Economic Valuation of Ecosystem Services in New Zealand Winegrowing Regions: Testing for Benefit Transfer

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Abstract

Benefit transfer (BT) is a pragmatic way of estimating values by transferring values from existing valuation studies to a target area of interest. BT using choice modeling (CM) is a potentially cost-effective method for valuing differences in improvements in environmental quality. After taking into account a range of policy options, ecosystem service attributes, socioeconomic characteristics and attitudinal variables for two winegrowing regions and populations, this study uses CM to value the marginal benefits of improvement in selected ecosystem services associated with winegrowing. This study tests the transferability of willingness-to-pay or welfare measures of equivalence across two sites to check the suitability of the estimates to be transferred between the sites. Policy implications conclude the paper.

Key Words: Benefit transfer, choice modeling, New Zealand winegrowing, ecosystem services

JEL Classification: Q1, Q2, Q5

1. Introduction

Non-market valuation methods have contributed an important set of new tools, in particular choice modeling, to estimate the value of Ecosystem Services (ES) that lack markets. Developing methods to describe ES and their values to society can help increase public awareness of the importance of ES benefits and understanding of how different policy approaches may impact their protection and enhancement. Thus, ES valuation can potentially provide new ways to compare the costs and benefits of different agricultural strategies, using the dollar as the metric of value.

However, non-market valuation studies are time consuming, labour intensive, and costly. Research funders are interested in finding ways to reduce costs of valuing ES and other non-market items. Benefit transfer uses value estimates from an existing study and transfers it to another site or alternative context that is of interest. The practice of benefit transfer is attractive if it can provide acceptable estimates of value at lower cost than would unique non-market value studies for each new site or context. Nevertheless, there are concerns about the accuracy of the values that are transferred and research is needed to determine in which circumstances benefit transfer provides acceptable value estimates.

This paper has two objectives. The first is to estimate values for selected ES associated with winegrowing using choice modeling (CM) method.[1] The second objective involves checking if transfer of the estimated ES values across sites (Benefit Transfer) is valid. An advanced CM approach incorporating heterogeneity of preferences, known as the Random Parameter Logit (RPL) model is used to estimate the selected ES values. Surveys focused on the two largest New Zealand winegrowing regions, Marlborough (MARL) and Hawke's Bay (HB), are used as case studies. This research is conducted with a goal of applying Benefit Transfer (BT). Several conditions necessary for performing effective and efficient benefit transfers have been considered in the study design, in particular the

[1] For a more detailed discussion of choice modelling applications, readers are referred to Bennett and Blamey (2001), and Rolfe and Bennett (2006).

similarity of site characteristics (Desvousges et al. 1992). Both sites exhibit some similarities in terms of their environmental resources and recent changes in the quality of the environment; demographic profiles of the two populations; the extent and magnitude of the population that may be affected by resource use impacts; the type of value measurement (marginal value); and the period when the studies are carried out (temporality). The only difference in this study is the spatial dimension between the study site and the policy site where attitudes, tastes and perception of environmental issues may differ among the populations in the two regions. Thus, an important hypothesis can be tested: Do the geographically distant HB (North Island) and MARL (South Island) regions have the same willingness-to-pay (WTP) estimates for the winegrowing ES considered and hence, is BT across sites valid?

We treat each region as both a 'study' site (original survey site from which to transfer values to other sites) and as a 'policy' site (the site values are transferred to from the original survey site). This study assesses the accuracy of such transfers. By comparing values, the study obtains an estimate of the 'transfer error' (i.e., the difference between the value obtained by surveying a given site and the value obtained by transfer from another site). The paper applies a new statistical validity test proposed by Johnston and Duke (2008) incorporating the tolerance level of transfer error for policy purposes. This is particularly useful in BT given that the transferred estimates can only be regarded as an approximation of the true estimates, so that a limit of tolerance is required to assess the validity of the BT. Assessment of this error may allow us to judge if the transfer process is reliable and hence whether in the future it is valid to transfer values from study sites to policy sites without having to conduct new research or surveys.

2 Winegrowing Environmental Impact on Ecosystem Services

The New Zealand wine industry began to flourish in the 1990s and area planted has tripled since 1995 to reach 24,271 ha in 2007. The productive area of grapes is projected to increase by 9.7% by 2010. The Marlborough region and Sauvignon Blanc grapes are main drivers of growth in productive area (NZW 2007). The Marlborough region has 13,187 ha (53% of the national total), Hawke's Bay 4,665 ha (19%), Gisborne 2,133 ha (9%) and Otago 1,415 ha (6%). Productive area lags planted area and the Waipara region productive area is forecast to increase by 53% in 2008 to reach 1,127 ha, 4% of the national total (NZW 2007).

Winegrowers derive most of their income from the grapes and wine they produce via agricultural ecosystems. While producing grapes, they can manage land in ways that conflict with the healthy functioning of ecosystems, including pesticides and fungicides leaching to groundwater, emissions of greenhouse gases that contribute to climate change, and removal of indigenous biodiversity. These impacts are not typically reflected in the winegrowers' incomes and therefore, may be a minor consideration in their decision making. These detrimental environmental impacts or external costs are typically unmeasured and often do not influence grower or societal choices about production methods.

New Zealand vineyards are typically managed in a highly manipulated setting where pesticides and fungicides are often used to control pests and diseases (Gurnsey et al. 2007). Spray drift from vineyards is a cause for concern to nearby residents; at least one claim to the Accident Compensation Corporation for compensation for harm caused by wine industry herbicides has succeeded in New Zealand (Thomas 2008). Winemaking procedures also can include the addition of substances such as egg white, fish extracts, and chemicals such as copper. Consumer concerns and food safety regulations can both be triggered by excessive levels of residues in wine. A 4000 case wine shipment was returned to New Zealand from Germany because of excessive copper levels (McKenzie-Minifie 2007).

Winegrowing and other horticulture crops occupy less than one percent of New Zealand's land area. All crops have a carbon footprint and the size of the footprint is of increasing interest to producers and consumers. Energy use is a major determinant of the size of the carbon footprint. An energy benchmark for the wine industry has been established of 0.58 kWh/litre of juice produced in making wine (SWNZ 2008). Greenhouse Gas Accounting Protocols for the International Wine Industry have been developed to measure emissions (Forsyth et al. 2008). At least one New Zealand winemaker has obtained a zero net emissions rating by changes in production systems and through offsetting remaining emissions.

Wine consumers, it is argued have become increasingly discriminating as globalization and increased worldwide access to information have occurred. Bisson et al. (2002: 696) comment that … 'consumers expect wines to be healthful and produced in an environmentally sustainable manner.' And … 'in contrast to other agricultural commodities … quality is associated with minimal vineyard inputs or manipulation.' Winegrowers and winemakers in many countries are responding to these demands from consumers and have introduced protocols for grape and wine production that aim to limit the impact of removal of native vegetation, erosion and water use (Bisson et al. 2002: 698).

In New Zealand, a certification system, known as Sustainable Winegrowing New Zealand® (SWNZ) has been developed to promote sustainable management of the winemaking process from the vineyard through to the bottle. Current membership of SWNZ as at October 2008 is 1000 vineyards representing 22,500 hectares or almost 80% of producing area, and 100 winery sites representing more than 75% of total production (NZW 2008). The winegrowing industry has set a goal of 100% of the industry operating under independently audited sustainability schemes by 2012.

