Consumer demands for organic and genetically modified foods

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Abstract:

Issues concerning consumer demands for genetically modified and organic food remain topical. It is unclear how consumers perceive issues associated with food production such as food safety, environmental impacts or animal welfare. It is also unclear how consumers might value potential changes in those issues in regional and metropolitan centres. This paper reports on research using the choice modelling technique to estimate and compare consumer demand for genetically modified and organic foods in Australia. The case study considers tomatoes, milk and beef commodities. The results draw comparisons between the contribution of associated factors influencing consumer purchasing decisions in a regional and metropolitan city. The results are relevant to the current policy debate regarding the introduction of GM foods.

Key words: Genetically modified, organic, demand, choice modelling

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1.0 Introduction

The development of genetically modified (GM) and organic food industries and associated food safety regulations has, to date, involved scientists and regulators much more than economists. Recently there has been growing recognition that to address food safety issues and other uncertainties, expertise from other disciplines will need to be considered (Appell 2001). Public and private interests associated with food production need to be assessed and evaluated.

A limitation of the current debates over GM and organic foods is that little is known about how demand for these foods is associated with factors such as concerns over health, environmental and animal welfare issues. Releasing GM crops may result in unforseen irreversible ecological outcomes. Similarly, halting the development of this technology may result in significant foregone producers' and consumers' surpluses for current and future generations. This dilemma of choosing between economically disruptive precautionary measures now or risking unfavourable ecological, health and ethical outcomes in the future currently faces policy makers world-wide. To inform this choice, information regarding the extent of relevant costs and benefits is useful.

Techniques have been developed to estimate the values of public good attributes of food and risks associated with their production. One of these techniques is Choice Modelling (CM). To date the CM technique has been used in market analysis and environmental valuation[1] but has had only limited application[2] in estimating consumers' values for items such as food safety and ethical farming practices.

In this paper, the findings of a CM experiment designed to estimate consumers' values for similar agricultural commodities produced from organic, conventional and genetically modified production systems are compared and reported for a regional and metropolitan city. Each system is differentiated by the environmental, food safety and ethical characteristics of its products. These attributes may have important influences on consumers' purchasing decisions and government policy directions.

The paper is structured as follows. In section 2, some of the background literature is reviewed. In section 3, the CM technique is described and in section 4, the research methodology used in this application of CM is provided. The sampling structure and technique are described in Section 5 and in Section 6 the findings of the research are reported. Discussion about the differences in results between the two populations sampled is presented in section 7, and conclusions are drawn from the results in Section 8.

2.0 Valuing consumer attitudes

A number of studies (Kelley 1995, Norton et al., 1998, Yann Campbell Hoare Wheeler, 1999, Mendenhall, 2000) have examined consumers' attitudes towards genetically modified foods, environmentally friendly foods and foods produced using 'ethically acceptable' production systems. The majority of these studies have

[1] There have been extensive applications of CM in the marketing and environmental valuation literature. See Blamey et al. 2000, Bennett and Adamowicz 2001, Hansen and Schmidt 1999 and Adamowicz, et al. 1998.

[2] Refer to Baker and Burnham (2001) and James and Burton (2001).

generated qualitative data and have not produced quantitative estimates of indirect use values[3] associated with food production.

Some studies have produced quantitative results. Ness and Gerhardy (1994) investigated consumers' preferences for multiple attribute food products using an application of conjoint analysis to freshness and quality attributes of eggs in the United Kingdom. Rolfe (1999) expanded this work through a contingent valuation method (CVM) study that identified the reasons why some consumers purchased free range eggs in preference to eggs produced from battery hens and estimated values consumers placed on eggs produced organically. Similar CM exercises have been undertaken where stated choices for environmentally friendly and conventional consumer items were compared with market related data (Blamey et al 2001).

More recently Baker and Burnham (2001) have used conjoint analysis to determine the extent to which the GM content of food products influences United States consumers' preferences. In Australia, James and Burton (2001) have used CM to test whether or not consumers are willing to pay a premium on their weekly food bill to avoid GM food.

The work of Rolfe (1998), Blamey et al. (2001), Baker and Burnham (2001) and James and Burton (2001) demonstrates the potential usefulness of CM and conjoint analysis in estimating consumer's values for environmental and health attributes of food. This study extends the use of CM to horticultural, dairy and beef products, generating estimates of consumers' willingness to pay for food safety, animal welfare and environmental attributes of tomatoes, milk and beef.

