This article was downloaded by: [Australian National University]

On: 22 January 2013, At: 17:29

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Journal of Environmental Planning and Management

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/cjep20>

Willingness to pay for kerbside recycling in Brisbane, Australia

Robert Gillespie ^a & Jeff Bennett ^b

^a Gillespie Economics, 13 Bigland Ave, Sydney, 2114, Australia

^b Australian National University, Crawford School of Public Policy, Lennox Crossing Road, Canberra, 0200, Australia

Version of record first published: 11 Jun 2012.

To cite this article: Robert Gillespie & Jeff Bennett (2012): Willingness to pay for kerbside recycling in Brisbane, Australia, Journal of Environmental Planning and Management, DOI:10.1080/09640568.2012.681033

To link to this article: <http://dx.doi.org/10.1080/09640568.2012.681033>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Willingness to pay for kerbside recycling in Brisbane, Australia

Robert Gillespie^{a*} and Jeff Bennett^b

^a*Gillespie Economics, 13 Bigland Ave, Sydney, 2114 Australia;* ^b*Australian National University, Crawford School of Public Policy, Lennox Crossing Road, Canberra, 0200 Australia*

(Received 7 March 2011; final version received 17 January 2012)

Domestic waste policy in Australia has a strong focus on kerbside recycling. In this paper mixed logit choice modelling is used to estimate the willingness to pay of households in Brisbane, Australia, for kerbside waste collection services including recycling. Respondents were found to have a positive willingness to pay for the fortnightly kerbside recycling and would be willing to pay an additional amount to increase the frequency of this service to weekly. The utility of respondents was, however, found to decline if general waste collection increased from weekly to twice a week.

Keywords: kerbside recycling; choice modelling; benefit cost analysis; willingness to pay

1. Introduction

Australian domestic waste management was historically focused on the collection and removal of waste from urban communities and disposal at some remote location with the aim of protecting public health. However, it became apparent that the disposal of waste, mainly by landfill, could have a range of off-site impacts, including greenhouse gas generation, leachate contamination of groundwater and exposure of neighbouring communities to odour, dust, litter and vermin. While in recent years these impacts have been reduced through the development of advanced landfill management techniques, including methane gas capture, there has been growing concern about the link between waste generation and upstream environmental impacts of virgin resource extraction as well as the sustainability of natural resource use associated with production and consumption (Productivity Commission 2006).

In response to these concerns, an integral component of waste policy in Australia since 1992 has been waste minimisation and recycling. The National Strategy for Ecologically Sustainable Development (ESD) (Commonwealth of Australia 1992) committed Australia to improving the resource use efficiency and reducing the environmental impacts of waste disposal (DEWHA 2009). The National Waste Minimisation and Recycling Strategy (NWMRS) (ANZECC 1992a) included a goal of reducing the amount of waste per capita going to landfill by 50% by 2000 (with 1991 as the reference year). The National Kerbside Recycling Strategy (NKRS) (ANZECC 1992b) was developed to expand on the goals of the NWMRS and

*Corresponding author. Email: gillecon@bigpond.net.au

included recycling targets for individual materials as well as proposing targets for urban household access to kerbside recycling (Productivity Commission 2006). The National Waste Policy 2009 continued the commitments of the National Strategy for ESD. It aimed, among other things, “to avoid the generation of waste, reduce the amount of waste for disposal and manage waste as a resource” (DEWHA 2009, p. 6).¹

At the state and territory level, policies and strategies have been developed to pursue the waste minimisation objective of the NWMRS and NKRS. These frequently refer to the concept of a waste hierarchy (Figure 1): waste avoidance is preferred to reuse, reuse to recycling, with disposal being the least desirable option (Productivity Commission 2006).²

In response to national and state waste management strategies, local governments have expanded the range of waste management services on offer. This includes moving from a single bin kerbside waste collection system, where all waste goes to landfill, to a two-bin service where mixed putrescibles waste is collected in one bin and sent to landfill and dry recyclables are collected in another bin and sent to a Materials Recovery Facility (MRF). In some areas a third bin is provided for recycling of green waste (Productivity Commission 2006).

Kerbside recycling can have a range of costs and benefits to the community. Consideration of the magnitude of these costs and benefits is useful for policy development (BDA Group and Gillespie Economics 2009). The costs of operating a kerbside recycling scheme can generally be estimated using market data. Some benefits such as the value of recovered materials and avoided costs of landfill can also be estimated using market data. However, other benefits are not marketed and are not so easily defined (Jamelske and Kipperberg 2006).

