ISSN 1835-9728

Environmental Economics Research Hub

Research Reports

Willingness to pay for recycling food waste in the Brisbane Region

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Research Report No. 96

March 2011

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Environmental Economics Research Hub Research Reports are published by The Crawford School of Economics and Government, Australian National University, Canberra 0200 Australia.

These Reports present work in progress being undertaken by project teams within the Environmental Economics Research Hub (EERH). The EERH is funded by the Department of Environment and Water Heritage and the Arts under the Commonwealth Environment Research Facility.

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ABSTRACT

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

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

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

If a compulsory food waste recycling scheme could be provided to all households for less than $32 to $35 per household per annum then the benefits of the scheme would exceed the costs and would be considered to be economically efficient and desirable from a community welfare perspective. Given the difficulties of estimating precise WTP values from dichotomous choice data, any BCA of a compulsory scheme incorporating the results of this study should undertake sensitivity testing that includes the range of values reported including dichotomous choice and open-ended means to determine the robustness of BCA results to variations in the welfare estimate.

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

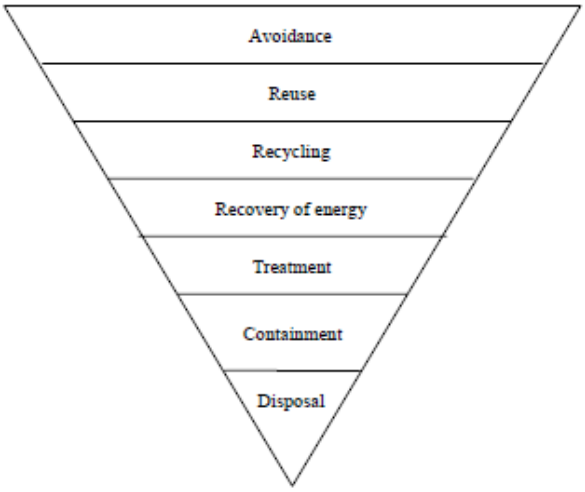
1.0 INTRODUCTION

Waste generation in Australia, across the three waste streams of municipal waste, commercial/industrial waste and construction/demolition waste, increased by 31 per cent between 2002-03 and 2006-07 (Hyder Consulting 2009). In 2006-07, Australia generated approximately 43.8 million tonnes of solid waste. Of the waste generated, 48 per cent was sent to landfill and 52 per cent was diverted (Allens Consulting Group 2009). The municipal solid waste stream (including kerbside collections) made up 22 per cent (5,082,000 tonnes) of this total recycling. While recycling proportions within each waste stream have increased (Allens Consulting Group 2009) the amount of waste being generated and the amount going to land fill remain a concern for policy makers and the community.

This concern arises from the perceived problem with waste because of the potential range of externalities associated with disposal, the scarcity of space for landfills and because waste is the end product of a life cycle process that can involve upstream environmental externalities and sustainability issues (Productivity Commission 2006).

Arising from these concerns, much waste policy in Australia has been based on the concept of a waste hierarchy (Figure 1). Under this approach waste avoidance is argued to be preferable to reuse, reuse to recycling, and so on. Disposal is seen to be the least desirable option (Productivity Commission 2006).

Figure 1 **A waste management hierarchy**



Source: Victorian Government (2005).

While the Productivity Commission considers that this approach is inconsistent with good policy principles and that there is little evidence that one option in the hierarchy is always better than another once all of the cost and benefits to the community have been considered, considerable policy effort in Australia has been placed on recycling[1]. For the municipal waste stream this involves kerbside recycling and collection and provision of central repositories for recyclable materials e.g. at waste transfer stations.

[1] Many of the waste policies of states and territories have their origins in two key national policy initiatives adopted in 1992: the National Waste Minimisation and Recycling Strategy (NWMRS) and the National Kerbside Recycling Strategy (NKRS) (Productivity Commission 2006).

Kerbside recycling has focused on paper, cardboard, plastics and bottles and in some areas green waste. Another area for potential kerbside recycling is organic waste. Organic waste originates from plant or animal sources and includes food scraps. In 2006–07 there was approximately 20.06 million tonnes of organic waste generated in Australia (DEWHA 2010a). This organic waste can be recycled to create products such as compost, biochar, soil conditioners and biogas. In 2006-07, 6.4 million tonnes (32 per cent) was recovered and the remaining 13.6 million tonnes (68%) was sent to landfill (DEWHA 2010a). Organic waste can comprise up to 65% of the general waste from households that goes to landfill.

On 5 November 2009, Australia's environment ministers, through the Environment Protection and Heritage Council (EPHC), released the National Waste Policy: Less waste, more resources. The policy sets the agenda for waste and resource recovery in Australia over the next 10 years. One of the sixteen strategies contained in the policy specifically addresses organic waste:

"7. Continued government focus to reduce the amount of biodegradable material sent to landfill" (DEWHA 2010b).

One way of reducing the amount of organic material going to landfill is to expand kerbside recycling schemes to include recycling of kitchen waste. However, recycling can have a range of costs and benefits to the community. Before implementing recycling schemes it is good policy to consider the magnitude of these costs and benefits (BDA Group and Gillespie Economics 2009). The costs of operating a kerbside recycling scheme can generally be estimated using market data. However, the benefits are not so easily defined (Jamelske and Kipperberg 2006) and are mainly non-market values.

There may be a range of motivations for households valuing a recycling service, including perceived problems with the existing disposal options, concern for the conservation of virgin resources and associated environments, ethical considerations, social obligations regarding a perceived fair-share contribution to such services (Lake et al 1996). Aadland and Caplan (1999) assume that a loosely defined notion of altruism motivates household demand for kerbside recycling reflecting a concern for the environment and the existence, option and amenity values that the household ascribes to the act of recycling. Whatever the motivations, studies that aim to estimate community values for kerbside recycling have not attempted to artificially disaggregate the diverse value components but have recognised that any WTP estimate for kerbside recycling represents an amalgam of these motivations (Lake et al 1996). The most appropriate non-market valuation method for estimating community WTP for a good or service which cannot be easily disaggregated into a range of attributes is the contingent valuation (CV) method.