Food safety, animal welfare and environmental attributes may be important influences on consumers' purchasing patterns. This is particularly so when consumers are confronted with the option of choosing a GM, organic or conventionally grown product. The degree to which these attributes vary between regional and metropolitan cities remains unclear. By estimating and incorporating these public good values into government policy considerations, the net benefits to the public from both GM and organic cropping options can be more fully considered.

3.0 The Choice Modelling case study

CM has been developed in the marketing, tourism, transportation and environmental fields (see McFadden, 1974, Louviere and Hensher, 1982, Bennett and Blamey 2001). CM allows the estimation of respondents' marginal rates of substitution between product attributes and willingness to pay to move from the "status quo" bundle of attribute levels to other alternatives that correspond with policy outcomes of interest to communities and the government (Bennett and Adamowicz 2001).

In a CM application respondents are asked to choose one option from each of several sets of multiple resource use options. Each choice is between a constant "status quo" and proposed alternatives. The groupings of "status quo" and proposed alternatives are

[3] Use values are generated through direct contact with a resource (Bennett and Blamey 2001). For example the nutritional value derived from the consumption of steak is a direct use value. Use values may also include indirect uses. For example consumers purchasing steak produced from sustainable grazing systems will also enjoy the beneficial ecological outcomes associated with the sustainable grazing system. These beneficial ecological outcomes are an indirect use of consuming environmentally friendly steak.

known as choice sets. The proposed alternatives in each choice set are differentiated by the levels taken by a set of attributes used to describe the alternatives of the status quo described to respondents and the financial burden they impose. The descriptors and the financial impost involved are known as the attributes of the alternatives (Bennett and Adamowicz 2001).

By observing and modelling how people change their preferred option in response to the changes in the levels of the attributes, it is possible to determine peoples' willingness to give up some amount of an attribute in order to achieve more of another. By including a financial impost as one attribute, it is also possible to estimate the additional price that people are willing to pay to achieve more of an attribute. This is called a part-worth or implicit price estimate and can be estimated for each of the non-monetary attributes used in the choice sets (Bennett and Adamowicz 2001).

Implicit Prices are calculated using the following formula where ß is the coefficient estimated in the choice model:

$$\text{Implicit Price} = -(\beta_{\text{non-marketed attribute}} / \beta_{\text{monetary attribute}})$$

CM can also be used to estimate the amount people are willing to pay to move from the "status quo" bundle of attribute levels to specifically defined bundles of attribute levels that correspond with policy outcomes that are of interest. In other words the value of a change from the status quo to a specific alternative can be derived (Bennett 1999).

4.0 Applying CM to food production

Three CM experiments were designed to estimate values Australian consumers hold for attributes of organic and GM foods relative to conventionally produced foods. One experiment each for milk, steak and tomatoes were run concurrently in a regional and metropolitan city using a single consumer survey. In each case survey respondents were asked to choose between an organic, GM and conventionally farmed alternative based on the attributes of each. The logic of combining the experiments into a single survey was that respondents were less likely to be fatigued by a variety of choice profiles[4]. This allowed more choice sets to be offered. There may also be some framing advantages[5] because respondents were made explicitly aware of the variety of alternate goods available through the questionnaire format.

Focus groups[6] were used to identify key attributes and estimate the frame of reference existing in respondents' minds relating to organic and GM foods. Results of focus group sessions and a review of the literature indicated that Australian consumers were influenced by a large number of attributes in their selection of foods. Using the focus groups these were condensed to seven key product attributes:

- food safety;

[4] A series of choice profiles on the one topic can appear monotonous or confusing to survey respondents. In this survey respondents were asked to complete four choice sets for each product thus providing some variety to respondents.

[5] Framing ensures that survey respondents are aware that the good under consideration is embedded in an array of substitute and complementary goods and establishes the context in respondents' minds which is appropriate to the circumstances of the decision being made (Bennett and Blamey 2001).

[6] Krueger (1988) define focus group interviews as an unstructured, free flowing discussion with a small group of people. Ideally the group will comprise an interviewer or moderator and six to ten participants.

