Testing for Benefit Transfer in Valuation of Ecosystem Services in New Zealand Winegrowing regions

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Summary

Benefit transfer (BT) is a pragmatic way of estimating values by transferring values from existing valuation studies to a target area of interest if there are limited resources or funding available to carry out an original valuation study. BT using choice modeling (CM) is a potentially cost-effective method for valuing differences in improvements in environmental quality as well as dealing with differences in socio-demographic factors. Surveys focused on two New Zealand winegrowing regions, Marlborough and Hawke's Bay, are used as case studies. After taking into account a range of policy options, ecosystem services attributes, socioeconomic characteristics, and attitudinal variables for these sites and populations, this study uses CM to value the marginal benefits of improvement in selected ecosystem services associated with winegrowing. The study then tests the transferability of willingness-to-pay (i.e., implicit prices) or welfare measures of equivalence across both sites to check the validity of CM for BT.

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

JEL Classification: Q1, Q2, Q5

Introduction

The health and well-being of human populations depend upon ecosystem services (ES) such as clean air, clean water and food production. ES provide many direct and indirect benefits to humans. These include the ability of ecosystems to provide clean air and water through natural filtration processes, reduce soil erosion and sedimentation in waterways, recycle nutrients, sequester carbon to mitigate climate change, moderate weather, reduce floods and drought, and provide habitat for a diversity of plants and animals. ES also include less tangible quality-of-life values, such as aesthetic landscapes, and cultural and recreational benefits. Agriculture (including winegrowing) is both a beneficiary and a provider of ES.

Agricultural ecosystems are by far the largest managed ecosystems in the world with the total land area of about 13 billion hectares. Crops and pasture occupy almost 5 billion hectares (FAO 2003). Expanding agricultural production can exacerbate damage to land-based ecosystems. Poorly managed intensification can result in harm to many ES such as pressure on water supplies, greenhouse gas emissions, water pollution (Tilman *et al*. 2002). A major concern is that increased agricultural production or intensification has come at the expense of environmental sustainability and on ES, highlighting the importance for more sustainable agricultural methods (Tilman *et al*. 2002).[1] The Millennium Ecosystem Assessment (2005) concluded that several ecosystem services (ES) that relate to agriculture are in decline, especially provisioning and regulating services such as erosion regulation, water purification, pest regulation, pollination, and natural hazard regulation. The degradation of ecosystems and the resulting impacts on the quantity and quality of the services they provide to humans are expected to continue over the next several decades (MEA 2005).

Valuing ES is fundamental to designing policies to induce landowners, including winegrowers to provide (or maintain) ES, or internalize the external costs at levels that are desirable

[1] Tilman et al. (2002) define "sustainable agriculture as practices that meet current and future societal needs for food and fibre, for ecosystem services, and for healthy lives, and that do so by maximizing the net benefit to society when all costs and benefits of the practices are considered".

to society. Thus, ecosystem service valuation can potentially provide new ways to compare the costs and benefits of different winegrowing management strategies, using the dollar as the common metric of value. Understanding how humans perceive and value ES is fundamental to ES management (Swinton *et al*. 2007).

Non-market valuation methods have contributed an important set of new tools, in particular choice modeling to estimate the value to society of ES that lack markets. Design of cost-effective public policy incentives for farmers to provide ES from agriculture requires estimates of how valuable improvements in the level of specific ES are to the public. Research is required both to measure which kinds of ES could provide the greatest overall welfare benefits to society (Swinton *et al*. 2007). It is also important to address the scale of changes in the levels of ES from or to agriculture when assessing the values because scarcity of an ES affects its value on the margin (Swinton *et al*. 2007). In other words, the relevant valuation concepts will measure changes in the values of the ES when management changes.

Non-market valuation studies are time consuming, labour intensive, and costly. Research funders are interested in finding ways to reduce costs of valuing ecosystem services and other non-market item. Value transfer uses value estimates from an existing study and transfers it to another site or alternative context that is of interest. This practice (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. However, 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 provides initial results from a choice modeling study in which New Zealand households value for selected ES associated with winegrowing are estimated.