3 Method

Choice Modeling (CM)

The theoretical basis of CM is the random utility model (RUM) developed by McFadden (1974). Under the RUM framework, there are models such as Multinomial Logit (MNL), Nested Logit (NL) and Random Parameter Logit (RPL) depending on which error distribution is used to predict an individual's probability of choosing the alternative with the highest level of utility among all available alternatives. The RPL model has some advantages over MNL and NL as it provides the analyst with a much richer specification of the utility function that allows flexible modeling of unobserved heterogeneity in the data (Train 1998; Train 2003; Hensher et al. 2005). In addition, in the context of BT analysis, incorporating taste heterogeneity via RPL reduces the magnitude of the transfer error (Colombo et al. 2007). Therefore, in this study, a RPL modeling framework is applied to estimate the marginal WTP in valuing marginal changes in environmental quality and subsequently, uses the estimated WTP values to determine the convergent validity of BT.[2]

The estimation of the marginal WTP for a discrete change in an attribute level will provide insights into the relative importance that respondents give to the attributes and can be used by policy makers to assign more resources in favour of the attributes which have higher WTP values. The WTP for an improvement of attribute A from level 1 to level 2 is estimated by dividing the difference between the attribute A coefficients at level 2 and level 1 by the coefficient of the cost attribute:

$$WTP_{A_{1 \xrightarrow{to} 2}} = -\left[(\beta_{A_2} - \beta_{A_1}) \big/ \beta_{COST} \right] \qquad (1)$$

In this study, given that all the attributes are randomly distributed, each value of the coefficients in equation (1) will be drawn from the mean (interpreted as the average

[2] The random parameter logit (RPL) model is a generalisation of the standard conditional logit model that explicitly considers taste variation among individuals. Those who are interested in the theoretical underpinnings of RPL can refer to the papers of Train (1998), Chapter 6 of Train (2003) or Chapters 15 and 16 of Hensher et al. (2005).

preference of respondents for the attribute) and standard deviation (interpreted as the magnitude of differences in respondents' preferences for the attribute) of the estimated coefficient distributions. The mean and 95% confidence interval of the WTPs will be calculated following the simulation approach proposed by Hu et al. (2005) and Johnson and Duke (2008).

Data Collection

The choice modeling surveys were designed to contain multiple choice questions (choice cards) about alternative policies for improving four selected ES attributes on winegrowing properties. The questionnaire consisted of three parts. The first part contained questions regarding respondent's opinions and their awareness of current environmental impacts caused by winegrowing. These questions had the objective of introducing the respondent to the subject of ES in viticulture. The survey booklet also contained two pages of information on the environmental and health impacts of current winegrowing practices. In addition, two pages succinctly explained sustainable winegrowing alternatives. The second part of the survey contained the choice situation questions. Before that, respondents were briefed about the selected attributes of ES and associated cost to the household. The cost to the household (the payment vehicle) was defined as an additional annual payment to the regional council responsible for the management of the environment over the next five years.

In the choice cards, respondents were asked to select the option they favoured the most out of the three alternatives provided. Each option contains different combinations and levels of the four attributes as well as the cost to the household of the action or policy. Attributes discussed were residue content in wine, risk of toxic chemicals reaching groundwater, greenhouse gas emissions per hectare per year, and the condition of native wildlife populations in vineyards. Each attribute was presented to respondents as several discrete levels. For example, the attribute of greenhouse gas emissions was presented as having three discrete levels: zero net emissions (the largest improvement level); 30% reduction; and 'no change' from current emissions level. The study preferred to use effects coding instead of dummy coding due to the identification problem. The advantage of using effects coding is that the affect of all attributes levels are estimated and are uncorrelated with the intercept (Adamowicz et al. 1994; Louviere et al. 2000; Hensher et al. 2005; Bech and Gyrd-Hansen 2005). Table 1 provides a more complete description of all explanatory variables and their specified effects coding based on the levels. All of the attributes selected are factors that a policy maker can affect, directly or indirectly, and they were judged as relevant based on expert advice, current debates in focus groups and information from wine industry literature. The last part of the survey contained questions regarding respondents' socio-economic status.

The experimental design was used to build the choice cards to quantify the effects of marginal changes in improving the environmental conditions. There are four attributes with three levels and the cost attribute with six levels (3^4 x 6^1) which were combined in a fractional factorial main effects experimental design (Louviere et al. 2000), providing 18 profiles in order to form the choice sets.[3] The choice sets were constructed following the procedure proposed by Street et al. (2005) obtaining choice sets with a 94.85% efficiency rate which were then blocked to 3 versions of 6 choice sets.[4] Each choice question has three alternatives and the third alternative was always a status quo (current plan). In other words, each respondent in each choice set has to choose either an improved environmental management plan (Alternative 1 or 2) or the current plan (Alternative 3). Figure 1 illustrates an example of the choice cards shown to respondents.

Insert Figure 1 here

[3] Actually, the cost attribute has 7 levels, but only 6 are used in the experimental design for the construction of the "policy on" alternatives to be included in the choice cards. The 7^{th} level (cost=0), is used to describe the constant *status quo* alternative which is used as the reference alternative and is added once the design has been created to the choice cards.

[4] This efficiency refers to the varying alternative in the choice sets. To the resulting choice sets, we include the constant *status quo* option and the design efficiency drops to 66%.

A mail survey form was selected for use. In the beginning of February 2008, pilot surveys were conducted on randomly selected residents in Canterbury, New Zealand. During the month of April 2008 a pre-survey card, survey booklet and cover letter, and a reminder post-survey card were sent to 2196 respondents selected from the New Zealand electoral roll using a random sampling design. The sample was divided into two strata: 1098 respondents were randomly selected from the Marlborough region (the largest winegrowing area in New Zealand) and 1098 from the Hawke's Bay region (second largest winegrowing area in New Zealand). The study received a total of 330 (30%) and 218 (20%) completed questionnaire responses for the two regions surveyed. The overall total effective response rate was 25%.

4 Results and Discussion

The choice data were analysed using NLOGIT 4.0 statistical software. Tables 2 and 3 present the descriptive statistics of HB and MARL samples for the socio-demographic and attitudinal variables. The two samples do not differ much from each other but show greater differences in comparison to regional population census data. For example, the respondent samples contain a significantly larger proportion of higher educated and higher income people than the population from which the samples were drawn. It is evident that the mail survey induced some self-selection bias where a substantial proportion of the questionnaires were not returned (i.e., unit non-response).

Tables 1-3 near here

HB Sample

In this region 197 respondents provided completed surveys. The results in Table 3 show that more than three quarters of the sample are satisfied with the environmental quality in the region and live less than 5 kilometers away from a vineyard. Interviewees' preferences are divided into two groups when they are asked if they enjoy views of vineyards landscape that include native plant species, with approximately half of the sample agreeing with this statement and half in disagreement. Interestingly, more than three quarters of respondents would not like wine bottles to be labeled so that consumers can be guaranteed that environmentally sustainable practices have been used in winegrowing and winemaking. Respondents were also asked their opinion on whether winegrowing practices are harmful to groundwater quality, greenhouse gases emissions, and health in terms of wine residue content. Generally, respondents agree that winegrowing has the potential to damage the environment if not properly managed, but there is variable knowledge regarding these issues; 39% of the respondents did not know the effect of winegrowing on groundwater quality, 35% did not know if it contributes to greenhouse gases emissions and 26% are not aware that weed killers, insecticides and fungicides in wine are dangerous to health.[5] Regarding the latter, almost 40% of the sample disagree on effects on health, perhaps because they are confident about the efficacy of food safety regulations.