There is a range of reasons why households may value a recycling service and so enjoy a non-market benefit. These include avoidance of perceived problems associated with the landfill disposal options, concern for the conservation of virgin resources and associated environments, ethical considerations and social obligations (Lake *et al.* 1996). Aadland and Caplan (1999) assumed that a loosely defined notion of altruism motivates household demand for kerbside recycling, reflecting a concern

Figure 1. A waste management hierarchy. Source: Victorian Government (2005).

for the environment and the existence, option and amenity values that the household ascribes to the act of recycling. Whatever the motivations, studies that have aimed to estimate community values for the non-market benefits of kerbside recycling have not attempted to disaggregate the diverse value components. They have however recognised that any willingness to pay (WTP) for the non-market benefits of kerbside recycling represents an amalgam of these motivations (Lake *et al.* 1996).

There are a number of international examples of non-market valuation studies of kerbside recycling. Aadland and Caplan (2006) used contingent valuation (CV) to estimate household WTP for kerbside recycling in 40 western US cities. The average WTP was US\$5.61 per month and when calibrated for hypothetical bias³ and sampling error, US\$2.97 per month. In a CV study of residents in Ogden Utah, Aadland and Caplan (1999) found a mean WTP for kerbside recycling of US\$2.05 per month. Lake *et al.* (1996) used CV to estimate mean WTP for a kerbside recycling scheme in the village of Hethersett, South Norfolk, UK, at £35.60 per annum. Jamelske and Kipperberg (2006) in a study of single stream kerbside recycling in Madison, Wisconsin, found a household WTP of US\$3.00 per month. Troske *et al.* (2009) estimated mean WTP for kerbside recycling for Lexington, Kentucky, residents in the USA at US\$2.29 per month. Adjusted for CPI and exchange rates these results range from AU\$32.71 to AU\$85.58 in December 2010 values.

In Australia, there has been little investigation of household WTP for kerbside recycling. The authors are unaware of any existing published studies. Non-market valuation studies in relation to waste management have been limited to packaging and beverage container waste management (PWC 2010) and E-Waste Recycling (URS 2009). This paper aims to remedy this deficiency by presenting the results of a choice modelling (CM) study of WTP for kerbside recycling by households in Brisbane. The paper is structured as follows. Section 2 introduces the CM method. Section 3 discusses waste management in Brisbane and kerbside recycling services that are provided. Section 4 discusses the survey design and implementation. The econometric results are reported in Section 5 and a discussion of those results along with their policy implications are given in Section 6. Conclusions are drawn in Section 7.

2. Choice modelling

While the CV method has historically been used to estimate WTP for kerbside recycling, one of its practical limitations is that it can only estimate the values of one change at a time and cannot disaggregate the value that individuals hold between the different attributes of change (Whitten and Bennett 2000). In CM, respondents are asked to choose their preferred alternative from a set of choice options (Bennett and Blamey 2001) where the options are described by differing levels of a number of attributes. A single application is able to elicit WTP for changes in levels of individual attributes as well as for a number of alternatives that comprise changes in levels to some or all attributes (Hanley *et al.* 1998). Other reported advantages of CM over CV include:

- Avoidance of yea saying, since respondents are faced with multiple choices rather than an all or nothing choice (Hanley *et al.* 1998);
- A reduction in hypothetical and strategic bias (Kragt and Bennett 2008);
- Reduction in embedding effects as respondents are constantly reminded of the range of levels of attributes (Hanley *et al.* 1998, Kragt and Bennett 2008);

- Increased information provision, more communication of scope issues and increased realism (Hanley *et al.* 2001); and
- Collection of higher quality valuation information at a lower cost (DeShazo and Fermo 2002).

CM is therefore the preferred approach for the valuation of “multiple mutually exclusive policy options” (Blamey *et al.* 1999, p. 3). It therefore fits well with the policy construct examined in this paper, where no specific policy alternative was defined. The CM survey data collected for the study reported in this paper were modelled using a mixed logit (ML) specification of the utility function. This allows for heterogeneity of preferences across individuals (Hensher *et al.* 2005) and across alternatives (Greene and Hensher 2007) and can also account for correlations in unobserved factors over repeated choices by each individual (Revelt and Train 1998).

3. Kerbside waste management in Brisbane

The Brisbane region comprises 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 used for recyclables such as cardboard, paper, glass and plastic bottles, and is collected fortnightly. This waste is transported to a MRF with recyclable materials sold to processors and unusable materials transported to landfill. Households in the LGA of Logan have a single split bin which separates both general waste and recyclables that is collected weekly.

At the time of the survey, the Brisbane City Council announced the introduction of a voluntarily third bin service for green waste collection in the Brisbane LGA. This bin, intended for lawn clippings and garden prunings, was to be collected fortnightly with the contents composted. However, the service had not commenced when the survey was conducted.

Figure 2 summarises how waste from the kerbside bin system is managed and the weights of material handled each year.