Winegrowing and Ecosystem Services

Winegrowing has occurred for over 100 years in New Zealand, but exports only began in about 1970. 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. Strong, but decreasing growth rate in productive area is forecast. 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 (New Zealand Winegrowers 2007). The Marlborough region has 13,187 ha (53% of the national total), Hawkes Bay 4,665 ha (19%), Gisborne 2,133 ha (9%), Otago 1,415 ha (6%). Productive area lags planted area and it is noticeable that Waipara region productive area is forecast to increase by 53% in 2008 to reach 1,127 ha, 4% of the national total (New Zealand Winegrowers 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 winegrower's incomes and their provision is not a key consideration in most winegrower's decision making. These detrimental environmental impacts or external costs are typically unmeasured and often do not influence farmer or societal choices about production methods.

Winegrowing typically occurs in highly manipulated setting with regimented rows of *Vitis vinifera* cultivars supported on post and wire trellises. Between row areas are typically cultivated or mown to reduce competition with the vines. Birdstrike is a serious problem in many New Zealand winegrowing regions and damage to grape crops has been estimated to cost the industry $70 million per annum (Fox 2008). Winegrowers attempt to reduce or avoid birdstrike losses by netting, shooting, use of noise generators, and introduction of raptors. Grapes can be attached by several pests and fungus including *Phylloxera vastatrix* (an aphid), *Botrytis cinerea* (grey mould), Grapevine Leafroll associated Virus type 3 (GLRaV-3). Pesticides and fungicides are often used to control these pests and diseases in New Zealand vineyards (Gurnsey et al. 2007). Spray drift from vineyards is a cause for concern to nearby residents. At least one claim to ACC 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. During 2007, a 4000 case shipment of wine was returned to New Zealand from Germany because of excessive copper levels (McKenzie-Minifie 2007). Winegrowing and other horticulture 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.

Wine consumers are argued to 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, Sustainable Winegrowing New Zealand® (SWNZ) has been developed to promote sustainable management of the winemaking process from vineyard to bottle. 2007 membership of SWNZ reached 457 vineyards representing 13,500 hectares or 60-65% of producing area, and 57 winery sites representing up to 70% of total production (Gurnsey et al. 2007). The winegrowing industry has set a goal of 100% of the industry operating under independently audited sustainability schemes by 2012. The Chair of the New Zealand Winegrowers has commented that … ‘the day is not to far away when the market will say no residues. No residues!’ (Smith 2007).

Method

Choice Modeling

The theoretical basis of CM is 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 the assumption of error distribution to predict an individual’s probability of choosing the alternative with the highest level of utility among all possible alternatives. The RPL model has some advantages over MNL and NL as it provides the analyst with valuable information regarding the interpretation of the unobserved part of utility, and provides unbiased parameter estimates even incorporating unobserved heterogeneity in the data (Train, 1998; Train, 2003; Hensher *et al*., 2005; Hanley *et al*., 2006). 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 model will be applied to determine the convergent validity of BT in valuing marginal changes in environmental quality which may be different across sites or populations.

Benefit Transfer (BT) Tests

There are two types of statistical test required to be performed in order to validate the BT analysis.

Test 1: The Models are Equivalent

The hypothesis for the site test can be stated as follows:

$$H_0 : \beta^s = \beta^p$$

where β^s and β^p are the parameter vectors corresponding to the study site and the policy site data sets respectively. As discussed in Swait and Louviere (1993) that MNL models have a scale parameter (μ) which is confounded with the true parameters in the deterministic part of the indirect utility function. The values of the estimated parameters β^s and β^p are equal to the values of the true parameters ($\beta^s = \mu^s \beta_t^s$ and $\beta^p = \mu^p \beta_t^p$). The scale parameter cannot be estimated for a single data set, and only the ratio of scale parameters from different data sets can be estimated. Thus, to estimate the ratio of scale parameters between sets, rescaling one of them (multiplied by the hypothesized value of the scale parameter) and pooling both to conduct a one-dimensional grid search using different values of the scale parameter. The correct value of the scale parameter ratio is found when the log-likelihood of the pooled model is maximized. The test statistic used is:

$$\chi^2 = -2 * \left(LL_{Pooled} - \left(LL_{ModelA} - LL_{ModelB} \right) \right)$$

The test statistic is approximately chi-square distributed with the degrees of freedom equivalent to the number of parameters added. If the test statistic is larger than the appropriate chi-square, there is a significant difference in the parameter vectors for each model.