Of the total number of respondents, 26 (13%) expressed a protest answer regarding the proposed project; these protest bids were removed from the sample.[6] The majority of respondents who provided a protest response contended that they should not have to pay and instead the polluters (winegrowers) should incur all costs associated with production. All respondents that displayed a genuine zero WTP by always choosing the current policy option (6%), and those that chose either alternative A or B at least once were considered in the analysis, giving a total number of 962 observations for model estimation.

MARL Sample

In this region 301 respondents completed the survey. The results in the last column of Table 3 show that almost 88% of the sample are satisfied with environmental quality in

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[5] In the analysis, these responses were recoded as the mean sample values to avoid missing observations of the choices made by these respondents.

[6] It is established in the literature that some respondents do not state their true value for the good in question. Respondents may state a zero WTP although their true WTP is higher than zero or they may state a very high amount which is much greater than their true WTP (Meyerhoff and Liebe 2008). If protest occurs, this will result in an incorrect economic value estimation of the good in question. In this study, those who expressed a protest answer were identified using a follow up question and deleted from analysis.

the region. The degree of satisfaction is high in this region relative to satisfaction in the Hawke's Bay region. The MARL respondents also differ in the enjoyment they experience viewing vineyards landscape that include native plant species, where approximately 80% of the sample disagree with the statement. In addition, 80% of respondents do not want bottles to be labeled so that consumers can be guaranteed that environmentally sustainable practices have been used in winegrowing and winemaking. When respondents were asked their opinion on whether winegrowing practices are harmful for underground water quality, greenhouse gases emissions and health in terms of wine residue content, they generally disagree with the statements, although as observed in the HB region, variability in knowledge regarding these issues is clearly revealed. In particular 24% of the sample did not know the effect of winegrowing on groundwater quality, 34% did not know if it contributes to greenhouse gases emissions and 17% are not aware that pesticides in wine are dangerous for health.

Of the total number of respondents 12% expressed a protest answer regarding the proposed project; these protest bids were removed from the sample. It is also observed that 57% of the protest response respondents want vineyards to accept all the costs of changed production systems. All respondents that displayed a genuine zero WTP by always choosing the current policy option (4%), and those that chose either alternative A or B at least once were considered in the analysis, giving a total of 1509 observations for model estimation.

RPL Models for HB and MARL

Table 4 presents RPL models for HB and MARL samples in which the socioeconomic and attitudinal characteristics of respondents have been added.[7] The models

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[7] A referee asked why not set the non-attribute variables as dummies since they are not continuous variables. We opted to include the socio-economic, attitude and belief variables as continuous to avoid parameter proliferation in the model. The inclusion of them as dummies would have required the additional estimation of more than 30 parameters. This is not justified because we are more interested in identifying general (linear) trends between respondents' socio-economic characteristics and the choice between the "policy on" and "policy off" alternatives rather than non linearities in the preferences. Note that some of the non-attribute variables were continuous (e.g., distance to vineyard, age, income) and all the others were ordinal. The only categorical variables (gender and does respondent live in a rural or urban setting) were introduced as dummy variables.

were estimated using 100 Halton draws and considered the random parameters to be independent.[8] In these models, a distribution for the random parameters is specified and parameters are estimated for that distribution. In this study, all the attributes except COST which has a triangular distribution, are assumed to be random variables with normal distribution. The normal distribution for the non-monetary attributes was used because respondents may be indifferent to increasing or diminishing quality or quantity of the attributes. For instance, people who completely trust the effectiveness of food safety regulations may not care even if the residue content in wine increases a bit. The cost attribute was assumed to follow a triangular distribution where the mean and the standard deviation parameters have been constrained to be the same. This guarantees non-negative WTP values by deriving behaviourally meaningful WTP measures and allows heterogeneity in the cost attribute.[9]

Table 4 near here

Overall the models are highly significant and show an excellent fit to the data (ρ^2 = 0.45 and ρ^2 = 0.42, respectively).[10] All the significant attribute coefficients have the *a priori* expected sign for both the models. Attributes RESORG, GHGZERO and NAT10 in HB model are insignificant. This suggests that reducing the residue content in wine is a matter that significantly affects people's utility only if the reduction is complete rather than a marginal reduction. The reduction in the emission of greenhouse gases is also of interest to HB respondents. Nevertheless, only a reduction of 30% of the greenhouse gas emissions increases respondents' utility. Respondent are indifferent about a greater reduction of greenhouse gases from winegrowing. Respondents also prefer increasing the native wildlife populations in vineyards by at least 30% relative to the current condition. A smaller

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[8] All the random parameters models described in this report have been estimated using these settings.

[9] Hensher and Green (2003) suggest that when using random parameter estimates, researchers should use distributions that provide behaviourally meaningful WTP measures.

[10]Simulations by Domencich and McFadden (1975) suggest values of ρ^2 between 0.2-0.4 are comparable to values between 0.7-0.9 for R^2 in the case of the ordinary linear regression. Generally, ρ^2 is reported as McFadden Pseudo R^2.

improvement is not of interest to people. Note that as presented in Table 3 for the HB sample more than 43.3% of respondent disagree with the statements that vineyard landscapes that include native species are attractive, about 35% are not aware of greenhouse gases from winegrowing and more than 32.3% disagree (also 25.6% don't know) that chemical residues in wine are of concern. This may explain why the coefficients RESORG, GHGZERO and NAT10 are insignificant in the HB model.

For the MARL model, only the RESORG attribute is insignificant. This is also due to the lack of knowledge (17.3%) and high disagreement levels among respondents (56.7% including strongly disagree). The effects that winegrowing has on groundwater quality is deemed extremely important by both groups of sample respondents, and a reduction in the risk of toxic chemicals reaching groundwater increases respondents' utility. Reduction in the emission of greenhouse gases is also of concern to both HB and MARL respondents. Respondents from HB and MARL regions prefer increases in native wildlife populations in vineyards. However, in contrast to the HB sample, MARL respondents get more utility from a 10% increase than from a 30% increase. As may be expected, cost is highly significant and has a negative sign for both samples, showing that the higher the cost associated with a policy option, the less likely a given respondent is to choose that option. It is surprising to note that the alternative specific constant (ASC) for HB sample is negative with a large coefficient and is highly significant, showing that there are systematic reasons other than the attribute values that drove respondents who choose the status quo option.