The amount paid by residents for general waste collection plus recyclable waste collection varies by LGA within the Brisbane region, from \$228 per annum in Moreton Bay to \$334 per annum on the islands of Redland LGA. For the Brisbane

Figure 2. Kerbside waste management in the Brisbane region.

LGA, which includes the majority of the population of Brisbane region, the charge is \$250 per annum.

Nolan-ITU (2004) has collected data on the costs to councils of waste collection and transport in large Australian cities. The data for Brisbane indicate that the recycling bin contributes around 15% of the total cost of the two-bin system. Applying this to the amount paid for the two-bin system by Brisbane residents suggests that approximately \$40 of the total fee relates to the provision of the recycling service.

For homeowners, payment for the existing kerbside waste collection system is via their council rates. For tenants, these charges are generally passed on by landlords through rents.

4. Questionnaire design and implementation

The questionnaire designed to investigate respondents' WTP for their recycling service included information on the existing household kerbside management in the Brisbane Region and the amount of waste that goes to landfill or is recycled. Households in Brisbane already pay for general waste collection and for kerbside recycling. They were therefore familiar with the service they were being asked to value. However, to elicit their willingness to pay for the existing kerbside recycling service it was necessary to provide respondents with a plausible scenario whereby the existing service would cease unless they expressed a sufficiently high WTP to have it continued.

This scenario involved recycling paper, cardboard, glass, plastic and aluminium not being commercially viable and that, even with payments currently made by residents, the recycling scheme is financially questionable. Hence, the prospect of ceasing the current kerbside recycling of paper, cardboard, glass, plastic and aluminium was raised in the questionnaire. With the fortnightly collection of the existing recycling bin ceasing, the scenario outcome was that all recyclable material would be placed in the general waste bin which would continue to be collected weekly.

To add realism to this base case scenario, respondents were advised in the questionnaire that it would involve the waste levy they currently pay annually being reduced from around \$250 to \$210. Respondents were informed that the recycling scheme would continue if the council could raise sufficient funds from the annual household waste levy to cover the costs of:

- Continuing to provide recycling bins;
- Continuing to manage the separated recyclables; and
- Recycling paper, cardboard, plastics, glass and aluminium.

While some studies have left unspecified what the potential benefits of recycling are, the questionnaire used in this study identified what some of these may be. This was an attempt to address the prospect of exaggerated perceptions of the benefits of recycling. As identified by the Productivity Commission (2006, p. xxii), "residual levels of externalities from modern, fully complying landfills appear to be small" and hence the non-market environmental benefits of reducing the waste going to landfill are also likely to be small. There is also sufficient landfill capacity for the medium term to serve the needs of the major population centres (Hyder Consulting 2009). Upstream benefits of recycling such as the conservation of virgin material are also considered highly uncertain (Productivity Commission 2006).

Potential benefits to respondents of recycling were therefore identified narrowly as:

- Reduced use of landfill space;
- Recovery of glass, plastic, cardboard, paper and aluminium for use in creating other products;
- Less wastage.

The attributes used to describe alternative waste collection schemes in the CM choice questions were selected with reference to previous studies, discussions with waste management experts and focus groups. Boyer (2006) found that household WTP for general waste and recycling waste services in Stillwater, Oklahoma, USA, varied with frequency of kerbside pick-up. Attributes used by Boyer (2006) therefore reflected levels of service provision rather than actual environmental benefits. A similar approach was used in this study. Attributes that could be used to represent a base case kerbside bin collection scheme and alternative bin collection systems were the frequency of general waste bin collection, frequency of recycled bin collection and annual waste levy payment.

Attribute levels represented a realistic range of service frequencies and cost levels. The final attributes and their levels are outlined in Table 1.

A Bayesian D-efficient design (Scarpa and Rose 2008) of 18 choice sets was constructed using three attributes, with six choice sets embedded in three blocks of the questionnaire. Prior parameter values for the design were obtained from an online pilot test. The design was based on effects coding of the 'general waste bin collection' and 'recycling bin collection' attributes as shown in Table 2.

Effects coding enables non-continuous variables (in this case the general waste collection attribute and recycling bin collection attribute) with n attribute levels to be represented by $n-1$ effects coded variables. This enables non-linearities between attribute levels to be explored. Effects coding was made possible by allowing the base levels for general waste bin collection and recycling bin collection (i.e. weekly collection and nil collection, respectively) to appear in the alternative bin collection options in the choice sets.

Each choice set comprised three alternative waste management options:

- option 1 – recycling ceases – return to a single bin. This option would result in weekly collection of the general waste bin and an annual waste levy of \$210.
- option 2 and option 3 – alternative bin collection systems. These options would result in different frequencies of collection of the general waste bin and a recycling bin but a higher annual waste levy payment.

An example choice set is provided in Figure 3.⁴

Table 1. Attributes, their measurement units and levels.