Test 2: The mean WTP are Equivalent

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 the value transfer method, a simple transfer of unadjusted mean WTP estimates from one site to another, and merely 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. In general, the test hypothesis is that the mean WTP for similar changes in environmental quality at the study and policy sites is the same

$$H_0 : WTP^s - WTP^p = 0$$

where WTP^s is the calculated mean (household) WTP at the study site and WTP^p is the calculated mean (household) WTP at the policy site. A convolution test developed by Poe et al. (2005) will be conducted to assess whether there are any significant differences between the mean WTP derived from the models.

While in the function transfer method, adjusted mean WTP value tries to improve the BT by adding information about the demographic or socioeconomic characteristics of beneficiaries at the policy site. In this case, the test hypothesis to be met is that the adjusted WTP at the study site, using the valuation function from the study site with sample information from the policy site, equals the observed willingness to pay at policy sites, that is

$$H_0 : adjustedWTP(\beta^s, X^p) - WTP^p = 0$$

where adjusted $WTP(\beta^s, X^p)$ is the WTP at the policy site estimated using the parameters of the benefit function of the study site (β^s) and X values (site attributes, socioeconomic characteristics, etc.) of the policy site. Similar Poe et al. (2005) test will be performed to see any significant differences between these values.

The performance of both mean value transfers and value function transfers 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 transferal from another site). In the case of mean WTP value transfers these errors are calculated as

$$\text{Mean value transfer} = \left(\frac{WTP^s - WTP^p}{WTP^p} \right) 100\%$$

For WTP function transfer errors are calculated as:

$$\text{Function transfer error} = \left(\frac{adjustedWTP(\beta^s, X^p) - WTP^p}{WTP^p} \right) 100\%$$

Assessment of this error allows for justification if the transfer process is reliable and hence whether in the future there is a need to transfer values from study sites to policy sites without having to conduct new research or surveys.

Data Collection

The choice modeling surveys were designed to contain multiple choice questions (choice situations) about alternative policies for improving four selected ES attributes on winegrowing properties. The questionnaire consisted of three parts. The first part contained questions regarding respondents' opinions and their awareness of current environmental degradation situation caused by winegrowing farming. These questions had the objective of introducing the respondent into the subject of ES services. 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 questions, respondent were asked to select an option they favoured the most out of the three alternatives provided. Each option contains the four attributes and the cost to the household with various levels of attribute combinations. 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 (highest improved level); 30% reduction; and 'no change' from current emission level. The payment vehicle is loss of household incomes. 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 and information from literature. The last part of the survey contained questions regarding the respondents' socio-economic backgrounds.

There are four attributes with three levels and the cost attribute with 6 levels ($3^4 .6^1$) were then combined in a fractional factorial main effects experimental design (Louviere et al. 2000), obtaining 18 profiles in order to form the choice sets. The choice sets were constructed following the procedure proposed by Street et al. (2005). The programme created 18 choice sets with a 94.85% efficiency rate which were then allocated to 3 versions (survey) of 6 choice sets. Hence there were 18 versions of the survey questionnaires differing only in the attribute levels in the choice questions. 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 improved environmental management plan (Alternative 1 or 2) or current plan (Alternative 3).

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%.

Results and Discussion

The choice data were analysed using NLOGIT 4.0 statistical software. The study preferred to use effects coding instead of dummy coding due to identification problem. The advantage of using the effects coding is that the effect 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 (refer Appendix 1). Table 2 and 3 present the descriptive statistics of Hawke's Bay (HB) and Marlborough (Marl) samples for the socio-demographic and attitudinal variables (refer Appendix 1).