By interacting individual socioeconomic and attitudinal variables with ASC, it is possible to enrich information about a particular sample and also to explain a part of respondent heterogeneity.[11] For instance, coefficient ASCVINLAN (HB model) which is

[11] Significant coefficients of these interactions indicate that the respondents' characteristics and beliefs are actually capturing some effects that are not reflected in the random coefficients, and hence, explain additional variability. Some of the interactions are included as behavioural interpretation (for example, we expect people who are more satisfied with the environmental conditions are more likely to choose the status quo option), and

highly statistically significant with positive sign indicates that people who strongly enjoy vineyard landscape views are more likely to choose policy options that increase the quality of the landscape.[12] The HB sample respondents are in favour of winegrowing management practices that lead to more wildlife in the landscapes, reduced wine residues, and more informative labelling of wine bottles. It is also interesting to note that the closer respondents live to the vineyard the more likely they are to stick with current winegrowing management. Similarly, highly educated residents are not in favour of improving winegrowing practices.[13] The results indicate that females and older people are more likely to choose improvement plans over current winegrowing practices. Household income is also significant, and higher income people are more likely to support the proposed winegrowing management practises. Finally, the degree of agreement respondents declared with the statements in the questionnaires about the effects of winegrowing on underground water, health, and greenhouse gases emissions, did not affect the probability of choosing the two environmental friendly alternatives relative to the current winegrowing management.

In contrast, MARL sample respondents who are satisfied with current environmental quality prefer to hold on to the current winegrowing practices instead of improving them. It is apparent that males and younger people are more likely to choose the improvement plans contrary to what is observed in the HB model. In this region, neither household income nor education affects the choice of the improvement alternatives relative to the status quo. Since the percentage of resource based employment in MARL sample was more than twice that of

others such as gender on statistical grounds as it is not possible to identify a theoretical ground to justify the sign of the gender coefficient.

[12] A referee has commented on the use of interaction effects on the non-attribute variables when estimating the models. Respondents' characteristics cannot be introduced directly into the model. This is because they are invariant across choices and Hessian singularities would arise, forbidding estimation of the model. To circumvent this problem in this study, the individual characteristics are introduced as interactions with the constant. The resulting interaction coefficients have to be interpreted as the effect that the characteristics of individuals have on the probability of choosing alternative 1 or 2 over the current policy option.

[13] Hawke's Bay region is the oldest winegrowing region in New Zealand, has experienced slower growth rate in area of vineyards, and vineyards are more dispersed in the region. Thus, highly educated respondents may know that the impacts on ES are likely to be less intensive compared to Marlborough region which has experienced rapid change in rural land use from sheep and crops to vineyards while becoming the largest wine growing region in New Zealand.

HB, the respondent's occupation significantly affects the choice of the current situation relative to the various alternatives. For example, ASCJOB is highly statistically significant with negative sign which means people who work in the agriculture or resource based sector are more likely to prefer the current winegrowing management. This may be due to apprehension of incurring extra costs or losing income if there is a change in management practices. Lastly, in contrast to HB, respondents found difficulty in understanding the environmental issues in the questionnaire and this did affect the probability of choosing the two improvement alternatives relative to the current winegrowing management. None of the other attitudinal and belief variables affect the probability of choosing the current management situation relative to the environmentally friendly alternatives proposed.

All of the standard deviation terms are highly significant at the 1% level for both models (except for RESZERO and NAT10 in HB), indicating preference heterogeneity does indeed exist. This may be expected given the different opinions of respondents about the effect of winegrowing management on groundwater quality, wildlife, greenhouse gases emissions and health. Lack of knowledge may also be an additional contributing factor that increases the heterogeneity in respondents' choices.

In summary, the HB and MARL models indicate that respondents value winegrowing practices which result in wine with no detectable residue content, reduction in the risk of toxic substances reaching groundwater, reduction in greenhouse gas emissions and an increase in natural environment and native wildlife populations in vineyards. The models show a high degree of heterogeneity exists within the samples.

Benefit Transfer (BT) Tests

There are three key hypotheses test to perform in order to validate the BT analysis.

(1) Testing if the Model Parameters are Equivalent

If similarity of population characteristics and other variables were to lead to statistical equivalence of the coefficients between the study and the policy site this would imply a convergence of transferability. To test for convergence transferability, the log likelihood ratio test is used to check the equivalence of the coefficients. More formally, this is a test of the difference in the parameters across the two samples:

$$H_0 : \beta_j(HB) - \beta_j(Marl) = 0$$

A comparison of preference estimates between the two sites needs to allow for the fact that the estimated parameters are confounded with a scale parameter which is inversely proportional to the variance of the random term. The study thus performs a grid search technique as proposed by Swait and Louviere (1993) using the pooled, stacked data sets, then rescaling the MARL data set. The maximization of the log likelihood function was attained when scaling of datasets was applied. Hence, the estimated variance-scale ratio was found to be 1.0 which implies that the MARL sample has on average the same response variability as the HB sample. The likelihood ratio test statistic for a comparison of the choice model parameters between the HB and MARL is

$$\chi^2 = -2\left(LL_{HB+MARL} - \left(LL_{HB} + LL_{MARL}\right)\right) = -2\left(-1617.68 - (-584.71 - 962.15)\right) = 141.64$$

The critical chi-square value of 44.99 at the 5% significance level (31 degrees of freedom), is well below the calculated value. Therefore, it can be concluded that a significant difference does exist between the two sites and we can reject the null hypothesis, even after taking scale differences into account. This means that using the model parameters for BT would be inaccurate or biased.

(2) Testing if the Mean WTP are Equivalent

Estimates of mean WTP derived from the models are presented in Table 5. The estimated values are marginal WTP annually for a period of five years for a change (improvement) in the ES attributes concerned, *ceteris paribus*. The mean WTP for all the attributes are positive, implying that respondents have positive utilities (well being) for increases in the quality or quantity of each attribute.

Table 5 near here

As shown in Table 5, on average respondents in HB region are willing to pay $10.69 per annum for toxic chemical residues in wine to reduce to zero. As might be expected, reduction in the risk of toxic substances reaching groundwater is the highest valued attribute, and respondents are willing to pay on average around $65 - $67 to obtain a situation where the risk is either low or zero. It is somewhat surprising that respondents are willing to pay $28.40 for a 30% reduction in greenhouse gases emissions but are not willing to pay for zero net emissions. A possible explanation is that respondents understand that it is not easy to reduce emissions completely in 5 years time and this may incur high cost of forgone economic growth. In addition, as mentioned previously in the paper, 64% of respondents disagree with the statement that winegrowing is currently adding greenhouse gases to the atmosphere. Increasing the landscapes quality by a 30% increase in the native wildlife populations gives utility to respondents, who are willing to pay $24.53 per annum.

In MARL region, purchasing wine with zero toxic chemical residues increases respondent's utility by $19.56 per annum. As expected from the high values of the coefficients, a reduction in the risk of toxic substances reaching groundwater is the highest valued attribute, and respondents are willing to pay more than $132.44 to obtain a situation where the risk is low and $145.29 for reduction of the risk to zero.[14] Respondents are also

[14] The absolute estimates should be taken with caution due to the random nature of the coefficients. When estimating the welfare measures, (see equation (1)) the random nature of the cost parameter causes some draws of the cost coefficient (especially in the MARL region) which are very close to zero and "inflate" the WTP. As

willing to pay for a reduction in greenhouse gases emissions (10% and 30%). It is interesting to note that respondents from this region prefer to pay more for a 10% increase than for a 30% increase in native wildlife populations in vineyards.