Attribute	Unit of measurement	Levels*
Cost	Annual waste levy payment (AUD\$)	210 ; 230; 280; 380
General waste bin collection	Frequency	weekly ; twice weekly
Recycling bin collection	Frequency	nil ; every two weeks; weekly

*The base level of attributes are given in bold.

Table 2. Effects coding of attributes.

	General waste*	Recycling fortnightly**	Recycling weekly**
Level 1 – Weekly	– 1		
Level 2 – Twice weekly	1		
Level 1 – Nil		– 1	– 1
Level 2 – Every two weeks		1	0
Level 3 – Weekly		0	1

Notes: *The general waste collection attribute could vary over two levels. Effects coding resulted in one general waste variable that takes the value of – 1 when collection is weekly and 1 when collection is twice weekly.

**The recycling bin collection attribute could vary over three levels. Effects coding resulted in two recycling bin variables being created – the recycling fortnightly variable and the recycling weekly variable. The recycling fortnightly variable takes the value of 1 when recycling occurs fortnightly, – 1 when there is no recycling bin collection and 0 when the recycling bin is collected weekly. The recycling weekly variable takes the value of 1 when recycling occurs weekly, – 1 when there is no recycling bin collection and 0 when the recycling bin is collected fortnightly.

Question 6

Carefully consider each of the following three options for managing kerbside waste. Suppose options 1, 2 and 3 in the table below are the **ONLY ones available**. Which one would you choose?

Option	Your annual waste levy payment	General waste bin collection	Recycling bin collection	Which option would you choose? (Please tick)
Option 1 – <i>Recycling Ceases – Return to a Single Bin</i>	\$210	Weekly	Nil	Option 1 ☐
Option 2 – <i>Alternate Bin Collection System</i>	\$280	Weekly	Weekly	Option 2 ☐
Option 3 – <i>Alternate Bin Collection System</i>	\$380	Twice a week	Every two weeks	Option 3 ☐
				Not Sure ☐

Figure 3. Choice set example.

The provision rule included in the questionnaire was:

Kerbside recycling would only continue to be provided if more than 50% of households across Brisbane region are willing to pay for it. If a decision is made to continue providing kerbside recycling, it would be compulsory for all households.

A provision rule can improve the incentive compatibility of non-market valuation studies as it provides a connection between respondent choices and actual outcome (Carson and Groves 2007) and removes ambiguity about how respondent choices

will impact policy. It provides an incentive to respond truthfully. The majority decision rule combined with the nature of the good (it is able to be provided to each individual household separately) results in there being no incentive for respondents to provide a 'yes' response if they do not want the scheme. 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.⁵

Follow-up questions were designed to detect problems that respondents may have experienced in answering the questionnaire, specifically protest responses, 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.

The questionnaire was administered between 11 November 2010 and 6 December 2010 using a web-based survey, with a sample drawn from an existing panel of pre-stratified and registered respondents. The sampling strategy was aimed at obtaining 200 completed questionnaires per block, with respondents for each block stratified by age and gender to reflect the Brisbane region population aged between 18 and 85 years of age.⁶ However, Chi-squared tests indicate that the sample had higher education and income levels than the population.

5. Results

5.1. Biases and protests

To test for problems that respondents had in answering the questionnaire, specifically in relation to the adequacy of and bias in the information provided, the level of the payment, and the difficulty of the choice questions, a series of Likert scale based questions was asked.

Table 3 summarises the mean response to these questions. On average respondents understood all the information provided, did not need additional information, did not consider the information biased and did not have difficulties answering the choice questions.

Less than 3% of respondents indicated a protest by choosing the status quo in all choice sets because they objected to a payment of any amount for a recycling bin collection system.

Table 3. Questionnaire issues.

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
I understood all the information provided (4.0)	1	2	3	4	5
I need more information than was provided (2.8)	1	2	3	4	5
I thought the information was biased towards recycling (2.6)	1	2	3	4	5
I thought the information was biased against recycling (3.1)	1	2	3	4	5
I found answering the choice questions confusing (2.5)	1	2	3	4	5

5.2. Data analysis

5.2.1. Mixed logit results⁷

The variables included in the choice models are shown in Table 4.

In the preferred ML model reported in Table 5, the three effects coded choice attributes (Gwaste, Recycweekly and Recycfortnightly) were defined as random variables.⁸ Four distributional assumptions were tested (normal, lognormal, uniform and triangular), of which the normal distribution performed best statistically. A range of socio-demographic variables was initially included in the model. Variables that were insignificant were not included in the final model specification. The model was estimated by simulated maximum likelihood using Halton draws with 1000 replications (Train 2003).