This study reports the result of a CV survey of households in Brisbane, Australia, to gauge community WTP for the introduction of a kerbside recycling scheme for kitchen waste. Section 2 introduces the CV method. Section 3 discusses the existing waste management scheme in Brisbane and the proposed kerbside recycling scheme that is the subject of the study. Section 4 discusses the survey design and implementation and econometric results are reported in Section 5. Discussion of the results and their policy implications are reported in Section 6. Conclusions are drawn in Section 7.

2.0 CONTINGENT VALUATION

The CV method establishes a hypothetical market for a non-market good or service and uses a survey questionnaire to elicit people's willingness to pay for some change in the supply or quality of the good or service (Morrison et al 1996).

There are a range of potential formats for the WTP question in the CVM. These range from an open-ended (OE) question, where respondents are simply asked to identify their maximum WTP for the environmental good in question, to dichotomous choice (DC) where respondents are presented asked whether they would be WTP a specified dollar amount for an environmental improvement, with the dollar amount rotated between respondents. OE questions were one of the earliest WTP question formats while DC formats were developed later and are now the most commonly employed question format (Boyle et al 1996).

The DC approach was endorsed by the NOAA panel who were concerned about protest responses and incentive compatibility issues with other methods. They considered that there is no strategic reason for an individual to answer a DC question untruthfully (Reaves et al 1999). However, the gain in incentive compatibility comes at a cost. While for OE data the mean and the median can be directly estimated from the bids that respondents make, with DC, estimates of WTP are not directly revealed by respondents and hence more complicated econometric approaches are required to reveal WTP (Haab and McConnell 2002). However, these econometric techniques can influence estimates of mean and median WTP (Reaves et al 1999).

DC data is generally analysed based on the standard random utility model (RUM). In this model a yes response from respondent j occurs if the utility of the change, net of the required payment, exceeds utility of the status quo:

$u_1 (y_j - bid_j, z_j, e_{1j}) > u_0 (y_j, z_j, e_{0j})$

Where:

- u_1 is the indirect utility for the environmental improvement;
- u_0 is the indirect utility function of foregoing the environmental improvement and maintaining income y;
- z_j is a vector of household characteristics;
- bid_j is the amount paid for the environmental improvement; and
- e_{1j} and e_{0j} are a component of preference known to the individual but not observed by the research (Haab and McConnell (1998).

The probability of a yes response from respondent j becomes:

$Pr(yes) = Pr(u_1 (y_j - bid_j, z_j, e_{1j}) > U_0 (y_j, zj, e_{0j}))$

Parameter estimation requires specification of the functional form of the utility functions and the distribution of $e_{1j.}$

This study specified the deterministic and stochastic components of the utility function as additively separable and the deterministic component as linear in income and covariates. e_{1j} and e_{oj} were assumed to have an extreme gumbel distribution with the difference having a logistic distribution.

Assuming that the marginal utility of income is constant between the two CV states (which is reasonable unless the CV scenario provides a substantial change) the probability of a yes becomes

$Pr(yes) = Pr(\alpha z_j - \beta bid_j + e_j > 0)$

Where:

- αz_j vector of parameters for the variables related to the individual
- e_j is difference between e_{1j} and e_{0j}

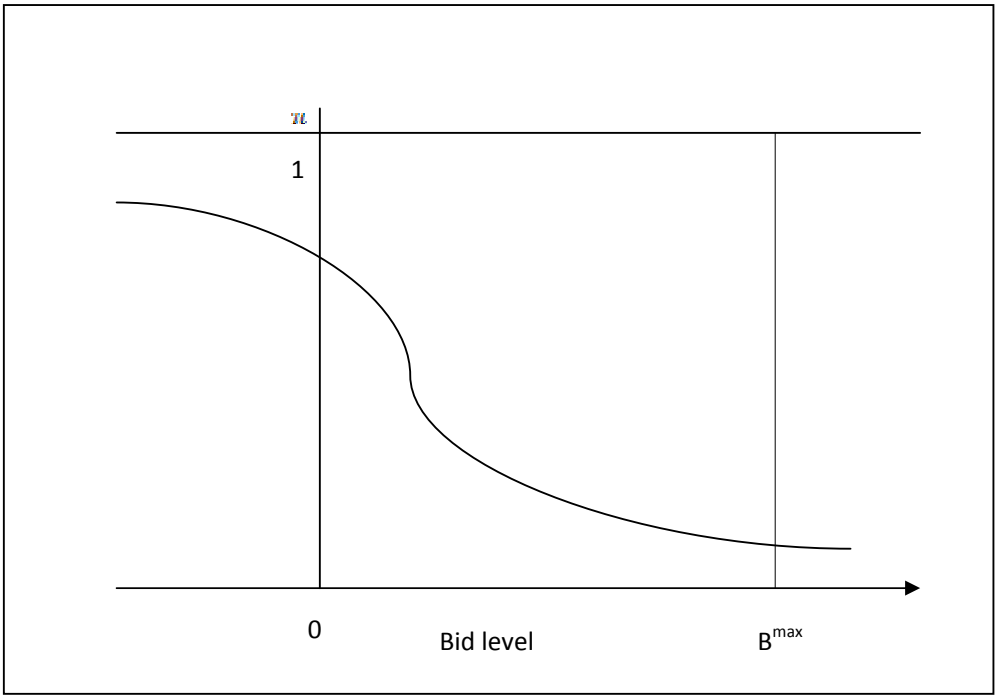
With this specification of a linear RUM, the mean and median WTP for the sample are the same, as the function is symmetrical about its mean (Langford and Bateman 1993), and is given as follows:

WTP= $\alpha z/ \beta$ based on the mean vector of exogenous variables for the sample.