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 far 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 about their opinion on whether winegrowing practices are harmful to underground water quality, greenhouse gases emissions, and health in term of wine residue content. Generally, respondents agree that winegrowing has the potential to damage the environment if not properly managed, but there is a general lack of knowledge regarding these issues. 39% of the sample 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 for health. 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 13% expressed a protest answer regarding the proposed project; these protest bids were removed from the sample. 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 interview. The results in the last column of Table 3 show that almost 88% of the sample is satisfied with the environmental quality in the region. The degree of satisfaction is higher in this region relative to 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 90% of the sample disagrees with the statement. In addition, more than three quarters of respondents (80%) do not like 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 practicing are harmful for underground water quality, greenhouse gases emissions and health in term of wine residues content, they generally disagree on this statements although a general lack of 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. 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 number 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. The models were estimated using 100 Halton draws and considered the random parameters to be independent[2]. Overall the models are highly significant and show an excellent fit to the data (ρ^2 = 0.43 and ρ^2 = 0.41, respectively)[3]. All the significant attribute coefficients have the expected sign for both the models. Attributes RESORG and NAT10 in HB model are insignificant and treated as fixed parameters (initially assumed as random parameters but not significant heterogeneity was found). This is because reducing the residue content in wine is a matter that significantly affects people utility only if the reduction is complete rather than a marginal reduction. Respondents also prefer increasing the native wildlife population in vineyards by at least 30% relative to the current condition. A smaller improvement is not of interest to people. Note that as presented in Table 3 for the HB sample more that 43.3% of respondent disagree with the statements that vineyard landscape that include native species are attractive and more than 32.3% disagree (also 25.6% don't know) that chemical residues in wine are of concern. This may influence the coefficients (RESORG and NAT10) to be insignificant in the HB model. While in 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 managing has on underground water quality is deemed extremely important by both groups of sample respondents, and a reduction of the risk of toxic chemicals reaching groundwater increases respondents' utility. The reduction in the emission of greenhouse gases is also a concern to both HB and MARL respondents.

[2] All the random parameters models described in this report have been estimated using these settings.
[3] Simulations by Domencich and McFadden (1975) compare values of ρ^2 between 0.2-0.4 to values between 0.7-0.9 of the R^2 in the case of the ordinary linear regression.

Respondents from HB and MARL regions prefer increasing the native wildlife population. However, in contrast to the HB sample, MARL respondents get more utility in the presence of 10% increase than from a 30% increase. Note that in this region 80% of people disagree when asked if they enjoy vineyards that are richer in native wildlife and plant populations. 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 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' choices in choosing 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. For instance, people that strongly enjoy vineyard landscape views are more likely to choose policy options that will provide payments to farmers to increase the quality of the landscape. The HB sample respondents are in favour of supporting improved winegrowing management practices in landscape, health issues on wine residues, and 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 the current winegrowing management. Finally, older respondents are more likely to choose the improved plans over the current plan.

In contrast, MARL sample respondents who are satisfied with the environmental quality prefer to hold on to the current management practices instead of improving them. Those who live nearer to vineyards are in favour of improving the present conditions of winegrowing practices. MARL respondents who agree that wine residues affect their health also willing to support the improvement alternatives. Respondent occupation significantly affects choice of the current situation relative to the various alternatives. In particular, 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 their management. Education plays an important role in this sample. Highly educated respondents are supportive of the improvement plans. Lastly, it is worth mentioning that the degree of agreement (understanding of the questionnaires), respondents declared 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 managing. 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, 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. Besides the lack of knowledge may also be an additional contributing factor that increase the heterogeneity in respondents' choices.

In summary, the HB and MARL models indicate that respondents value programs which result in a significant total reduction in wine residue content, a reduction of the risk of toxic substances reaching groundwater, a reduction of greenhouse gases emissions and an increase of natural environment and native wildlife populations. The models show a high degree of heterogeneity exists within the samples.

RPL Models for HBMARLSE and MARLHBSE

Table 5 presents RPL models for HBMARLSE (model parameters of HB study site attributes added with the socio-demographic characteristics of the MARL site) and MARLHBSE (model parameters of MARL study site attributes added with the socio-demographic characteristics of the HB site). The models were estimated using 100 Halton draws and considered the random parameters to be independent. Overall the models are highly significant and show an excellent fit to the data ($\rho^2 = 0.41$ and $\rho^2 = 0.38$, respectively). All the significant attribute coefficients have the expected sign for both the models. Comparing the interaction with ASC, both models indicate opposite results compared with the previous models in terms of the number of significant variables, signs and the magnitude of the significant coefficients. For example, in MARLHBSE model, only ASCWQ is significant. The standard deviations of parameters distributions for all the random parameters are statistically significant indicating heterogeneity does exist amongst sampled respondents in choosing those attributes levels. In MARLHBSE model, GHG30 is assumed to have a triangular distribution instead of normal distribution.