- animal welfare;
- environmental impacts;
- location of production;
- beef tenderness;
- appearance;
- freshness.

Based on the focus group information, a three page explanatory brochure was prepared and attached to the questionnaire. Respondents were asked to read the brochure prior to completing the questionnaire. The brochure contained basic explanatory notes regarding genetic modification, cloning, a brief description of GM crops currently grown in Australia and a summary of the major benefits and risks associated with GM crops. The brochure defined terms used in the questionnaire and provided basic background information to respondents.

Focus group discussions confirmed participants' preference for the use of icons to label attributes and the combination of percentage changes and words to represent changes to attributes. The use of "percentage change" was chosen as the preferred method for describing levels due to the difficulty experienced in framing attributes such as risk to human health, impact on the environment and animal welfare. Many of these attributes were a combination of a number of factors with different measurement units. The percentage change approach improved the consistency with which attributes were described across the three experiments. An example of how an attribute was defined to respondents is as follows:

> ***What does*** *"Impact on environment"* ***mean?***
>
> *Land degradation can be an outcome of agriculture in some parts of Australia. The type and magnitude of impacts on the environment resulting from agriculture vary depending on the farming system used.*
>
> *Impacts on the environment from agriculture may include:*
> - *Sediment, nutrient and chemical contamination of waterways*
> - *Dryland salinity*
> - *Soil erosion*
> - *Biodiversity decline*
> - *Ecological risks associated with the use of GMO's*

Apart from such explanatory notes, no other information was provided to respondents. Several follow-up questions were included in the survey to test that respondents understood the choice they were making and to uncover the reasons for their answer. This also allowed researchers to ascertain whether respondents who were confused, or felt the survey was biased, had a particular preference for one of the choice options.

The payment vehicle used in the experiment was the purchase price of each product if bought at a supermarket. A range of levels for each attribute was used to construct choice profiles for each product. An example of one of the choice sets used in each CM experiment is attached as Appendix 1. The questionnaire comprised 12 choice sets (four for each of the three experiments) with three options per choice set. The options included purchasing either the conventional good (status quo option), GM good or organic good. Icons were used to label each attribute.

An experimental design[7] was used to construct 16 different versions of the questionnaire. The *impact on environment* attribute was varied across eight levels. The other attributes varied across four levels. The model incorporated both discrete attribute levels (eg. location of milk production) and continuous attribute levels (eg. price). The pool of attributes and levels used in each of the three experiments is presented in Table 1.

Table 1 Attributes and levels used in each of the three CM experiments

CM Experiment	Attribute	Conventionally farmed Levels	GM Levels	Organic Levels
Milk	Location of milk production	Current Standard	Local, Regional, Elsewhere in Qld, Other states	Local, Regional, Elsewhere in Qld, Other states
	Risk to human health (% change)	Current Standard	0,-5,-10,-15	0,5,10,15
	Impact on the environment from production (% change)	Current Standard	-20,-15,-10,-5,0,5,10, 15	-20,-15,-10,-5,0,5,10,15
	Animal welfare (% change)	Current Standard	-15,-10,-5,0	0,5,10,15
	Price ($/2 litres)	2.50	1,1.50,2,2.50	2.75,3,3.50,4
Tomatoes	Appearance of tomato (% change)	Current Standard	0,5,10,20	-15,-10,-5,0
	Risk to human health (% change)	Current Standard	0,-5,-10,-15	0,5,10,15
	Impact on the environment from production (% change)	Current Standard	-20,-15,-10,-5,0,5,10, 15	-20,-15,-10,-5,0,5,10,15
	Freshness of the tomato (% change)	Current Standard	-15,-10,-5,0	0,5,10,15
	Price ($/kg of tomatoes)	2	1,1.25,1.50,1.75	2.25,2.50,2.75,3
Steak	Tenderness (% change)	Current Standard	0,5,10,20	-15,-10,-5,0
	Risk to human health (% change)	Current Standard	0,-5,-10,-15	0,5,10,15
	Impact on the environment from production (% change)	Current Standard	-20,-15,-10,-5,0,5,10, 15	-20,-15,-10,-5,0,5,10,15
	Animal welfare (% change)	Current Standard	-15,-10,-5,0	0,5,10,15
	Price ($/kg of steak)	8	4,5,6,7	9,10,11,12

Attribute levels (with the exception of the environment attribute) were given opposite signs (+ or -) depending on whether or not the good in question was organic or GM. For example the risk to human health attribute for organic goods ranged from zero (no change from the status quo) through to a 15 per cent improvement from current levels. For GM goods the *risk to human health* attribute levels ranged from zero through to a 15 per cent decrease. This approach fitted well with the use of labelled models. Attempts were made to ensure that the choice sets offered to consumers were balanced with two positive, two negative attributes and an environmental attribute that could be either positive or negative for both organic and GM goods.