WTP values are higher in the Marlborough region than in the HB region. Respondents in the Marlborough region showed less aversion to costly alternatives, as long as they provide improved environmental conditions relative to the current ones. This is indeed observed in the MARL sample where the percentage of people who selected the most expensive alternative is greater (39%) relative to the HB region (29%). A possible reason could be that the MARL region has experienced very rapid changes while growing to become the largest wine growing region in New Zealand. The rapid expansion of vineyards and their environmental impacts may be a nuisance and of concern to many residents. On the other hand, HB being the oldest winegrowing region in New Zealand has experienced slower growth, its vineyards are more dispersed and the impacts on ES are likely to be of less concern to residents.

Although the two sites ES attributes are similar, the study is able to identify a number of attributes that either increase or decrease respondents' perceived value of the ecosystem services studied. There is strong heterogeneity in the preferences for these attributes and only some (e.g., groundwater quality has the highest marginal WTP) are considered really important in both sites. The mean WTP offer some insights on the relative importance of each attribute and can be used by policy makers to assign more resources to improving those attributes that have higher values, such as the reduction in the risk of toxic chemicals reaching groundwater which is important in both regions.

There are two main approaches to see whether mean WTP are equivalent in the BT analysis: value transfer (unadjusted WTP) and function transfer (adjusted WTP). In this

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a result, some of the WTP estimates are really high. For example, the case of improvement in the water quality attribute, where the low values of the cost attribute are associated with high values of the water quality attributes.

paper, a simple value transfer of unadjusted mean WTP estimates from one site to another is considered, and this assumes that the welfare change experienced by the average person in the study site is the same as that experienced by the average person in the policy site. More formally, this test is concerned with the difference in the estimated WTP across the two samples:

$$H_0 : WTP(HB) - WTP(Marl) = 0$$

The null hypothesis states that WTP of HB respondents is the same as that of MARL residents. The complete combinatorial method proposed by Poe et al. (2005) has been carried out and results in rejection of the null hypothesis of equivalence of the WTP values for attributes WATLOW, WATNO, GHGZERO, NAT10 and NAT30 between HB and MARL regions. The Poe et al. (2005) test shows that only RESORG, RESZERO and GHG30 mean WTP estimates are equivalent and suggests that BT is valid for these attributes. The results show that the mean WTP from the sampled populations have larger confidence intervals, reflecting greater variations in respondents' preferences for these attributes.

(3) Testing if the Mean WTP are Transferable

The results of the Poe et al. (2005) test in Table 5 indicate that it is possible to transfer three out of eight WTPs between the two sites. However, Kristofersson and Navrud (2005) illustrated that the above results may provide a Type II Error null hypothesis, since welfare estimates with greater variances lead to a greater likelihood of finding transfers invalid (i.e., of failing to reject the null hypothesis that WTPs are the same when it is false). The authors further comment that it is also important for the analyst to choose a tolerance limit when testing for the transferability of the welfare measures. They reverse the traditional null and alternative hypothesis of the Poe et al. (2005) test and assume that the welfare estimates are different unless with a chosen probability level, the difference between the welfare measures is smaller than a specified tolerance limit. This test is known as "two one-sided *t*-test" (TOST) and it is typically applied in most of the BT studies to assess equivalence (Kristofersson and Navrud 2005; Hanley et al. 2006).

Nevertheless, the proposed TOST of Kristofersson and Navrud (2005) may not be appropriate if the distributions of the welfare measures are not normal.[15] In order to overcome this limitation, Johnston and Duke (2008) suggest an extension of this test which is statistically valid regardless of the empirical distribution of welfare estimates. The test is denoted as the two one-sided convolutions (TOSC) test which incorporates the complete combinatorial convolutions approach of Poe et al. (2005) as well as the Kristofersson and Navrud (2005) equivalence test with a null hypothesis of WTP divergence (i.e., H_0: $WTP_{HB} - WTP_{MARL} \neq 0$).[16]

In order to implement the test, an analyst should choose the tolerance limit of difference between the welfare measures they are willing to accept and calculate the interval of tolerance.[17] Following the Poe et al. (2005) test, the analyst must calculate the differences of the complete combinatorial of the distributions of WTP at the study and policy sites, and test if the resulting difference falls inside or outside the tolerance interval.[18] These distributions are obtained by using the simulation procedure recommended by Hu et al. (2005). The idea is to assign to the difference a value of 1 or 0 depending whether the differences between the WTP at the study and policy site are smaller (greater) than an error which is tolerable by the analyst. The significance of the test is the number of ones relative to the number of zeroes. Therefore, given distributions WTP_{HB} and WTP_{MARL}, where the

[15] The distributions of the welfare measures estimated in this paper are not normal as the attributes (which assumed normal distributions) are being divided by a triangular distributed random variable (cost).
[16] Both TOSC and TOST provide similar results when welfare distributions are approximately normal. Thus, TOSC is practical and can be a more general alternative equivalence test for BT (Johnston and Duke, 2008).
[17] As pointed out by Johnson and Duke (2008) in BT applications the limit of tolerance can be set as a fixed percentage of the WTP measure that the analyst is seeking to approximate, which is the WTP at the policy site. That is, the lower limit of the tolerance interval is $\theta_1 = -\delta(WTP_{policy\ site})$, whilst the upper limit is $\theta_2 = \delta(WTP_{policy\ site})$. δ represents the percentage of tolerance the analyst is willing to accept.
[18] As an example, if the tolerance error δ= 50% and the mean WTP at policy site is $10, the interval of tolerance will be ± $5. All the differences between the i^{th} WTP value of the study site WTP distribution and the j^{th} WTP value of the policy site WTP distribution that fall within the tolerance interval are accepted for transfer.

MARL site is treated as the policy site, and an admissible error of 50%, this may be accomplished through two one-sided tests of the difference between empirical distributions:

$$H_0 : (WTP_{HB} - WTP_{MARL}) - \theta_1 \leq 0 \text{ for Lower } p\text{-value} \quad (1)$$

$$H_0 : (WTP_{HB} - WTP_{MARL}) - \theta_2 \geq 0 \text{ for Upper } p\text{-value} \quad (2)$$

where θ_i, (i = 1, 2), are the lower and upper limits of tolerance set by the analyst. Based on the intersection-union test (IUT) theory (Berger and Hsu 1996), rejection of both (1) and (2) at the selected critical p-value (e.g., α = 0.10) leads to the acceptance of alternative hypothesis (i.e., two WTP distributions are equivalent (do not differ) at tolerance limit 50%). Rejection of the null hypothesis of non-equivalent WTPs requires that both p-values fall beneath a specified critical value (e.g., α = 0.10). As such, the TOSC p-values based on an empirical convolution lead to appropriate statistical inference.

The performance of mean value transfer can be assessed in terms of their corresponding transfer errors (i.e., the difference between the value obtained by surveying a given site and the value obtained by transfer from another site). Assessment of this error allows for verification if the transfer process is reliable and hence, whether in the future it is valid to transfer values from study sites to policy sites without having to conduct new research or surveys. Colombo et al. (2007) suggest for the purpose of resource economics valuation, a value transfer error of 30 – 80% may be acceptable for a cost-benefit analysis, particularly when the benefits clearly outweigh the costs.