Testing if the Models (HB and MARL) are Equivalent

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. We thus perform 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 dataset was applied. Hence, the estimated variance-scale ratio was found to be 3.0 which implies that the MARL sample has on average higher response variability (larger error variance) than the HB sample. The likelihood ratio test statistic for a comparison of the choice model parameters between the HB and MARL is

$$\chi^2 = -2\left(LL_{HB+MARL} - \left(LL_{HB} + LL_{MARL}\right)\right) = -2\left(-1647.53 - (-598.18 - 976.16)\right) = 146.38$$

The critical chi-square value $\left(\chi^2_{0.05,23} = 35.17\right)$ is 35.17 at the 5% significance level (23 degrees of freedom), is well below the calculated value; therefore it can be concluded that a significant difference does exist (reject the null hypothesis) between the two sites, even after taking scale differences into account. This means that using the models parameters as BT would be inaccurate or biased.

Testing if the Mean WTP are Equivalent

This test focuses on the equality of the mean WTP (implicit price). Estimates of mean WTP derived from the models are presented in Tables 6 and 7. The estimated values are marginal WTP annually for a period of five years for a change (improvement) in the ES attributes concerned, *ceteris paribus*. This test has been carried out using the Poe et al. (2005) procedure and shows that there are no significant differences among mean WTP between the two sites and can be considered statistically the same at a confidence level of 95%. This means that the HB, MARL, HBMARLSE and MARLHBSE models are generally supportive of the use of mean WTP for BT[4].

Based on these estimated values, it is possible to calculate the transfer errors of unadjusted and adjusted mean WTP as presented in Table 8. In general, a *priori* expectation is that study and policy site populations are similar so the errors associated with function transfer should be relatively small. However, certain circumstances where simple absolute value difference transfers should also work best as similar populations are likely to have similar WTP. Conversely, where the preferences of study populations differ substantially from those at the policy site both function transfers and absolute value difference transfers may well produce relatively large errors.

The average unadjusted mean WTP (absolute value difference) for HB vs MARL and HBMARLSE vs MARLHBSE are 46.25% and 59.94%, respectively. While the average adjusted mean WTP for HBMARLSE vs MARL and MARLHBSE vs HB are 43.67% and 235.60%, respectively. The results indicate that when HB is used as study site for transferring both unadjusted as well as adjusted mean WTP, the magnitude of transfer error is small compared to using MARL as the study site. In addition, comparison of unadjusted (absolute value difference) and adjusted (function transfer) mean WTP errors derived by both approaches are tolerably small with the function transfer outperforming the absolute value difference of mean values. Similarly, the CS

[4] This is true statistically. However, behaviorally or economically it may be illogical to say the two measures are not different given the heterogeneity (wider confidence intervals) of the WTP. Using the unconditional distribution always get this results, since the Poe et al. test is not really sensitive to how much wider is a distribution. In other words, two spread distributions are considered always the same, although the variance of the distribution may forbid a "sound" economic interpretation of the results.

transfer errors are also consistent with the mean WTP results. Nevertheless, no studies in the literature indicate which level can be considered as the 'acceptable range' for policy makers. 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.

The results show that the mean WTP for these models have larger confidence intervals, reflecting greater variations in respondents' preferences for these attributes. It is also important to observe that there are no substantial differences of mean WTP between HB vs HBMARLSE and MARL vs MARLHBSE. The mean WTP for all the attributes are positive, implying that respondents have positive utilities for increases in the quality or quantity of each attribute except RESORG and NAT10. For example, on average HB respondents would be willing to pay $7.89 annually for a period of five years for a total reduction (zero level) in wine residues. These 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 of toxic risk in water quality where both samples show a high level of importance for the attribute. Relative to the HB region the willingness to pay in the MARL region is higher. This is principally due to it being the highest value of the attributes. Respondent in the MARL region showed "less aversion" to costly alternatives, as long as they provide improved environmental conditions relative to the current ones. Although the sites attributes are similar, respondents posed different preferences for the ecosystem services studied. There is also a high heterogeneity exists on these attributes and some (e.g., water quality) are considered really important in both sites.

In order to estimate respondent's Compensating Surplus (CS) for environmental improvements in winegrowing over the current (deteriorating) conditions, four options were created for policy analysis[5]. Different combinations of attributes are considered as the outcomes of different

[5] Some studies testing the equivalence of estimates of CS for BT. In this paper, the authors find that the CS testing are based on the discretion of analyst chosen criteria or policy options and not from the sample respondents. Thus, may have limitation on the information of transferability of welfare estimates.

management options. The estimates of mean WTP from the models for the four scenarios are reported in Table 9.