When bid level specification results in near 100% acceptance at the lower level and near zero acceptance at the higher level then mean and median calculation from the RUM will be a good representation of true WTP.

However, an issue with the above RUM is that it allows ej to vary between positive and negative infinity and hence WTP can also vary between positive and negative infinity. Refer to Figure 2.

Figure 2 – Linear Logistic Functional Form for Modelling DC Data



If an unconstrained mean or median is calculated from an underlying model where WTP includes negative values then it is possible to obtain a negative mean or median WTP[2]. In any case, in most situations allowing for a negative WTP in model specification is an incorrect representation of the choice situation and the resulting WTP estimate will not represent a true reflection of WTP.

An alternative is to estimate an unconstrained linear logistic model and truncate mean WTP at zero and the maximum bid level (or income) at the WTP calculation stage. This is considered acceptable as long as Fwtp(Bmax)-Fwtp(Bmin) is close to one (i.e. bid range results in near 100% acceptance for low bid and near zero acceptance for the upper bid level), because under this scenario the

[2] This is the case if at a zero bid level the predicted acceptance rate is less than 50% (Vaughan et al 1999).

inconsistency between estimation of the model and calculation of WTP is of small consequence (Haab and McConnell 2002). However, where this is not the case then the method of truncation can cause big differences in means and divergence of means and medians.

A log transformation of the bid variable truncates the logistic model at zero and therefore avoids negative WTP. However, estimation of mean and median WTP is sensitive to how the upper tail is truncated.

Another approach is to estimate a model that has the correct bounds and impose the same bounds in the model estimation and WTP calculation stage. WTP estimates from this approach are more plausible than means from linear logistic models and the exponential of WTP models. But Haab and McConnell (2002) regard them as a repair of a difficult data set rather than well-founded estimates of WTP.

Because there are many cases where the estimates of WTP will be highly sensitive to the choice of distribution for the unobserved random component of preferences and the functional form of the utility specification, Haab and McConnell (2002) suggest the approach known as the Turnbull distribution-free estimator. This approach is considered to provide a lower bounds of sample mean WTP directly from raw data without assuming any distribution for the unobserved component of preferences or adhoc assumptions about the tail of the distribution.

While for OE data the mean and the median can be directly estimated from the bids that respondents make, modelling of this data is complicated. Ordinary Least Squared regression enables values to range from positive to negative and assumes constant variance across all estimates of the dependent variable, nNeither of which are likely to be met with count data (Gardner et al 1995). The application of OLS to OE CV data can therefore result in inefficient, inconsistent and biased estimates (Long 1997). The most basic model for addressing these deficiencies of OLS is the Poisson regression model followed by the negative binomial regression model (Long 1997). Both these models assume that the dependent variable is an exponential function of the independent variables with the latter model allowing the variance of the dependent count variable to be different to the mean. However, with CV data there may be a relatively large number of zero counts which exceeds the number predicted by Poisson or negative binomial regression. The zero inflated negative binomial regression model addresses this issue by generating two separate models and then combining them. The first explicitly models the number of predicted certain zeros using a logit regression. A negative binomial model is then generated that predicts the counts for those respondents who are not certain zeros. The mean count can be estimated from the model by estimating the probability that respondents will not be a certain zero from the logit regression and multiplying this probability by the mean predicted count from the negative binomial regression.

3.0 KERBSIDE WASTE MANAGEMENT IN BRISBANE

3.1 Existing Situation

This study focused on kitchen waste recycling in the Brisbane region, comprising the local government areas (LGAs) of Brisbane, Logan, Ipswich, Moreton Bay and Redland.

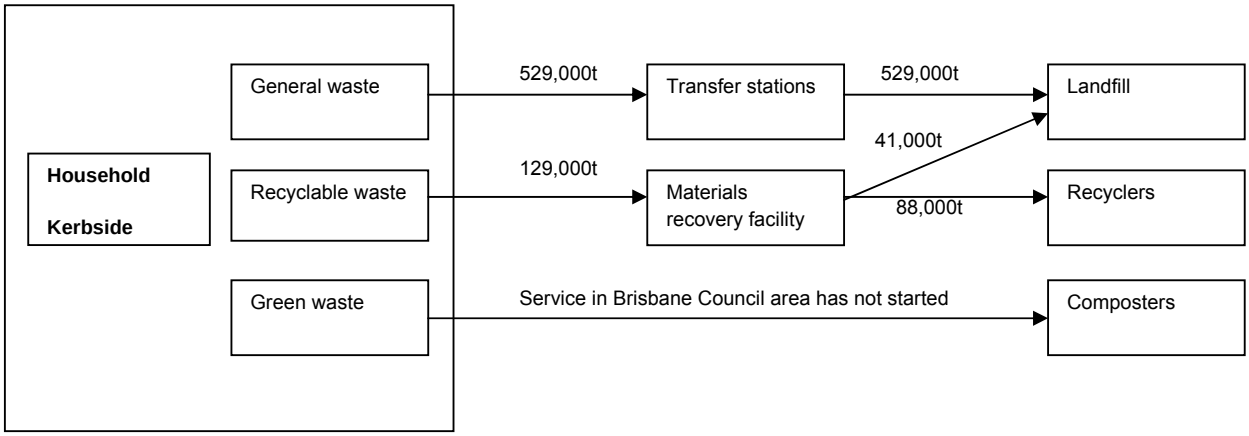
Households in the LGAs of Brisbane, Ipswich, Moreton Bay and Redland have a two bin kerbside waste collection system. One bin is for general waste and is collected weekly. This general waste is transported to a transfer station and then to landfill. Another bin is for recyclables such as cardboard, paper, glass and plastic bottles, and is collected fortnightly. This waste is transported to a Materials Recovery Facility with recycled materials provided to recyclers and unusable materials transported to landfill.