Table 6 near here

Table 6 shows the TOSC equivalence test results for unadjusted annual mean WTP at α = 0.10 using three different tolerance limits (i.e., 30%, 50% and 80%) for the HB and MARL regions and treating each as both a study site and as a policy site. For example, if the policy maker is willing to tolerate a 30% or 50% difference between the WTP estimated at HB and MARL, there is a failure to reject the null hypothesis of different WTP, implying that the two measures cannot be shown to be equivalent, and therefore, transfer is presumed invalid. In contrast, if the policy maker chooses an 80% tolerance limit, it is possible to reject the null for GHG30 and this implies that the two WTP measures are equivalent *if and only if* transferring the value from MARL to HB. The BT is statistically valid only under these conditions and only for this one attribute.

5 Policy Implications

Most of the nation's vineyards are already committed to the Sustainable Winegrowing New Zealand (SWNZ) programme that provides a framework for environmentally and economically sustainable winegrowing. In essence, the concept involves greater reliance on natural methods of control of pests and plant diseases in viticulture, resulting in a significant reduction of the types and volumes of chemical pesticides and fungicides, management of wastes associated with winegrowing, as well as other winemaking practices to enhance sustainability and improve wine quality. It enables full traceability from vineyard to bottle and facilitates industry adoption of sustainability systems.

The marginal WTP values estimated in this study provide SWNZ managers and policy makers with information on the potential benefits of alternative (more sustainable) winegrowing strategies. These WTP values can facilitate policy development to incentivise winegrowers to maintain or improve ES. These incentives could take the form of compensation paid to winegrowers who adopt more sustainable production practices, charges to winegrowers who degrade the environment, or regulation of winegrowing to meet some environmental objectives. In any case, the estimated values can be used to calculate the maximum sum that government should dedicate to specific "agri-environmental" schemes to promote "environment friendly" vineyard management to increase social welfare.

New Zealand winegrowers have limited ability to pass on the additional costs of improved management practices to consumers as they face strong competition in both international and domestic wine prices. Green practices can be highly expensive, especially when they involve state-of-art technology and some wineries with lower profit margin may not be able to cover these additional costs. Moreover, it may not be feasible for local winegrowers to increase their prices if they will be at a price disadvantage compared to imported wines which have been produced using unsustainable winegrowing practices. Thus, compensation payment to winegrowers could be introduced to cover the costs of additional SWNZ programmes. Compensation payments are typically based on costs borne by growers when undertaking prescribed measures that reduce their incomes. These payments could be linked to winegrowing practices and only available if winegrowers adopt the sustainability practices recommended by SWNZ to reduce carbon footprints, develop comprehensive pest and disease management protocols, increase efficiency of water usage, improve winery waste management and add functional biodiversity to vineyards.

The “Grape Futures” project under the SWNZ programme, is aimed at addressing environmental and economic concerns surrounding agrichemical use and developing pest and disease management strategies to minimize chemical inputs. The estimated WTP values can be used to calculate the maximum payments to cover any additional costs as well as incentivising winegrowers to use sustainable production practices. For example, the mean WTP for zero toxic residues content for Marlborough region, on average is around $20 per household per year. The aggregate annual benefit to Marlborough households for reducing the residues content to zero is $328,740 ($20 x 16,437) and that figure is the maximum amount that government is warranted allocating to promote the “Future Grapes” project in Marlborough. This amount may also be useful when judging whether the costs of implementing controls on toxic residue in wine are likely to outweigh the benefits of reduced residues.

Another way of looking at the estimated values is to estimate the benefits of changes that involve combination of multiple attributes using utility models of respondent choice behaviour. This involves the calculation of the additional benefits that respondents receive from the environmental condition of winegrowing regions after the changes in management that are being proposed. In order to estimate respondents' Compensating Surplus (CS) for environmental improvements in winegrowing over the current (deteriorating) conditions, four options were created for policy analysis. Different combinations of attributes are considered as the outcomes of different management options which may be suitable for a region such as Marlborough or Hawke's Bay. The estimates of mean CS from the models for the four scenarios are reported in Table 7.

Table 7 near here

As expected, the CS increases if there is improvement over the current (deteriorating) ES towards better environmental conditions in winegrowing regions. For a change from current conditions to improved conditions as in Policy 1, on average respondents in HB are willing to pay NZ$147.35 each year over five years for the specified ES improvements. In contrast, greater improvements under Policy 2 increases the mean WTP to NZ$164.69. In addition, the results also indicate the importance of attribute tradeoffs when calculating CS for environmental improvements. For instance, Policy 1 and Policy 3 differ only in terms of native wildlife effects (with and without native wildlife improvement). The 'without native wildlife effect' reduces WTP by about 12% for Policy 3 compared to Policy 1. Comparing Policy 2 to Policy 4, trading off GHG reduction and native wildlife attributes reduces WTP by about 34%. Overall the respondents on average not only experience positive marginal utility for improvement in the selected ES attributes but also are willing to pay more for higher levels of environmental enhancement.

In the context of transferring the estimated welfare measures to a new site, the differences in preferences towards the ES at the study sites indicates we should be extremely cautious about transfers. Given the similarity of the environmental issues and socioeconomic profiles at two sites it will be very difficult to select either one of them as the "study" site for transferring the resulting welfare measures. In addition, the statistical tests validating the BT did not show strong plausibility in transferring the estimated values. For example, the equivalent test for parameters strongly opposed using the model parameters especially for the benefit function transfer. On the other hand, the Poe et al. (2005) tests suggest that only three out of eight WTPs can be transferred. In this situation, the best approach to follow would be the estimation of a pooled model and transfer the resulting welfare estimates as they represent the "average" value of the estimates at the two sites.[19]

Assessing how well benefit transfers can predict values at new sites and under which conditions they perform best is very subjective and depends on the judgment of the analyst. Although these transfers can definitely perform no better than original studies, they are considerably less costly and time consuming than original valuation studies, and are therefore frequently used in cost benefit analyses. Assessment of BT should focus on the level of transfer errors in absolute terms relative to the cost benefit of improvement plans in winegrowing practices. Policy makers should give great attention when choosing levels of acceptable transfer errors that may lead to false policy decisions when the actual welfare gains do not justify the level of investment. In other words, accepting a larger transfer error may lead to the overestimation or underestimation of the real value and wrongly suggest a level of benefit well distant to the costs of improving the environmental attributes.

6. Conclusion

This paper has two foci: what values do respondents of the two major winegrowing regions (Hawke's Bay and Marlborough) place on improving environmental conditions in winemaking; and does CM method provide encouraging evidence for BT across sites in this context? It is important to stress that the present study suffers from sample selectivity bias

[19] Colombo and Hanley (2008) observed that the use of exogenous indicators of site similarity to select the study site is more efficient than using a pooled model provided the study sites available have different socio-economics and environmental characteristics. However, in the context of this study, that approach is not applicable.

and therefore, the sample is not strictly representative of the population. In future research, attention should be paid to these aspects and perhaps, another method of data sampling would be preferred. For example, a sequential mixed-mode approach to induce nonrespondents to answer. This study found the general population has variable knowledge about winemaking and there is high heterogeneity in people's preferences regarding ES linked to winegrowing. In particular, respondents value programs which result in a significant total reduction in toxic chemical residues in wine, a reduction in the risk of toxic chemicals reaching groundwater, a reduction in greenhouse gas emissions and an increase in natural environment and native wildlife populations in vineyards. The overall welfare estimation results show that respondents not only experience greater marginal utilities for improvements in these selected ES attributes but also are willing to pay more for higher levels of environmental enhancement.