As expected, the CS increases if there is improvement over the current (deteriorating) ES towards better environmental conditions in winegrowing. For a change from current conditions to improved conditions as in Policy 1, on average, respondents in New Zealand are willing to pay NZ$43.86 each year over five years for the specified ES improvements. In contrast, greater improvements under Policy 2 increases the mean WTP to NZ$119.32. 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 2% for Policy 3 compared to Policy 1. Comparing Policy 2 to Policy 4, trading off GHG and native wildlife attributes reduces WTP by about 38%. 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.

Conclusion

Winegrowing is an important source of income and export revenue for New Zealand. In response to strong global demand and high export market values, winegrowers tend to intensify their production practices in ways that can 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 winegrower's incomes and their provision is not a key consideration in most winegrower's decision making. Valuing ES is fundamental to designing policies to induce winegrowers to provide (or maintain) ES or internalize the external costs at levels that are desirable to society.

This paper has two purposes: using CM what values do respondents of the two major winegrowing regions (Hawke's Bay and Marlborough) place on improving environmental conditions in winemaking; and whether CM method provides encouraging evidence for BT across sites in this context. This study found that respondents value programs which result in a significant total reduction in wine residue content, a reduction of the risk of toxic substances reaching groundwater, a reduction of greenhouse gases emissions and an increase of natural environment and native wildlife populations. The results may possibly serve as informative campaign (not only directed to winegrowing, but more generally to the effect of farming on the environment) to the general population given the high heterogeneity in people preferences and an extensive lack of knowledge regarding the ES provided by winegrowing. The overall welfare estimation results show that respondents not only experience greater marginal utilities for improving 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. Two types of tests were conducted. The study rejected the notion that the two models parameters estimated are equivalent and therefore, it is not advisable to use the values for BT analysis. However, the second test on the equivalent of mean WTP strongly supports use of mean WTP for BT analysis. Lastly, the transfer error resulting indicate that when HB is used as study site for transferring both unadjusted as well as adjusted mean WTP, the magnitude of transfer error is smaller by an average of 50% (if use HB site attributes) compared to MARL as the study site. In addition, comparison of unadjusted (absolute value difference) and adjusted (function transfer) mean WTP errors derived by both approaches are tolerably small with the function transfer outperforming the absolute value difference of mean values. Since the acceptable range for transfer error is contentious, the judgment of policy makers is required to decide how much to rely on BT values, or whether to initiate new studies.

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Appendix

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 on value of 1 for Alternative 1 and 2, and 0 for the 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)
GENDER	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	**MARL**
Total number of respondents	197	301
Gender (%)		
Males (%)	43.2	56.1
Females (%)	56.8	43.9
Age (mean)	55.1	53.4
Education (%)		
Primary School	1.2	1.0
High School	41.3	36.0
Trade/technical qualification	23.2	31.0
Degree/professional	34.3	32.0
Occupation (%)		
Agriculture or resource based	14.6	32.1
Manufacturing and transportation	13.8	8.6
Banking or financial services	4.9	1.8
Education	10.6	8.3
Health services	16.9	11.8
Accommodation, retail, and leisure services	13.8	12.2
Government and defence services	12.1	8.3
Others	13.4	17.0
Income (%)		
Less than $20000	14.9	11.0
$20001 to $40000	26.6	24.2
$40001 to $60000	18.1	23.3
$60001 to $80000	15.7	15.3
$90001 to $100000	10.4	12.1
More than $100000	14.3	14.2