Households in the LGA of Logan have a single split bin system collected weekly which separates both general waste and recyclables.

The Brisbane LGA has recently announced the introduction of a voluntarily third bin service for green waste collection. This bin is mainly for lawn clippings and prunings. It will be collected fortnightly and the contents turned into compost. At the time of the study this scheme had not commenced.

Figure 2 summarises how waste from the kerbside bin system is managed each year.

Figure 2 – Kerbside Waste Management in the Brisbane Region



For homeowners, payment for the existing kerbside waste collection system was via their Council rates. For tenants these costs are generally passed on by landlords to their rent.

Each household in the Brisbane region generates on average, 725 kg of general waste per year that goes directly to landfill. 65% of this (472 kg) is food waste (left over kitchen scraps including from food preparation).

2.2 Potential Solution

The amount of household food waste that ends up in landfill can potentially be reduced by recycling it to make compost products. This can be achieved either through backyard composting or kerbside collection and recycling of food waste.

Kerbside collection and recycling food waste in Brisbane, Ipswich, Moreton Bay and Redland LGAs would require the existing **general waste** bin to be replaced by a split bin to take **general waste** and **food waste** separately.

In Logan LGA the existing split bin system which separates **general waste** and **recyclables** would be replaced by a split bin to take **general waste** and **food waste** separately and an additional bin for recycling that would be collected fortnightly.

4.0 QUESTIONNAIRE DESIGN AND IMPLEMENTATION

The questionnaire design in this study was based on the recommendations of USA National Oceanic and Atmospheric Administration panel regarding the use of the CVM in environmental litigation[3] and to take account of conditions which Bennett et al (1997) identified as being significant in Australian applications.

Information was provided on the existing household kerbside management in Brisbane, Ipswich, Moreton Bay, Redland and Logan LGAs and the amount of food waste per person that goes directly to landfill. The questionnaire identified that food waste going to landfill could be reduced through a change in the kerbside bin system.

The questionnaire stated that kerbside collection of food waste would not be commercially viable and therefore Council would require funds to cover the costs of providing new bins, management of the separated food waste and composting household food waste.

While some studies have left unspecified what the potential benefits of recycling are, the questionnaire used in this study did identify what some of these may. This was to combat the incorrect perception Australia that recycling will somehow have substantial environmental benefits, or reduce virgin materials extraction or that landfill opportunities are limited. As identified by the Productivity Commission (2006 p xx11) "residual levels of externalities from modern, fully complying landfills appear to be small". There is also sufficient landfill capacity for the medium term in most of the major population centres (Hyder Consulting 2009). Upstream benefits of recycling are highly uncertain (Productivity Commission 2006).

Potential benefits to respondents of recycling were therefore identified as:

- Reduced use of landfill space;
- Creation of useful products such as compost
- Less wastage.

If the food waste collection and recycling scheme were to proceed it would need to be funded by an additional payment per year on Council rates/rent. The provision rule included in the questionnaire was:

The scheme would only be provided if more than 50% of households across Brisbane region are WTP for it. If provided the scheme would be compulsory for all households.

A sample split was given an alternate provision rule

The scheme would be voluntary and only provided to those households who are willing to pay for it.

A DC WTP format, rotating seven bid levels of $5, $10, $20, $50, $100, $150 and $200, was used, with a follow-up OE WTP question. Research undertaken by Bennett et al (1997) indicated that respondents may find the DC choice format difficult to answer because the choices they are being asked to make may involve conflicts with their belief systems. This has been described as respondent dissonance.

Respondent dissonance was addressed in the questionnaire by adapting the DC WTP question to enable respondents who were not WTP the bid amount to select a response which most closely

[3] An example of this approach is found in Carson et al (1994).

represented their view. This approach is referred to as the dissonance-minimising (DM) elicitation format (Blamey et al 1997).

The seven alternatives presented to respondents were adapted from Bennett et al (1997):

(i) support the proposal and can afford payment;
(ii) support the proposal but it is not worth $x to me;
(iii) support the proposal but cannot afford payment;
(iv) support the proposal but object to the method of payment;
(v) support the proposal being available to others but I do not wish to participate in it;
(vi) oppose the proposal as I do not think that it will work; and
(vii) oppose the proposal, regardless of cost.

To create a DC format for logit estimation from responses to the DM format, (i) is considered to be a 'yes', while (ii), (iii), (iv), (v), (vi) and (vii) are considered to be a 'no'. The fourth response category (allowing objection to the payment vehicle) was included to permit respondents to protest against the payment vehicle used.

In order to provide value estimates that are not biased downward due to the exclusion of category (iv) respondents, a specially designed follow-up question was included immediately after the WTP question for category (iv) respondents only to answer.

What was sought was a positive way of treating payment vehicle protest respondents that did not necessitate their rejection from the data set at the model estimation stage. This is especially important given the high number of such rejections reported in some studies (Loomis, Lockwood and DeLacy (1993). In focus groups that were conducted by Bennett et al (1997)) there was considerable protest over the payment vehicle. Those protesters often stated that they would need to be more convinced that government couldn't, or wouldn't pay, before they would consider paying themselves.

The category (iv) follow-up question sought respondent's views on whether their non WTP was because they could not afford it or whether they are WTP provided:

- they could be convinced that the Council was not prepared to pay for it out of existing revenue
- they could be convinced that the Council doesn't have enough money to pay for it; or
- an alternative, acceptable way of collecting the money could be found.