The second purpose of this paper was to carry out tests of BT. The study rejected the notion that the two model's parameters estimated are equivalent and therefore it is not advisable to use the coefficient values for BT analysis. In addition, it has been shown that using the Poe et al (2005) test may lead to erroneous conclusions about the transferability of the welfare measures. Finally, the equivalence test indicates that only the implicit prices of GHG30 attribute do not differ between the two sites *if and only if* the policy maker is willing to tolerate a transfer error of at least 80% when transferring these values from the MARL region to the HB region.

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Figure 1 Example of a choice card from the questionnaire

Please tick the option that you most prefer:

	Alternative 1	**Alternative 2**	**Status Quo**
Residues in wine	Zero detectable residues	Organic wine with fewer residues	Current level of residues
Risk of toxic chemicals reaching groundwater	No risk	Low risk	High risk
Greenhouse gas (CO_2) emissions per hectare per year	Zero net emissions	Current level of 3 tonnes	Current level of 3 tonnes
Natural environment and native wildlife populations	30% increase	10% increase	Few native species
Cost to household ($ per year for the next 5 years)	$90	$75	$0
	Option A ☐	Option B ☐	Option C ☐

Table 1 Definition and coding of variables

Variable	Description
Attribute variable	
RESORG	Organic wine with fewer residue levels Effect Coding: 1 if organic wine; 0 if zero residue; -1 if current level
RESZERO	Wine with no detectable residue levels Effect Coding: 1 if zero residue; 0 if organic wine; -1 if current level
WATLOW	Low risk of toxic chemical reaching groundwater Effect Coding: 1 if low risk; 0 if no risk; -1 if high risk
WATNO	No risk of toxic chemical reaching groundwater Effect Coding: 1 if no risk; 0 if low risk; -1 if high risk
GHG30	30% reduction on greenhouse gas emissions per hectare per year Effect Coding: 1 if 30% reduction; 0 if zero reduction; -1 if current level
GHGZERO	Zero greenhouse gas emissions per hectare per year Effect Coding: 1 if zero reduction; 0 if 30% reduction; -1 if current level
NAT10	10% increase of natural environment and native wildlife populations Effect Coding: 1 if 10% increase; 0 if 30% increase; -1 if current level
NAT30	30% increase of natural environment and native wildlife populations Effect Coding: 1 if 30% increase; 0 if 10% increase; -1 if current level
COST	Cost to household per year for the next 5 years - NZ$0, 15, 30, 45, 60, 75, 90
Non-attribute variable	
ASC	Alternative-specific constant with value of 1 for Alternative 1 and 2, and 0 for current level
SATIS	How satisfied is respondent with environmental quality (1=not; 3=highly)
CLOSE	How close is respondent from the nearest vineyard (1=>20Km; 5=<200m)
VINLAN	Respondents enjoy vineyards with native plant species (1= strongly disagree; 4=strongly agree)
WQ	Respondents think that winegrowing damages groundwater (1= strongly disagree; 4=strongly agree)
GHGE	Respondents think that winegrowing increase greenhouse gases (1= strongly disagree; 4=strongly agree)
HEALTH	Respondents think that winegrowing leaves dangerous residues in wine (1= strongly disagree; 4=strongly agree)
WINELA	Respondents would like wine bottles to be labelled to show environmental friendly practises in winegrowing (1= strongly disagree; 4=strongly agree)
MALE	Respondent sex (1=male; 0=female)
AGE	Respondent age
EDU	Respondent education (1=primary school; 4=degree/professional)
JOB	Respondent occupation (1= based on agriculture sector; 0 = otherwise)
INCOME	Respondent income (1= ≤ $20,000; 6= > $100,000)
UNDER	Respondents think the survey was easy to follow (1= strongly disagree; 4=strongly agree)

Table 2: Principal socio-economic characteristics of survey samples

	HB	Population Census	MARL	Population Census
Total number of respondents	197	147,783	301	42,558
Genders (%)				
Males	43.2	48.6	56.1	49.9
Females	56.8	51.4	43.9	50.1
Age (mean)	55.1	37.5#	53.4	41.7#
Education (%)				
Primary School	1.2	27.5*	1.0	25.9*
High School	41.3	43.5	36.0	45.3
Trade/technical	23.2	8.5	31.0	8.9
Degree/professional	34.3	9.1	32.0	8.3
Occupation (%)				
Agricultural/resource	14.6	19.1	32.1	20
Manufacturing and transportation	13.8	18.2	8.6	20.7
Banking/financial	4.9	1.4	1.8	1.2
Education	10.6	7.8	8.3	4.7
Health services	16.9	9.5	11.8	8.1
Accommodation, retail, and leisure	13.8	17.4	12.2	19.5
Government and defence services	12.1	2.5	8.3	4.4
Others	13.4	23.9	17.0	21.3
Income (%)				
Less than $20000	14.9	45.4	11.0	43.7
$20001 to $40000	26.6	32.0	24.2	33.5
$40001 to $60000	18.1	8.7	23.3	8.9
$60001 to $80000	15.7	8.6	15.3	8.5
$80001 to $100000	10.4	3.0	12.1	2.9
More than $100000	14.3	2.3	14.2	2.5

Note: * - No qualification; # - Median

Source: Populations censuses were obtained from www.stats.govt.nz; Hawke's Bay Region Quarterly Review December 2007 (SNZ); and Marlborough Region Quarterly Review December 2007 (SNZ).

Table 3: General environmental attitudes and beliefs on winegrowing management

	HB	MARL
Total number of respondents	197	301
How satisfied are you with environmental quality in the region (%)?		
Highly satisfied	14.8	46.2
Satisfied	62.0	41.3
Not satisfied	14.8	4.7
Don't know	7.9	7.1
How close is the nearest vineyard to your home (%)?		
Less than 200m	6.4	29.1
Less than 1 Km	24.7	18.0
1-5 Km	43.4	10.4
5-20 Km	19.3	23.1
More than 20 Km	6.3	19.4
I enjoy views of vineyard landscapes that include native plant species (%)		
Strongly agree	4.3	4.9
Agree	47.7	11.5
Disagree	43.2	52.9
Strongly disagree	4.3	26.2
Don't know	4.8	4.4
Grape growing and winemaking practices are damaging the quality of groundwater (%)		
Strongly agree	6.8	3.1
Agree	37.8	14.5
Disagree	12.1	28.8
Strongly disagree	4.3	29.8
Don't know	39.0	23.7
Grape growing and winemaking practices are adding to greenhouse gas emissions levels (%)		
Strongly agree	5.8	5.9
Agree	36.0	18.9
Disagree	19.2	29.9
Strongly disagree	4.3	11.7
Don't know	34.7	33.6
Weed killers, insecticides and fungicides in grape growing are dangerous to my health in terms of wine residue content (%)		
Strongly agree	4.9	5.7
Agree	30.2	20.4
Disagree	32.3	33.6
Strongly disagree	6.9	23.1
Don't know	25.6	17.3
I would like wine bottles to be labelled so that I am guaranteed that environmentally sustainable practices have been used (%)		
Strongly agree	3.8	2.3
Agree	15.1	11.6
Disagree	51.5	38.9
Strongly disagree	26.9	41.0
Don't know	2.7	6.2