[7] A fractional factorial experimental design was used to assign attribute levels to the alternatives. The resultant alternatives were assigned to 16 blocks (comprising 64 unique choice sets per product) such that each respondent was only presented with the alternatives that comprise one block of the fractional factorial.

5.0 Sampling structure and technique

The survey was administered to 240 Rockhampton[8] and 300 Brisbane residents using a drop off and collect distribution method with respondents having up to seven days to complete the survey. Market researchers were contracted to undertake the surveys in December 2001. Questionnaires were collected from nodes in each city using a random selection technique eg. every third house in every fourth street. For Rockhampton two hundred and eight questionnaires were returned giving an 87 per cent response rate. Of the returned questionnaires, 203 were analysed giving an effective response rate of 82 per cent. 221 Brisbane questionnaires were returned giving an 74% response rate. Of the returned surveys 203 were analysed giving an effective response rate of 68%.

One-sample t-tests were conducted to determine whether or not respondents' mean age and income levels were significantly different from the appropriate city population means. In addition to the t-test a one-sample chi-square test was run to evaluate whether the proportion of male and female respondents was significantly different to hypothesized values of 50% male and 50% female.

For the Rockhampton sample, respondents' mean income of $41,461 (Standard Deviation = $28,986) was significantly larger than the cities average annual income of $32,336 [t(158)= 3.97, p=0.000]. Similarly respondents' mean age of 43 years (Standard Deviation = 13.85) was significantly higher than the Rockhampton population mean age of 33.16 years [t(180)=9.938, p=0.000]. The one-sample chi-square test indicates that the proportion of male and female respondents is also significantly different from the hypothesized values of 50% male and 50% female, [χ^2 (1, N=180)=4.356, p=0.037]. The results suggest that the sample population does have significantly different income, age and gender characteristics to Rockhampton population.

For the Brisbane sample, respondents' mean income of $37,872 (Standard Deviation = $28,734) was not significantly larger than the cities average annual income of $37,517 [t(183)= 0.168, p=0.867]. However respondents' mean age of 42.73 years (Standard Deviation = 12.85) was significantly higher than the Brisbane population mean age of 33.72 years [t(199)=9.912, p=0.000]. The one-sample chi-square test indicates that the proportion of male and female respondents is also significantly different from the hypothesized values of 50% male and 50% female [χ^2 (1, N=199)=10.176, p=0.001]. The results suggest that the sample population does have significantly different age and gender characteristics compared to the Brisbane population.

6.0 Results

Respondents completed four choice sets for each product. The data were analysed utilising multi nomial logit (MNL) models. The choices involved labelled alternatives and were modelled using the MNL formulation[9]. Respondents' familiarity with the products on offer and the inclusion of heterogenous factors (socio-economic characteristics) into the choice sets helped to minimise potential IIA/IID violations (Louviere et al 2000).

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[8] Rockhampton is a regional city in Queensland Australia. It has a population of approximately 59,000 residents and a strong association with the region's rural industries, particularly beef production.
[9] The models did not allow the Hausman Independence of Irrelevant Alternative (IIA) test to be performed for model violations. The most probable cause was the relatively small sample size.

For the steak and tomato experiments the environmental attribute was split into positive and negative ranges, and a significant attribute coefficient was estimated for each range[10]. Part-worths with confidence intervals were calculated for each to facilitate comparisons. Splitting the environmental attribute into positive and negative ranges enabled comparisons of peoples' willingness to pay a higher per unit price for environmental improvements when the condition of the environment is below current standards or above current standards. The positive and negative ranges were termed the *environmental positive* and the *environmental negative* attributes

The steak, tomato and milk data were analysed as labelled models with the attributes specific to the alternatives. Designing the models in this manner enables comparisons of how respondents have chosen GM and organic alternatives compared to the base of normal goods in each city. Only one price coefficient was calculated for each model. This assumes a constant opportunity cost exists across each of the three models.