The estimated attribute parameters are all significant at the 1% level. The negative sign on the Gwaste attribute indicates that when the collection of the general waste bin increases from weekly to twice a week the utility of respondents declines. The positive signs on the Recycweekly and Recycfortnightly attributes indicate that respondents' utility increases with the introduction of a recycling bin that is collected weekly or fortnightly. The relative utility of respondents is greater for a weekly collection of the recycling bin. However, graphical representation of the effects coded recycle bin attribute indicates that the majority of the utility gain from a recycle bin is associated with fortnightly collection (Figure 4). An increase in the frequency of collection of the recycle bin from fortnightly to weekly appears to result in additional but declining marginal utility. Whether this is significant can be

Table 4. Variables considered in models.

Variable code	Description
ASC	Alternative Specific Constant (1 = status quo alternative)
Cost	Cost of choice alternative (AU\$ pa)
Gwaste	Frequency of collection of general waste bin – effects coded
Recycweekly	Frequency of collection of recycling bin – effects coded
Recycfortnightly	Frequency of collection of recycling bin – effects coded
Age	Age as continuous variable
Gender	Respondent gender (1 = female)
Locat	Respondent LGA of residence (1 = Brisbane)
Recyc	Respondent recycling (1 = household recycles)
Comp	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
Houseown	Respondent house ownership (1 = owned outright or paying off)
Housetype	Respondent house type (1 = house)
Educ	Respondent education level (1 = post school qualification)
Income	Annual household income before taxes (\$000)
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)

Table 5. Mixed logit model results.

Variable	Coefficient mean	Standard deviations of random parameters
<i>Random parameters</i>		
Gwaste	-0.2185***	0.4225***
Recycweekly	0.7163***	0.9218***
Recycfortnightly	0.4824***	0.5220***
<i>Non-random parameters</i>		
Cost	-0.0128***	
Gender	0.6654**	
Recyc	2.0240***	
Int	1.9643***	
Income	0.0173***	
Envdev	0.5718***	
Envorg	1.5075**	
ASC	-5.2577***	
Standard deviation of latent random effects	2.7508***	
Log likelihood	-2923	
McFadden Pseudo $R^{2(a)}$	0.29	

Notes: Significance levels: * $p = 0.1$; ** $p = 0.05$; *** $p = 0.01$; ^(a)Compared to a constants only base model.

Figure 4. Relative utility of frequency of recycling bin collection.

determined using a Wald Test of Linear Restrictions. This test rejects the equality of parameters and hence it is concluded that the parameters are not equal and that the non-linear specification is better.

The significant standard deviations on the random parameters reflect the heterogeneity in preferences towards all attributes.

Being female, living in a household that undertakes some recycling, having an interest in recycling, having a higher household income, favouring the environment over development and being a member of or contributing to an environmental organisation are all factors that increase the probability of respondents choosing one of the 'alternative bin collection systems'. The ASC is negative and significant at the 1% level, indicating a systematic preference for Option 1 – recycling ceases, return to a single bin system. However, the significance of the latent error component indicates

individual heterogeneity in the way respondents evaluate the base case option, compared to the alternative bin collection system options.

5.2.2. Estimates of willingness to pay

The parameter estimates reported above were used to estimate implicit prices (in 2010 AU\$⁹) for each of the non-market attributes levels (Table 6).

The results show that, on average, a respondent's utility declines by \$34.18 per year if general waste collection increases from weekly to twice a week. Respondents are, however, on average willing to pay \$131.49 per year for a fortnightly recycling service and an extra \$18.30 to increase the frequency of this service to weekly.

6. Discussion

While recycling is a fundamental component of waste policy in Australia and households are required to pay extra for the provision of a kerbside recycling service in most LGAs, the community's WTP for this service (and the implied benefits it provides) has rarely been estimated. Benefit cost analysis of recycling services in Australia has been limited and, where undertaken, has been reliant on benefit transfer rather than primary non-market valuation studies (Nolan-ITU 2001). In terms of recouping the financial costs of recycling, it has also generally been implicitly assumed that households on average value the recycling service (and the implied benefits it provides) by at least the financial cost that is imposed on them.

While a full benefit cost analysis of recycling in Brisbane is beyond the scope of this paper, consideration of the general costs and benefits of recycling provides some context for the WTP figure estimated here. In the absence of kerbside recycling, household domestic waste would be collected and transported to landfill for disposal. The incremental costs and benefits of kerbside recycling therefore need to be considered relative to this base case. Table 7 summarises these potential incremental costs and benefits.

Kerbside recycling requires households to expend time and effort separating their waste into a number of bins. This is a non-financial cost to society that is borne by households. In return they obtain some increase in overall kerbside waste disposal capacity.

Households may also experience some non-market external costs of kerbside recycling associated with increased truck movements collecting and transporting dual waste streams and from the operation of MRFs (Productivity Commission 2006). Reported potential non-market benefits associated with recycling include avoided externality costs associated with landfills, reduced resource depletion leaving

Table 6. Mean estimated implicit prices (AUD\$/household/year).