If any of the latter three reasons applied, responses were recoded as a 'yes'.

Regular embedding, where the value of the good under consideration is affected by its "positioning" relative to substitute and complementary goods, was addressed by inclusion of a simple framing statement prior to the WTP question reminding respondents to keep in mind their available income and all the other things they have to spend money. Respondents were reminded that it is also possible that other MPAs and environmental projects may one day cost them additional money through increases in rates, levies and taxes.

Perfect embedding is where respondents are insensitive to the scope of the good they are asked to value. A plausible scenario was unable to be developed to test for scope insensitivity as respondents could either be provided with a bin capable of accommodating food waste as a separately component of the general waste bin (collected weekly) or not. Less frequent collection of the food waste or more frequent collection of a split food waste/general waste bin was considered unrealistic.

Following-up questions were designed to detect problems that respondents may experience in answering the questionnaire, specifically the adequacy and bias of the information provided, the level of the payment, and the difficulty of the WTP question. The final section of the questionnaire sought attitudinal and socio-economic data.

Two focus groups were held on 6th September in Brisbane, to refine and test the questionnaire. Key amendments that resulted from the focus groups included some simplification of the information presented in the questionnaire and adjustment of the original bid levels downwards to reflect the very low level of yes responses in the focus groups. There was also some concern about the scheme being compulsory if 50% of households were willing to pay for it. Most respondents were happy for the recycling scheme to be provided if other people wanted it but did not want to be compulsory made to participate. This led to the split sample approach referred to above, where one sample was provided with a majority provision rule and a second sample where participation was voluntary.

The questionnaires were implemented via an online panel, by PureProfile between 21 October 2010 and 22 November 2010. The sample was stratified by age and gender to reflect the Brisbane region population aged 18 years and above.

5.0 RESULTS

5.1 Biases and Protests

To test for problems that respondents may have had in answering the questionnaire, specifically in relation to adequacy and bias of the information provided, the level of the payment, and the difficulty of the WTP question, a Likert scale from 1 to 5 was used, where:

- 1 was strongly disagree
- 2 was disagree
- 3 was neither agree or disagree
- 4 was agree; and
- 5 was strongly agree

Table 4 summarises the mean response to a number of statements. On average respondents understood all the information provided, did not need additional information, did not consider the information biased, were comfortable with the level of payments presented to them and did not have difficulties answering the payment question.

Table 4 – Mean Response to Questions 6

	Compulsory	Voluntary
I understood all the information provided	4.2	4.2
I need more information than was provided	2.7	2.7
I thought the information was biased towards the recycling scheme	3.1	3.0
I thought the information was biased against the recycling scheme	2.5	2.5
The amount of the payment seemed unrealistically low	2.5	2.5
The amount of the payment seemed unrealistically high	3.3	3.2
I found answering the payment question confusing	2.2	2.2

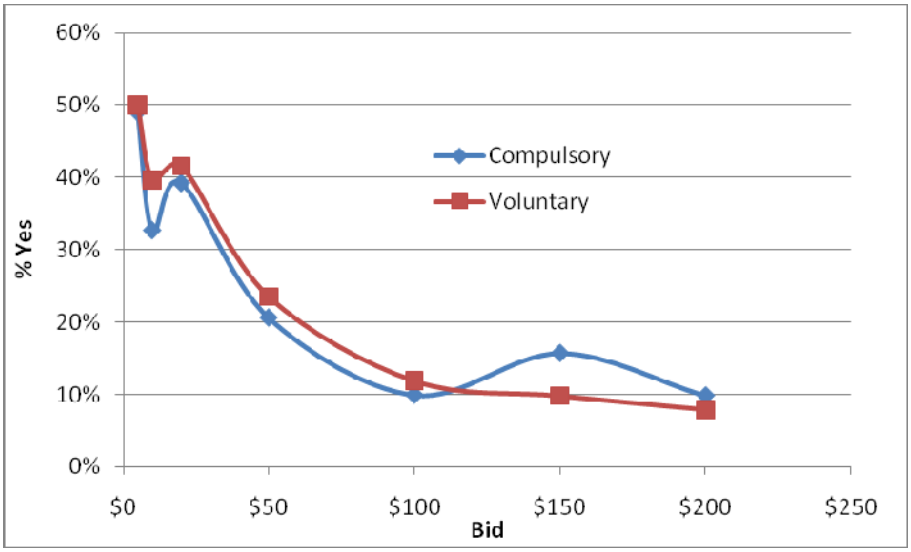
The dissonance minimisation format of the questionnaire explicitly allowed for protests against the payment vehicle. Across the splits, between 24% and 29% of respondents selected the payment vehicle protest option. With the follow-up question, 76% to 78% of these responses were able to be coded as a 'no' – cannot afford a payment, while the remainder were able to be recoded as a 'yes'.

5.2 Data Analysis

Proportional analysis

A proportional analysis, summarised in Figure 3, indicates that generally as the bid level increased a smaller proportion of respondents were willing to pay. However, the bid curves did not vary significantly between the splits and so respondents were insensitive to the provision rule included in the questionnaire.

Figure 3– Bid Curves



Logit Analysis

Models for the three splits were estimated using NLOGIT4.0 (Econometric Software, 2007). The variables tested for significance shown in Table 5.