Table 3: General environmental attitudes and beliefs on winegrowing managing

	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				
RESZERO	0.2792**	(0.1333)	0.2751** *	(0.1088)
WATLOW	0.9953***	(0.1589)	0.7695***	(0.1090)
WATNO	1.0266***	(0.1590)	0.9622***	(0.1311)
GHG30	0.3937***	(0.1397)	0.2016**	(0.1006)
GHGZERO	0.2273*	(0.1304)	0.4232***	(0.1020)
NAT10			0.4294***	(0.0988)
NAT30	0.5574***	(0.1365)	0.2034**	(0.0972)
Non-random Parameters				
ASC	-20.8158***	(3.9645)	2.3306	(2.1637)
RESORG	0.0028	(0.1234)	-0.0914	(0.0941)
NAT10	0.0305	(0.1152)		
COST	-0.0341***	(0.0051)	-0.0133***	(0.0035)
ASCSATIS			-1.7089***	(0.4253)
ASCCLOSE	-0.8476***	(0.2608)	0.3234**	(0.1324)
ASCVINLAN	2.2863***	(0.5298)		
ASCHEALTH	1.3861***	(0.4679)	0.9319***	(0.2543)
ASCWINELA	1.6404***	(0.3697)		
ASCAGE	0.0379**	(0.0163)		
ASCJOB	-0.9076	(0.6429)	-0.7265*	(0.4136)
ASCUNDER	0.5376	(0.4548)	-1.4918***	(0.3322)
ASCEDU			0.5319**	(0.2469)
Standard Deviation of Parameter Distributions				
NsRESZERO	0.5691***	(0.1767)	0.5373***	(0.1370)
NsWATLOW	1.2422***	(0.1819)	0.7769***	(0.1195)
NsWATNO	1.0813***	(0.1951)	1.3274***	(0.1419)
NsGHG30	1.0132***	(0.1876)	0.5652***	(0.1631)
NsGHGZERO	0.6646***	(0.2173)	0.6358***	(0.1372)
NsNAT10			0.5731***	(0.1168)
NsNAT30	0.7931***	(0.1546)	0.7229***	(0.1385)
Model statistics				
N (Observation)	962		1509	
Log L	-598.18		-976.16	
McFadden Pseudo R^2 (%)	43.4		41.1	
χ^2 (degrees of freedom)	917.38*** (23)		1363.28*** (23)	

Notes: Standard errors in parentheses; *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Table 5: RPL model results for HBMARLSE and MARLHBSE

Variable	HBMARLSE		MARLHBSE	
Random Parameters				
RESZERO	0.3236^{**}	(0.1504)	0.2695^{**}	(0.1107)
WATLOW	1.0789^{***}	(0.1731)	0.8505^{***}	(0.1066)
WATNO	1.0626^{***}	(0.1651)	1.1006^{***}	(0.1583)
GHG30	0.4533^{***}	(0.1433)	0.2104^{**}	(0.1058)
GHGZERO	0.2509^{*}	(0.1444)	0.4835^{***}	(0.1099)
NAT10			0.5539^{***}	(0.1016)
NAT30	0.5217^{***}	(0.1522)	0.2423^{**}	(0.1111)
Non-random Parameters				
ASC	-1.3593	(2.7726)	0.7978	(1.2025)
RESORG	-0.0410	(0.1309)	-0.0824	(0.0951)
NAT10	0.0317	(0.1221)		
COST	-0.0350^{***}	(0.0054)	-0.0110^{***}	(0.0034)
ASCSATIS	0.0596	(0.4177)	0.0126	(0.2215)
ASCCLOSE	-0.3222^{**}	(0.1539)	-0.2605	(0.2019)
ASCVINLAN	0.1592	(0.2425)		
ASCGHGE	-0.1702	(0.3672)		
ASCHEALTH	0.4430	(0.3255)	-0.0330	(0.1528)
ASCWINELA	0.4367	(0.3151)		
ASCWQ	-0.3125^{**}	(0.1464)	0.4057^{**}	(0.1670)
ASCAGE	-0.0056	(0.0157)		
ASCINCOME	-0.3713^{**}	(0.1536)	-0.1513	(0.1371)
ASCUNDER	0.0837	(0.3234)		
ASCEDU	0.6495^{**}	(0.2611)	-0.2053	(0.2489)
Standard Deviation of Parameter Distributions				
NsRESZERO	0.8414^{***}	(0.1745)	0.6589^{***}	(0.1298)
NsWATLOW	1.3230^{***}	(0.2076)	0.6199^{***}	(0.1446)
NsWATNO	1.2440^{***}	(0.2039)	1.7087^{***}	(0.1678)
NsGHG30	1.0274^{***}	(0.1989)		
TsGHG30			1.4396^{***}	(0.3091)
NsGHGZERO	0.7889^{***}	(0.1971)	0.6992^{***}	(0.1452)
NsNAT10			0.5685^{***}	(0.1695)
NsNAT30	1.0553^{***}	(0.1863)	0.9208^{***}	(0.1394)
Model statistics				
N (Observation)	962		1509	
Log L	-627.97		-1022.37	
McFadden Pseudo R^2 (%)	40.6		38.3	
χ^2 (degrees of freedom)	857.79^{***} (27)		1270.87^{***} (23)	

Notes: Standard errors in parentheses; *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Table 6: Mean annual WTP per household for the attributes and testing its differences between HB and MARL models.