Attribute	Mean	95% Confidence interval ^a
Gwaste	−\$34.18	(−\$13.83 – −\$57.07)
Recycfortnightly	\$131.49	(\$105.23 – \$160.29)
Recycweekly	\$18.30	(\$15.02 – \$19.42)

Note: ^aThe 95% confidence intervals are in brackets and were calculated using the Krinsky and Robb procedure (Krinsky and Robb 1986) with 1000 draws.

Table 7. Potential incremental benefits and costs of kerbside recycling compared to landfill.

Costs		Benefits
Non-financial	Household time and effort of separating waste	Any increased waste disposal capacity
Non-market	Amenity, congestion, pollution and accident risk associated with increased truck movements.	Decreased landfill externality costs
	Amenity effects of MRFs	Reduced resource depletion (marginal user cost)
		Avoided externalities associated with reduced resource depletion)
Financial	Increased collection and transport	Decreased landfill costs
	MRF operation costs	Revenue from sale of recyclables

Note: The shaded area is potentially captured by the estimate of household willingness to pay in this study.

a greater stock available for future extraction and the avoided environmental externalities associated with this reduced resource depletion. However, a review of waste management in Australia by the Productivity Commission (2006) identified that the net external costs of recycling (benefits from reduced landfill and costs from truck movements and MRF operation) are not likely to be significant.

Furthermore, the extent to which current day recycling actually leads to a reduction in the use of virgin materials with associated reduction in marginal user cost and avoided environmental externality benefits, is questionable.¹⁰ Care was therefore taken in the CM questionnaire not to refer to any environmental costs or benefits of recycling or saving of virgin resources.

Nevertheless, it is recognised that respondents would also draw on other information in making their choices, including the campaigns of government, industry and environmental groups promoting recycling that may overstate the physical environmental and sustainability benefits of recycling.¹¹ Consequently, the WTP estimate from this study is likely to reflect the value the respondents hold for the recycling service provided, net of the non-financial private costs they incur, as well as a range of perceived non-market effects, including avoiding some of the problems of landfills, concern for conservation of virgin materials or ethical considerations, i.e. the non-financial private and non-market costs and benefits in Table 7. Ultimately it is difficult to disaggregate the diverse value components of respondents and so no attempt has been made here to do so.

This aggregate household WTP can be compared to the net costs associated with operation of kerbside recycling schemes, i.e. the financial costs and benefits in Table 7. These net financial costs comprise the additional costs associated with collecting waste from multiple bins, transporting general and recycling waste to different destinations and the operation of MRFs, net of the value of the recyclable material and the cost saving in operation and management of landfills from less waste ending up in landfill (Productivity Commission 2006). The net financial costs of waste collection, transportation and disposal are passed on to households via the waste levy in their council rates.

Provided the household WTP for kerbside recycling exceeds the net financial costs of kerbside recycling then kerbside recycling may be considered to provide an increase in economic efficiency. The net financial costs of fortnightly kerbside

recycling were estimated to be in the order of AU\$40 per household per year while the WTP for this service and the perceived non-market net benefits was estimated at approximately AU\$131 per household per year. This comparison suggests that the scheme is more economically efficient than the base case of a weekly general waste bin collection. However, more specific estimation of the net financial costs of kerbside recycling is required by councils in the Brisbane region to confirm this conclusion.

With regard to general waste collection, the results of this study show that there is disutility associated with increasing the frequency of bin collection from once per week to twice per week. This is consistent with the findings of Boyer (2006) who found that the second garbage pick-up per week imposes a negative externality on residents of Stillwater, Oklahoma, USA. The disutility associated with increased frequency of general waste collection may be related to the time and effort associated with putting the bin out and bringing it back in, and perhaps that households generate insufficient general waste to warrant an additional collection each week, i.e. the absence of a capacity constraint.

7. Conclusion

While kerbside recycling is a fundamental component of waste management policy in Australia the community's willingness to pay for it has never been examined. This study shows that households in Brisbane have a positive and significant WTP of AU\$131.49 per annum for fortnightly kerbside recycling and would be WTP an additional AU\$18.30 to increase the frequency of this service to weekly. The utility of respondents was, however, found to decline by AU\$34.18 per year if general waste collection increased from weekly to twice a week.

Whether kerbside recycling in Brisbane is economically efficient requires a consideration of all the potential costs and benefits. Provided household WTP for kerbside recycling exceeds the net financial costs that they actually pay it may be considered to be economically efficient. Based on the assumptions used in this study it would appear that the WTP for kerbside recycling exceeds the net financial costs of this service, suggesting that the scheme results in an improvement in economic efficiency. However, more specific estimation of the net financial costs of kerbside recycling is required by councils in the Brisbane region to confirm this conclusion.

