the wider community.

The issues raised in this study regarding CVM and yea-saying point to the need for further research. The psychological precursors of stated preference techniques are still generally poorly mapped and understood by the majority of economists, and more experience and experiment needs to be directed towards this area. It appears that the traditional dichotomous choice model, which leaves little room for self-expression may lead to biased results.

The DM method offers some hope toward the alleviation of the yea-saying bias. Further testing of the method involving more extensive bid vectors and a host of different scales of good, as against the DC method would be useful in determining the extent of respondent sensitivity to the scenarios presented, and give some clues as to the extent of yea-saying prevented.

Overall, the tests conducted here indicate that CVM is able to facilitate valid preference searching and statement, with results useful for the calculation of changes in personal and household welfare.

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