Data for several non-attribute variables were collected in the survey to help explain respondents' choices over the options available. Table 2 describes the non-attribute variables included in the analysis.

Table 2 Non-attribute variable definitions

Variable	Definition
ASC	Alternative-specific constant taking on a value of 1 for either the organic or GM option in the choice sets, and 0 for the base.
Bias	Dummy variable taking on a value of 1 for respondents that thought the information provided in the survey was biased in favour of the environment; otherwise 2.
Confused	Dummy variable taking on a value of 1 if respondents thought the information or options presented in the survey was confusing; otherwise 2.
Unrealistic	Dummy variable indicating whether or not respondents found the survey believable. A value of 1 was used if respondents thought the options were unrealistic; otherwise 2.
Q1	Dummy variable measuring how strongly respondents ranked the environment against 5 other socio-economic concerns. If environment was ranked either first or second in importance it was given a value of 1; otherwise 0.
Q2	Five-point Likert scale indicating frequency with which respondents purchased organic products. A value of 1 corresponded with "never purchased organic" and 5 "frequently purchased organic".
Q4	Dummy variable indicating how much experience respondents have had with food production. A value of 1 was used if respondents had experience in food production (owned or worked on farms, regularly grew vegetables at home or studied agriculture or related topic); otherwise 0.
Income	Respondents income on a sliding scale of 1 (under $6,239) to 8 ($104,000 +). The midpoint of each income range was coded into the model.
Gender	Dummy variable indicating gender. A value of 1 indicated a female respondent and 2 male.
Donate	Dummy variable taking on a value of 1 for respondents that had donated to any environmental organisation; otherwise 2.
Membership	Dummy variable taking on a value 1 for respondents that held a membership to any animal welfare organisation, otherwise 2.
Age	Age of respondent on a sliding scale of 1 (18-24) to 6 (65+). The midpoint of each age bracket was coded into the model.

6.1 Steak results

[10] The –20, -15, -10 and –5 levels were coded in for environment negative, while the 5,10 and 15 levels were coded into environment positive. Zero per cent change represented the status quo.

The results of the MNL model for the steak CM experiment are contained in Table 3. There is a significant negative alternate specific constant[11] (ASC) for the GM alternative in both models, indicating there are a number of unobserved factors that reduce the probability of choice compared to organic and conventionally produced steak. The Brisbane organic ASC was also negative and significant indicating there are a number of unobserved factors that reduce the probability of this choice in Brisbane compared to GM and conventional farmed steak. The *biased, confused* and *unrealistic* attributes are not significant in either model indicating that respondents in both cities understood the choice sets. For Brisbane the *organic unrealistic* variable was positive and significant. Brisbane respondents who found the survey unrealistic were likely to choose the conventionally farmed steak in preference to the organic product.

Table 3 Results of the MNL Model for Steak

Variables	**Coefficient**		**Standard Error**	
	Rock	**Bris**	**Rock**	**Bris**
All Alternatives				
Price	-0.3515* **	-0.2640***	0.0731	0.0614
GM and Organic Alternatives				
Environment positive	0.0259*	0.0227*	0.0143	0.0120
Environment negative	0.0419**	0.0209	0.0185	0.0116
GM Attributes				
ASCGM	-1.1851**	-1.3669***	0.5884	0.4246
GM Tender	0.0408*	0.0408**	0.0245	0.0190
GM Health	0.0053	-0.0052	0.0244	0.0187
GM Animal Welfare	0.0503**	0.0669***	0.0234	0.0185
GM Non-attributes				
GM Question 1	-0.9807***	-0.4338*	0.3719	0.2440
GM Question 4	0.4887*	-0.2878	0.2739	0.2140
GM Age	-0.0366***	-0.0458	0.0095	0.0707
Organic Attributes				
ASC Organic	1.3559	-2.2998***	1.0887	0.4330
Organic Tender	0.0556***	0.0133	0.0173	0.0150
Organic Health	0.0301*	0.0252	0.0173	0.0154
Organic Animal Welfare	-0.0063	0.0222	0.0171	0.0152
Organic Non-attributes				
Organic Question 1	0.4194*	0.3734**	0.2146	0.1820
Organic Question 2	0.2241**	0.5714***	0.1079	0.0850
Organic Question 4	0.4751**	-0.0057	0.1947	0.1751
Organic Unrealistic	0.4187*	0.2164	0.2521	0.1998
Organic Donate	-0.5051**	0.3301***	0.2048	0.0876
Organic Member	-0.8327*	0.1166	0.4644	0.2123
Organic Income	0.0000*	0.0287	0.0000	0.0385
Model Statistics	Rockhampton	Brisbane		
Log L	-535.2333	-701.9695		
Adj Rho-square	0.32475	0.19068		
Chi-squared [19]	145.80311	182.0686		