The willingness to pay estimates for kerbside recycling from this study are higher than those reported in non-Australian studies, perhaps reflecting underlying perceptions about the environmental and resource sustainability benefits of recycling as a result of concerted government, industry and environmental group campaigns.

Acknowledgements

Funding for the research reported in this paper was provided by the Australian Department of Sustainability, Environment, Water Population and Communities under the Commonwealth Environment Research Facility. The authors are also grateful to Gabrielle Scheufele for providing the experimental design and two anonymous referees for their valuable input. Responsibility for errors and omissions lies with the authors.

Notes

1. In the European Union the landfill reduction target is partly justified in terms of avoided methane emission. This is also the case in Australia. However, greenhouse gas emissions

- from Australian landfills comprise only 2% of total emissions. The implementation of gas capture technology at landfills is a more direct means of addressing emission concerns.
2. The waste hierarchy ranks different technical solutions for waste management without any consideration of the relative economic costs and benefits of different technical solutions in different circumstances. It can therefore result in management options being favoured that have higher costs and/or lower benefits than other alternatives.
 3. Aadland and Caplan had a unique dataset that contained stated preference data from the CV study and revealed preference information from actual decisions made by households in communities with voluntary kerbside recycling programmes. They used the difference in values to calibrate the WTP estimates from the CVM. They do this to address a common criticism of CVM that respondents tend to overstate their true WTP due to the hypothetical nature of the good.
 4. 'Not sure' responses were conservatively coded as Option 1 responses.
 5. No cheap talk script was used. Instead, expressions of true demand were encouraged through the inclusion of an incentive compatible provision rule and a questionnaire design that made the policy and payment scenario as realistic as possible. This included identifying that council would not be able to fund the continuation of kerbside recycling from its existing revenue and identifying that the respondent's answers would help determine how household waste in the Brisbane region would be managed in the future. Respondents were also reminded of their budget constraint and that other policies may also need funding in the future.
 6. Logan LGA was excluded from the study because its existing bin collection system was different from other LGAs within the Brisbane region.
 7. A variety of models were estimated using NLOGIT4.0 (Econometric Software 2007).
 8. The cost attribute was specified as a fixed parameter as it simplifies the estimation of implicit prices. This is a common approach in CM studies, e.g. Hensher and Greene (2003), Hanley *et al.* (2005), Rigby *et al.* (2009).
 9. The average exchange rate during the survey was 1 AU\$ = 0.9809 US\$0.98.
 10. A marginal user cost occurs where, because of scarcity, greater current use of a resource diminishes future opportunities. The marginal user cost is the present value of these foregone opportunities at the margin (Tietenberg 1992). Conversely, where actions taken today, such as recycling, increase the resources available in the future, this marginal user cost may be avoided, and becomes a benefit of current day actions. However, where there is a sufficient supply of minerals and other resources for many decades or centuries, which is the case for aluminium, steel, glass and plastic, any future scarcity from current day consumption is a considerable distance in the future and the present value of foregone future extraction net benefits is likely to be negligible under realistic discount rates. So even if actions, such as current day recycling, do reduce current day extraction of virgin material, the avoided marginal user cost is likely to be negligible. Notwithstanding this, given that demand for these materials is likely to be relatively elastic, it is far from clear that recycling will actually lead to a reduction in the current day resource depletion. Even if some reduction in resource depletion does occur, the environmental externalities avoided may be minimal given the internalisation of upstream externalities through environmental regulations (Productivity Commission 2006).
 11. This does not invalidate the WTP estimate from this study as all preferences of individuals for market and non-market goods are influenced by a whole range of factors including, in CM studies, those that are exogenous to the questionnaire and associated with imperfect information.

References

- Aadland, D.M. and Caplan, A.J., 1999. Household valuation of curbside recycling. *Journal of environmental planning and management*, 42 (6), 781–799.
- Aadland, D.M. and Caplan, A.J., 2006. Curbside recycling: waste resource or waste of resources, recycling. *Journal of policy analysis and management*, 25 (4), 855–874.
- ANZECC (Australia and New Zealand Environment and Conservation Council), 1992a. *National waste minimisation and recycling strategy*. Canberra: ANZECC.
- ANZECC, 1992b. *Report on the establishment and implementation of the National Kerbside Recycling Strategy*. Canberra: ANZECC.