Table 5 – Variables Considered in Models

Variable code	Description
Bid	Bid level
Age	Age as continuous variable
Gender	Respondent gender (1 = female)
Locat2	Respondent LGA of residence (1=Logan)
Recyc2	Respondent recycling (1= household recycles)
Comp2	Respondent composting (1=composts food waste)
Int	Respondent interest in waste management and recycling (1=interested)
Child	Respondent has children (1 = children)
HHsize	Number of people living in the respondents household
Nukids	Number of people living in the respondents household who are under 18 years of age

Variable code	Description
Houseown	Respondent house ownership (1 = owned outright or paying off)
Housetype	Respondent house type (1 = house)
Educ	Respondent education level (1 = post school qualification)
Envdev	Respondent attitude to development and the environment (-1= favour development, 0=favour neither, 1=favour protection of the environment more frequently)
Envorg	Respondent or close family a member or contribute to an environmental organisation (1= yes)
Fishorg	Respondent or close family associated with waste management industry (1= yes)

Initially all attributes were included in linear utility models with insignificant variables being systematically excluded. Preferred models for each split are provided in Table 6.

Table 6 – RUM Models with Linear Utility Function

Variables	Compulsory	Voluntary
Bid	-0.011*	-0.015*
Age		-0.019*
Int	1.468**	0.969**
HHsize	0.170**	
Housetyp	-0.773*	
Envdev	0.495*	0.398**
Envorg	0.550***	
Constant	-1.922*	-0.420
N	712	710
LL	356	353
McFaddens Pseudo R-squared	0.12	0.14

Significance: * !%, ** 5%, ***10%

All preferred models were statistically significant as indicated by a LLR test. Parameters that were statistically significant varied between questionnaire splits. However, the bid variable was highly significant in both splits. Where parameters were common between splits they had the same sign. Across the sample splits, an interest in waste management and recycling, greater household size, favouring protection of the environment when there are conflicts between development and the environment, the respondent or close family being a member of an environmental organisation or contributing regularly to this type of organisation, was found to increase the probability of saying yes to a bid level, as was. Being older, living in a house, and increasing bid levels was found to reduce the probability of saying yes to a bid level.

Zero Inflated Negative Binomial Regressions

As for the logit modelling reported above, initially all attributes were included in the zero inflated negative binomial regression models with insignificant variables being systematically excluded. Preferred models for each split are provided in Table 7.

Table 7 – Results of Zero Inflated Negative Binomial Regressions

	Compulsory		Voluntary	
	Coefficient	P[|Z|>z]|	Coefficient	P[|Z|>z]|
Negative Binomial Regression				
CHILD	-0.327	0.00	0.214	0.03
HOUSETYP	0.228	0.07		
LOCAT2	0.444	0.00	-0.387	0.01
BID	0.009	0.00	0.009	0.00
HOUSEOWN			-0.201	0.09
Constant	2.949	0.00	3.019	0.00
Dispersion factor				
Alpha	0.808	0.00	0.747	0.00
Zero Inflation Model				
INT	-1.118	0.00	-1.428	0.00
CHILD	0.273	0.02	0.250	0.03
HHSIZE	-0.106	0.01		
HOUSETYP	0.457	0.00		
BID	0.004	0.00	0.003	0.00
ENVDEV	-0.295	0.01	-0.369	0.00
COMP2			0.216	0.04
ENVORG	-0.574	0.02	-0.594	0.01
AGE			0.021	0.00
LOCAT2			-0.799	0.00
EDUC	-0.395	0.00		
Constant	1.350	0.00	0.515	0.06
R2 NB	0.89		0.89	
LLPOIS	-17878		-17876	
LL ZINB	-1806		-1833	
Vuong	9.3		8.0	

All preferred models were statistically significant as indicated by a LLR test. Parameters that were statistically significant varied between questionnaire splits and between the zero inflation model and the negative binomial model. For the zero inflation models, variables which increased the probability of having a certain zero WTP were having a child, living in a house, facing a higher DC bid amount, having a high level of composting and being older. Having an interest in recycling, larger household size, favouring the environment over development, being associated with an environmental organisation, living in Logan and a higher level of education decreased the probability of having a certain zero WTP. For the negative binomial models, living in a house and facing a higher DC bid

amount, increased the respondent WTP. Having a child and living in Logan had a mixed impact on WTP between sample splits.

The ZINB models from both sample splits was significant as indicated by a significantly lower LL than a poison or negative binomial model alone and a significant Vuong statistic (greater than 1.96).

Estimates of Willingness to Pay

Five point estimates of willingness to pay are reported in Table 8:

- the mean from the open-ended WTP question;
- the mean from truncating the logit regression above zero and at the maximum bid level;
- the mean from the Turnbull estimator calculation;
- the median from the open-ended WTP question; and
- the median from the Turnbull estimator calculation..

Following Haab and McConnell (2002) the mean from the Turnbull estimator is the preferred measure of WTP for the DC responses. 95% confidence intervals are reported for this estimate and for the mean open-ended WTP question.

Table 8 – Mean and Median WTP Per Household (Annual Payment)

	Compulsory	**Voluntary**
Mean from open-ended	$18.43 ($15.50 to $21.36)	$18.72 ($15.16 to $22.28)
Mean from RUM Linear in bid, truncated mean between zero and max bid	$38.00	$38.28
Mean from Turnbull Estimator	$35.23 ($27.13 to $43.33)	$32.29 ($26.05 to $38.53)
Median from open-ended	$0	$0
Median from Turnbull Estimator	$4.90	$5.00