Notes:1. *** Significance at the 1%, ** Significance at the 5%, and * Significance at the 10% levels.
2. The Adj Rho-square (p^2) value in MNL functions is similar to R^2 in conventional analysis except that significance occurs at lower levels. Hensher and Johnson (1981) comment that values of p^2 between 0.2 and 0.4 are considered extremely good fits so that the analyst should not be looking for values in excess of 0.9 as is often the case when using R^2 in ordinary regression.

The estimated utility function for the steak model in each city takes the following form:

[11] Alternate specific constants capture the influence on choice of unobserved attributes relative to specific alternatives (Blamey et al 2000).

Rockhampton Steak Utility Function

$$V_{ij} = -1.1851 - 0.3515(Z_{price}) + 0.0259(Z_{environment\ positive}) + 0.0419(Z_{environment\ negative}) + 0.0408(Z_{GM\ tender}) + 0.0503(Z_{GM\ animal\ welfare}) - 0.9807(Z_{GM\ question\ 1}) + 0.4887(Z_{GM\ question\ 4}) - 0.0366(Z_{GM\ age}) + 0.0556(Z_{organic\ tender}) + 0.0301(Z_{organic\ health}) + 0.4194(Z_{organic\ question\ 1}) + 0.2241(Z_{organic\ question\ 2}) + 0.4751(Z_{organic\ question\ 4}) + 0.4187(Z_{organic\ unrealistic}) - 0.5051(Z_{organic\ donate}) - 0.8327(Z_{organic\ member}) + 0.0000(Z_{organic\ income})$$

Brisbane Steak Utility Function Model

$$V_{ij} = -3.6667 - 0.2640(Z_{price}) + 0.0227(Z_{environment\ positive}) + 0.0408(Z_{GM\ tenderness}) + 0.0669(Z_{GM\ animal\ welfare}) - 0.4338(Z_{GM\ question\ 1}) + +0.3734(Z_{organic\ question\ 1}) + 0.5714(Z_{organic\ question\ 2}) + 0.331(Z_{organic\ donate})$$

For the Rockhampton model a significant positive relationship was found for both the *GM tenderness* and *organic tenderness* attributes indicating that improvements in steak tenderness from both positive and negative levels are positively associated with choice. The results suggest that consumers rate improved *tenderness* as an important attribute when levels drop below current standards, and, when levels climb above current standards.

For Brisbane consumers *tenderness* was found to be significant for GM steak, and not for organic steak. Brisbane consumers rate improved tenderness as an important attribute when purchasing GM steak, but are not interested in paying for improvements when levels drop below current standards.

For both the Rockhampton and Brisbane models the *animal welfare* attribute was found to be significant for GM beef (where levels were negative), suggesting that avoiding reductions in *animal welfare* is positively associated with choice (ie consumers are concerned about animal welfare issues when purchasing GM steak). In contrast, consumers do not value highly any improvements to *animal welfare* from current standards when purchasing organic beef.

A significant positive relationship was found for both the *environmental positive* and *environmental negative* attributes for the Rockhampton model indicating that improvements to the environment from both positive and negative levels are positively associated with choice. For the Brisbane model only the Environmental positive attribute was positive and significant. Implicit prices for the *environment* (positive and negative), *animal welfare* and beef *tenderness* attributes are reported in Table 4. These implicit prices provide the value of each 1% increase in the attributes.

The *risk to human health* attribute was only significant for the Rockhampton organic health attribute (where levels were positive). *Risk to human health* was not a determining factor affecting consumers purchasing steak in Brisbane.