- Bennett, J. and Blamey, R., 2001. *The choice modelling approach to environmental valuation*. Cheltenham: Edward Elgar.
- BDA Group and Gillespie Economics, 2009. *Analysis of social and environmental valuation methodologies for waste management*. Prepared for DEWHA, Canberra.
- Blamey, R., Gordan, J., and Chapman, R., 1999. Choice Modelling: Assessing the environmental values of water supply options. *The Australian Journal of Agricultural and Resource Economics*, 43(3), 337–357.
- Boyer, T., 2006. Talking trash: valuing household preferences for garbage and recycling services bundles using a discrete choice experiment. Paper presented at the *American Agricultural Economics Associate annual meeting*, 23–26 July, Long Beach, California.
- Carson, R. and Groves, T., 2007. Incentive and informational properties of preference questions. *Environmental and resource economics*, 37, 181–210.
- Commonwealth of Australia, 1992. *National Strategy for Ecologically Sustainable Development*. Canberra: Commonwealth of Australia.
- DeShazo, J.R. and Fermo, G., 2002. Designing Choice Sets for Stated Preference Methods: The Effects of Complexity on Choice Consistency. *Journal of Environmental Economics and Management*, 44, 123–143.
- DEWHA, 2009. *National waste policy: less waste, more resources*. Fact sheet. Canberra: Commonwealth of Australia.
- Econometric Software, 2007. *LIMDEP 9.0*. Castle Hill: Econometric Software.
- Greene, W.H. and Hensher, D.A., 2007. Heteroscedastic control for random coefficients and error components in mixed logit. *Transportation research part E: logistics and transportation review*, 43, 610–623.
- Hanley, N., Wright, R., and Adamowicz, V., 1998. Using choice experiments to value the environment. *Environmental and resource economics*, 11, 413–428.
- Hanley, N., Mourato, S., and Wright, R., 2001. Choice modelling approaches: a superior alternative for environmental valuation? *Journal of Economic Surveys*, 15, 433–60.
- Hanley, N., Adamowicz, W., and Wright, R.E., 2005. Price vector effects in choice experiments: an empirical test. *Resource energy economics*, 27, 227–234.
- Hensher, D.A. and Greene, W.H., 2003. The mixed logit model: the state of practice. *Transportation*, 30, 133–176.
- Hensher, D.A., Rose, J.M., and Greene, W.H., 2005. *Applied choice analysis: a primer*. Cambridge University Press.
- Hyder Consulting, 2009. *Waste and recycling in Australia*. Canberra: Department of the Environment Water Heritage and the Arts.
- Jamelske, E. and Kipperberg, G., 2006. A contingent valuation study and benefit/cost analysis of the switch to automated collection of solid waste with single stream recycling in Madison, Wisconsin. *Public works management & policy*, 11 (2), 89–103.
- Kragt, M. and Bennett, J., 2008. Designing choice experiments to test for anchoring and framing effects. Environmental Economics Research Hub, Research Report No. 10, Australian National University, Canberra, Australia.
- Krinsky, I. and Robb, A.L., 1986. On approximating the statistical properties of elasticities. *The review of economics and statistics*, 68, 715–719.
- Lake, I., Bateman, I., and Parfitt, J., 1996. Assessing a kerbside recycling scheme: a quantitative and willingness to pay case study. *Journal of environmental management*, 46, 239–254.
- Nolan-ITU, 2001. *Independent assessment of kerbside recycling in Australia*. Canberra: National Packaging Covenant Council.
- Nolan-ITU, 2004. *Global renewables: national benefits of implementation of UR-3R process: a triple bottom line assessment*. Sydney: Nolan-ITU.
- PWC (Pricewaterhouse Coopers), 2010. *Estimating consumers' willingness to pay for improvements to packaging and beverage container waste management*. Canberra: Environment Protection and Heritage Council.
- Productivity Commission, 2006. *Waste management. Draft report*. Canberra: Productivity Commission.
- Revelt, D. and Train, K., 1998. Mixed logit with repeated choices: households' choices of appliance efficiency level. *Review of economics and statistics*, 80, 647–657.

- Rigby, D., Balcombe, K., and Burton, M., 2009. Mixed logit model performance and distributional assumptions: preferences and GM foods. *Environmental resource economics*, 42 (3), 279–295.
- Scarpa, R. and Rose, J., 2008. Design efficiency for non-market valuation with choice modelling: how to measure it, what to report and why. *Australian journal of agricultural and resource economics*, 52 (3), 253–282.
- Tietenberg, T., 1992. *Environmental and natural resource economics*. New York: Harper Collins.
- Train, K.E., 2003. *Discrete choice methods with simulation*. New York: Cambridge University Press.
- Troske, K., *et al.*, 2009. Estimating willingness of citizens to pay for recycling. *Industry Studies Association 2009 annual conference*, Chicago, USA.
- URS, 2009. *Willingness to pay for e-waste recycling*. Canberra: Environment Protection and Heritage Council.
- Victorian Government, 2005. *Towards zero waste strategy*. Melbourne: Victorian Government.
- Whitten, S. and Bennett, J., 2000. Wetland Management Trade-offs in the Upper South-East of South Australia. *Rural Society*, 10(3), 341–359.