6.0 DISCUSSION

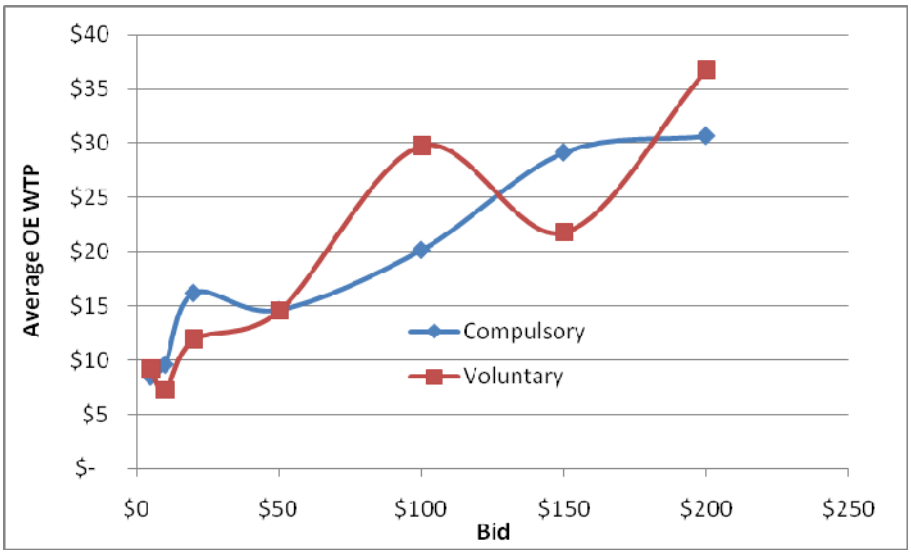
The results indicate that based on the Turnbull estimator, Brisbane households have a mean WTP of $32 to $35 per respondent household for a food waste recycling scheme. These WTP estimates from the DC format are almost two times those from the OE follow-up questions, consistent with O'Conor et al (1999). The result is also reflective of the finding in the literature where the DC method has been found to produce higher estimates of WTP than open-ended methods (Boyle et al 1996, Langford and Bateman 1993; Desvouges et al 1992, McFadden 1994)). Cameron et al (2002) report that the DC/OE WTP ratios can range from 1.1 to 5.0.

While the DC format has been the preferred format since the support of the NOAA panel, it is not without its challenges. Apart from its statistical inefficiency compared to open ended formats (i.e. it requires substantially larger samples to achieve the same levels of precision (Green et al 1998)) it requires more complex econometric techniques to estimate mean and median WTP and modelling assumptions can influence mean and median estimates. Methods to address this statistical inefficiency include double and triple bounded DC as well as DC with follow-up open-ended question, the underlying assumption being that the starting bid focuses responses without biasing it (Green et al 1998). The latter approach was used in this study.

However, single bounded DC, double bounded DC and DC with open-ended follow-up questions can suffer from psychometric anchoring effects. For single bounded DC the bid value offered may suggest to the respondent that the quantity to be estimated lies near this value and pulls the respondent to the nearest end of their a priori range of possible values (Green et al 1998). For double-bounded DC Cameron and Quiggin (1994) showed that the second choice is not independent of the initial bid levels. Similarly, when respondents answer a DC question followed by an open-ended question, the bid amount in the initial question can influence the response to the follow-up open-ended question (Green et al 1998; Langford and Bateman 1993), although it has been found that the mean of open-ended follow-up questions may not be significantly different from the mean of the a pure open-ended question (O'Conor et al 1999) even though they exhibit anchoring effects to the DC bid levels. Kuriyama (1999) found that DC followed by OE leads to free riding in the OE questions. Furthermore, strategic behaviour in the follow-up OE responses will be affected by the payment offered in the first DC.

Anchoring effects of DC format are generally analysed with respect to pure open-ended WTP formats. However this is not possible here as no pure-open ended WTP split was undertaken. However, the anchoring effect of DC format on the follow up OE question can be evaluated in a number of ways. Firstly, anchoring in the follow-up question is indicated by the mean OE WTP of respondents increasing as higher bid levels are offered to them in the initial DC question (Refer to Figure 5).

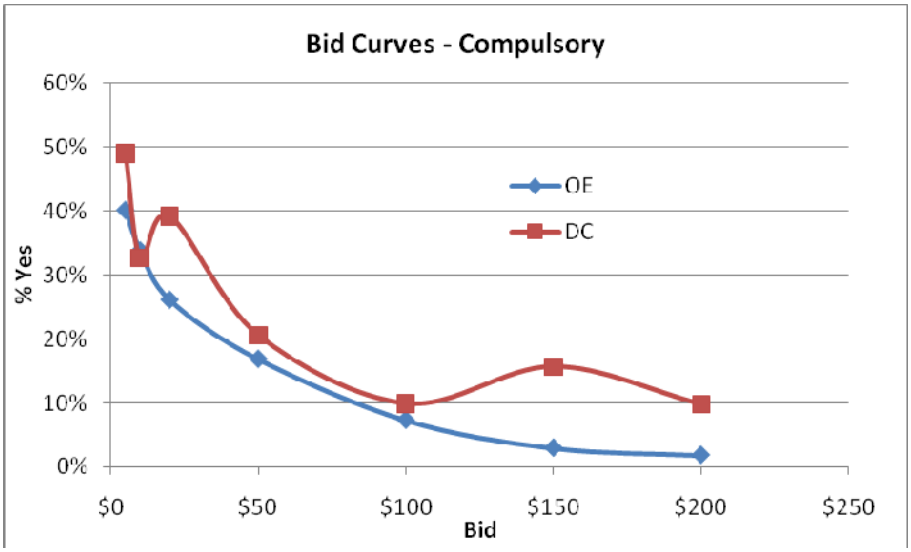
Figure 5 – Mean OE WTP Relative to DC Bid Levels