Table 4: RPL model results for HB and MARL

Variable	**HB**		**MARL**	
Random Parameters				
RESORG	-0.1476	(0.1226)	-0.0841	(0.1088)
RESZERO	0.3162**	(0.1391)	0.2647** *	(0.1178)
WATLOW	0.9633***	(0.1605)	0.9059***	(0.1283)
WATNO	1.0528***	(0.1541)	1.1871***	(0.1684)
GHG30	0.5649***	(0.1367)	0.2224**	(0.1150)
GHGZERO	0.1709	(0.1376)	0.4408***	(0.1110)
NAT10	-0.0486	(0.1195)	0.4712***	(0.1111)
NAT30	0.5824***	(0.1441)	0.2980***	(0.1139)
COST	-0.0385***	(0.0054)	-0.0195***	(0.0043)
Non-random Parameters				
ASC	-13.8075***	(4.9253)	0.7256	(3.4759)
ASCSATIS	-0.9589	(0.6389)	-1.4961***	(0.4956)
ASCCLOSE	-1.5122***	(0.3131)	0.1247	(0.1606)
ASCVINLAN	1.7121***	(0.4831)	0.4064	(0.3269)
ASCWQ	0.6836	(0.7656)	0.0145	(0.3739)
ASCGHGE	-0.1013	(0.5798)	0.2620	(0.3639)
ASCHEALTH	0.2937	(0.5808)	0.5261	(0.3469)
ASCWINELA	2.2091***	(0.4793)	0.5036	(0.3692)
ASCMALE	-1.7411***	(0.6502)	0.8138**	(0.4052)
ASCAGE	0.0336*	(0.0197)	-0.0283**	(0.0144)
ASCEDU	-0.5607*	(0.3355)	0.4316	(0.2634)
ASCJOB	-1.2128	(0.8436)	-1.0253***	(0.4268)
ASCINCOME	0.7009***	(0.2007)	-0.1218	(0.1529)
ASCUNDER	1.0474*	(0.5926)	-1.0895***	(0.3969)
Standard Deviation of Parameter Distributions				
NsRESORG	0.1306	(0.1548)	0.6465***	(0.1902)
NsRESZERO	0.6587***	(0.1587)	0.6850***	(0.1877)
NsWATLOW	1.1437***	(0.1788)	0.8677***	(0.1733)
NsWATNO	0.8849***	(0.1880)	1.5643***	(0.1857)
NsGHG30	0.7047***	(0.1818)	0.7147***	(0.1312)
NsGHGZERO	0.8218***	(0.1787)	0.5930***	(0.1534)
NsNAT10	0.0724	(0.2826)	0.8336***	(0.1362)
NsNAT30	0.8222***	(0.1769)	0.9011***	(0.1459)
TsCOST	0.0385***	(0.0054)	0.0195***	(0.0043)
Model statistics				
N (Observation)	962		1509	
Log L	-584.71		-962.15	
McFadden Pseudo R^2 (%)	44.7		41.9	
χ^2 (degrees of freedom)	944.30*** (31)		1391.31*** (31)	

Notes: Standard errors in parentheses; single (*), double (**) and triple (***) asterisks denote significance at the 10%, 5% and 1% levels respectively.

Table 5: Mean annual WTP per household for the HB and MARL attributes.

Attribute	HB	MARL	Poe *et al*. (2005) test (*p* value)
RESORG	0.75#	4.40#	0.3730
	(-9, 11)	(-19, 26)	
RESZERO	10.69	19.56	0.2519
	(-1, 23)	(-3, 47)	
WATLOW	64.98	132.44	0.0063***
	(45, 88)	(84, 213)	
WATNO	67.11	145.29	0.0055***
	(48, 90)	(87, 237)	
GHG30	28.40	39.37	0.2679
	(15, 43)	(14, 75)	
GHGZERO	19.68#	48.59	0.0311***
	(6, 35)	(24, 89)	
NAT10	10.54#	55.13	0.0012***
	(-0.5, 22)	(27, 101)	
NAT30	24.53	47.81	0.0915*
	(11, 39)	(19, 88)	

Note: Confidence intervals (CIs) in parentheses at 95% level; the unconditional mean WTPs and CIs are calculated following the simulation procedure proposed by Hu et al. (2005); single (*), double (**) and triple (***) asterisks denote significance at the 10%, 5% and 1% levels respectively; # - non significant coefficient

Table 6: TOSC equivalence test results for unadjusted annual mean WTP

	RESORG	RESZERO	WATLOW	WATNO	GHG30	GHGZERO	NAT10	NAT30
If 30% TE								
HB vs MARL								
p_L	0.6197	0.6600	0.9500	0.9622	0.5241	0.9230	0.9973	0.8038
p_U	0.3655	0.1778	0.0004	0.0004	0.1132	0.0106	0.0005	0.0338
MARL vs HB								
p_L	0.5823	0.5794	0.7951	0.8234	0.4426	0.7935	0.9591	0.6619
p_U	0.3301	0.1289	0.0000	0.0000	0.0743	0.0018	0.0000	0.0099
If 50% TE								
HB vs MARL								
p_L	0.6148	0.5956	0.8664	0.9009	0.3865	0.8736	0.9955	0.7075
p_U	0.3606	0.1376	0.0000	0.0000	0.0529	0.0049	0.0002	0.0148
MARL vs HB								
p_L	0.5517	0.4574	0.4566	0.4993	0.2731	0.5751	0.8247	0.4441
p_U	0.3027	0.0761	0.0000	0.0000	0.0223	0.0003	0.0000	0.0011
If 80% TE								
HB vs MARL								
p_L	0.6072	0.4954	0.6431	0.7213	0.2208	0.7706	0.9912	0.5407
p_U	0.3534	0.0903	0.0000	0.0000	0.0133	0.0015	0.0000	0.0033
MARL vs HB								
p_L	0.5055	0.2904	0.1243	0.1524	**0.1087**	0.2473	0.4586	0.1988
p_U	0.2638	0.0312	0.0000	0.0000	**0.0027**	0.0000	0.0000	0.0000

p-values lower than 0.10 indicate no differences in the two distributions (bolded)

Table 7: Mean annual CS estimates per household associated with different policy options

Attribute	Current	Policy 1	Policy 2	Policy 3	Policy 4
Wine Residue	0	organic	zero	organic	zero
Water quality	0	low risk	no risk	low risk	no risk
GHG reduction	0	30%	zero	30%	0
Native increase	0	10%	30%	0	0
HB CS ($)		147.35 (111, 193)	164.69 (125, 216)	136.81 (103, 183)	108.41 (82, 146)
MARL CS ($)		287.54 (183, 466)	317.44 (203, 518)	232.41 (150, 373)	193.03 (126, 304)

Notes: Confidence intervals (CIs) in parentheses at 95% level; the unconditional mean WTPs and CIs are calculated following the simulation procedure proposed by Hu et al. (2005).