Attribute	HB	MARL	Proportion of $WTP_{HB} - WTP_{MARL} > 0$
RESZERO	7.89	19.79	0.60505
	(-25.35, 41.13)	(-59.79, 99.38)	
WATLOW	30.32	55.83	0.65292
	(-43.09, 103.73)	(-53.28, 164.93)	
WATNO	30.38	73.99	0.65915
	(-29.47, 90.23)	(-119.03, 267.01)	
GHG30	10.21	15.99	0.54488
	(-45.95, 66.38)	(-68.32, 100.31)	
GHGZERO	6.16	31.51	0.69338
	(-31.88, 44.19)	(-64.02, 127.04)	
NAT10	-	33.56	-
		(-49.52, 116.64)	
NAT30	16.80	16.17	0.50154
	(-29.88, 63.49)	(-92.12, 124.46)	

Note: Confidence intervals (CIs) in parentheses at 95% level; The mean WTPs and CIs are calculated using the unconditional parameter distribution estimates.

Table 7: Mean annual WTP per household for the attributes and testing its differences between HBMARLSE and MARLHBSE models.

Attribute	HBMARLSE	MARLHBSE	Proportion of $WTP_{HBMARLSE} - WTP_{MARLHBSE} > 0$
RESZERO	9.39	23.51	0.57804
	(-37.98, 56.75)	(-95.04, 142.06)	
WATLOW	30.30	79.48	0.76416
	(-42.61, 103.21)	(-32.04, 190.99)	
WATNO	28.78	94.29	0.65135
	(-40.65, 98.20)	(-205.80, 394.38)	
GHG30	12.96	26.02	0.56278
	(-44.75, 70.67)	(-59.19, 111.23)	
GHGZERO	6.92	46.37	0.72337
	(-37.49, 51.34)	(-79.27, 172.02)	
NAT10	-	53.29	-
		(-48.93, 155.51)	
NAT30	15.26	22.77	0.52061
	(-43.37, 73.89)	(-137.95, 183.49)	

Note: Confidence intervals (CIs) in parentheses at 95% level; The mean WTPs and CIs are calculated using the unconditional parameter distribution estimates.

Table 8: Transfer Errors for WTP and CS

	Unadjusted Value Transfer (%)		Adjusted Value Transfer (%)	
	HB^s vs $MARL^p$	$HBMARLSE^s$ vs $MARLHBSE^p$	$HBMARLSE^s$ vs $MARL^p$	$MARLHBSE^s$ vs HB^p
WTP RESZERO	-60.13	-60.06	-52.55	197.97
WTP WATLOW	-45.71	-61.88	-45.75	162.14
WTP WATNO	-58.94	-69.48	-61.10	210.37
WTP GHG30	-36.15	-50.19	-18.95	154.85
WTP GHGZERO	-80.45	-85.08	-78.04	652.76
WTP NAT30	3.90	-32.98	-5.63	35.54
AVERAGE	**-46.25**	**-59.94**	**-43.67**	**235.60**
CS1	-56.96	-69.00	-55.29	235.09
CS2	-57.20	-69.75	-56.89	232.96
CS3	-38.15	-55.28	-36.97	127.88
CS4	-61.02	-68.66	-58.81	237.24
AVERAGE	**-53.33**	**-65.67**	**-51.99**	**208.29**

Note: s and p identifying study sites and policy sites, respectively. Negative values indicate cases where $WTP^s > WTP^p$ (and vice versa for positive values).

Table 9: 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 ($)		43.86 (-49.13, 136.86)	119.32 (-64.58, 303.22)	42.97 (-50.03, 135.96)	73.73 (-67.74, 215.21)
MARL CS ($)		101.90 (-69.73, 273.54)	278.78 (-223, 780.57)	69.48 (-76.89, 215.85)	189.17 (-217.09, 595.42)
HBMARLSE CS ($)		45.56 (-59.06, 150.18)	120.19 (-104.92, 345.31)	43.79 (-47.56, 135.13)	77.92 (-91.86, 247.72)
MARLHBSE CS ($)		146.97 (-28.11, 322.05)	397.29 (-369.44, 1164.03)	97.92 (-45.98, 241.82)	248.65 (-398.50, 895.81)

* Current levels coded as 0, ** medium levels coded as 1, and *** best level coded as 2.
Note: The mean CS and CIs (95% level) are calculated using the unconditional parameter distribution estimates.