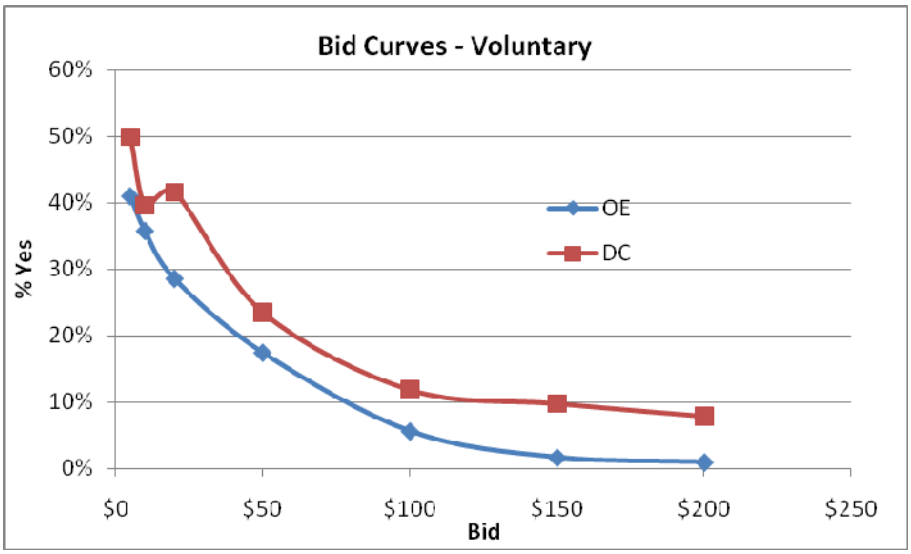


Zero inflated negative binomial regression of the open-ended follow-up response on the bid level indicates a significant (at the 1% level) and positive impact of the bid level on the open-ended response.

Evidence of the existence of anchoring effects is also provided by lower proportions of yes responses at each bid level compared to the distribution in the DC responses, (refer to Figure 6). Similar to the findings of O'Conor et al (1999) and Langford and Bateman (1993) this pattern was found at all but the lowest bid level.

Figure 6 – DC and OE Bid Curves





While the mean WTP is the theoretically correct point estimate of WTP it can be sensitive to the model specification and estimation methods when DC formats are used and the inclusion/exclusion of outliers in OE formats (Smith et al 1999). In contrast, the median is relatively stable and may be of political interest since it represents the cost where 50% of the sample is in favour of the proposal and 50% are against it (Smith et al 1999). In this study, the median WTP from the OE question was $0 and the median WTP from the DC (using the Turnbull Estimator) was around $5. This reflects the high percentage of respondents that were not willing to pay the lowest bid level ($5) in the DC format, 51% in the compulsory split and 50% in the voluntary split, and the high percentage of zero bids in the OE WTP question, 59% in the compulsory split and 57% in the voluntary split.

The single binary choice elicitation format used in this study is generally considered to be incentive compatible in many circumstances (Clarke 1971, Groves 1973), i.e. the respondents dominant strategy is to truthfully reveal their preferences (Hurwicz 1972). However, other questionnaire design characteristics, such as inclusion of a provision rule, can also improve the IC of non-market valuation studies. A provision rule provides a connection between respondent choices and actual outcome (Hoen and Randall 1987) and removes ambiguity about how respondent choices will impact policy. It provides an incentive to respond truthfully. In this study, two provision rules were used. The first split contained a majority decision rule while the second split contained a provision rule where participation is voluntary.

With the majority decision rule combined with the nature of the good and it being able to be provided to each individual household, there is no incentive for respondents to provide a “yes” response if they do not want the scheme as if there are enough votes then the good will be provided to each household at a cost to all respondents. Similarly, there is no incentive for respondents to provide a “no” response if they do want the scheme as insufficient votes will lead to the service not being provided.

Carson and Groves (2007) have shown that a voluntary provision rule for the supply of a public good can be incentive incompatible as respondents may provide a “yes” response to encourage the provision of the good, with the possibility of free riding during any actual revenue raising effort. However, in this case the voluntary decision rule is associated with an almost private good that can be provided to all households or only some households. There is therefore no incentive to provide a “yes” or a “no” response unless this reflects their true preference. It would therefore be expected to provide the same response incentives as the majority provision rule and therefore the two sample splits should yield the same results. This is evidenced by the bid curves in Figure 3 and the mean WTP estimates not being significantly different from each other.

7.0 CONCLUSION

Households in Brisbane have a positive mean WTP for a kerbside food waste recycling scheme. Given the anchoring effect of the follow-up OE WTP question the mean estimate from the Turnbull estimator for the DC survey is the preferred estimate of this WTP.

Households across the Brisbane SSD currently pay in the order of $250 per annum for their current kerbside waste collection scheme. This study indicates that on average Brisbane households would be WTP an additional $32 to $35 per year for a general waste bin where food waste is split from general waste.

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

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

Given the difficulties of estimating precise WTP values from DC data, any BCA of a compulsory scheme incorporating the results of this study should undertake sensitivity testing that includes the range of values reported including DC and OE means (Langford and Bateman 1993) to determine the robustness of BCA results to variations in the welfare estimate.

Notwithstanding, the results of any BCA, decision-makers also need to be cognisant of the high proportion of respondents who did not support a kerbside food waste recycling scheme. The data from the study could be used to undertake a BCA of a voluntary scheme. The mean WTP estimates for a voluntary scheme could be aggregated to all the households of Brisbane to estimate the benefits of such a scheme and this compared to the other costs and benefits of a voluntary scheme. To estimate the other costs and benefits of a voluntary scheme it is necessary to know how many households would likely participate. The bid curve reported in this study can be used to estimate the proportion of households that would be willing to participate in a voluntary scheme at each cost level.

The study results are consistent with the literature, with the WTP estimate from the DC being considerably greater than that from the OE question and anchoring evident in follow-up OE data. Consistent with *apriori* expectations, the nature of the economic good being considered meant that there was no statistical difference between samples splits using a majority provision rule and a voluntary provision rule. This is unlikely to be the case when the good be provided is of a public nature.

While the CV method has been used extensively to value non-market effects of environmental programs, particularly overseas, its application is not without its methodological issues, particularly in the model estimation and calculation of WTP. Any comparison of the results here with other CV studies therefore needs to be mindful of the modelling and estimation assumptions used.

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