For the Rockhampton model the *environment positive* implicit price shows that when environmental conditions can be improved above current levels, Rockhampton consumers are willing to pay an extra \$0.07/kg for each unit reduction in environmental impacts compared to \$0.12/kg when the environmental conditions are worse than current levels. However, overlapping confidence intervals means there is no significant difference in part worths. For the Brisbane model only the environmental positive attribute was positive and significant. The environmental implicit price for the Brisbane model was $0.09c/kg.

Table 4 Implicit Prices for Steak Attributes

Variable	Value of a one unit improvement (A$)		Confidence Intervals (A$)	
	Rock	Bris	Rock	Bris
Environment Positive	$0.07	$0.09	$-0.01 - $0.18	$-0.01 - $0.21
Environment Negative	$0.12	Not Significant	$0.00 - $0.22	Not Significant
GM Animal Welfare	$0.14	$0.25	$0.00 - $0.30	$0.10 - $0.47
GM Tenderness	$0.12	$0.15	$-0.01 - $0.33	$0.01 - $0.33
Organic Tenderness	$0.16	Not significant	$0.06 - $0.31	Not Significant

Analysis of the non-attribute variables included in the Rockhampton model suggests that consumers who donate to *environmental organisations* or hold a membership with an *animal welfare organisation* are more likely to choose organic steak in preference to the status quo (conventionally produced steak) or the GM option. Brisbane consumers who donate to environmental organizations are more likely to purchase organic steak in preference to the GM or conventionally farmed alternative. Membership of an animal welfare organisation was not a determining factor for Brisbane residents purchasing steak.

Both Rockhampton and Brisbane consumers who chose GM steak in preference to either organic or the status quo option tended to rate *unemployment, defence, education, health* and *crime prevention* as more important than *environmental issues*. Conversely consumers from both cities who chose the organic option tended to rate *environmental issues* as more important than *defence, education, health* and *crime prevention*.

The organic *question 2* variable (frequency with which respondents purchased organic food products) was positive and significant for both models suggesting that consumers choosing the organic steak option are also more likely to have purchased organic food products previously. The GM *question 4* and organic *question 4* variables (respondents experience with food production) were both positive and significant for the Rockhampton model indicating that respondents with agricultural experience are more likely to choose the organic or GM steak option in preference to the status quo option. Experience with agriculture was not a determinate of choice for Brisbane consumers. *Income* was a significant determinant of choice for Rockhampton consumers purchasing organic steak.

6.2 Tomato results

The results of the MNL model for the tomato CM application are contained in Table 5. A similar coding and model structure used in the steak experiment was applied to the tomato experiment. The Rockhampton model fit is slightly weaker than for the steak experiment. Analysis of the Brisbane data revealed a poor fitting model incapable of predicting choice on the basis of consumers WTP for any of the key product attributes associated with tomatoes. The estimated utility function for the Rockhampton tomato model took the following form:

Rockhampton Tomato Model

$$V_{ij} = -2.5131-0.9288(Z_{price})+ 0.0773(Z_{environment\ negative})+ 0.0413(Z_{GM\ appearance}) +0.0668(Z_{GM\ health})+0.0427(Z_{GM\ freshness})-1.2444(Z_{GM\ biased})+0.2448(Z_{GM\ occupation})+0.0000(Z_{GM\ income})+0.3691(Z_{organic\ question\ 2})-0.4332(Z_{organic\ gender})-0.7067(Z_{organic\ donate})+0.0000(Z_{organic\ income})$$

Table 5 Results of the MNL model for Tomatoes

Variables	**coeff.**		**s. error**	
	Rock	**Bris**	**Rock**	**Bris**
All Alternatives				
Price	-0.9288***	-0.3792*	0.2689	0.2159
GM and Organic Alternatives				
Environment positive	0.0061	0.00920	0.0135	0.0011
Environment negative	0.0773***	-0.0033	0.0177	0.0146
GM Attributes				
ASCGM	-2.5131***	-2.1387***	0.5853	0.4779
GM Appearance	0.0413*	-0.0096	0.0250	0.0188
GM Health	0.0668**	-0.0054	0.0260	0.0195
GM Freshness	0.0427*	-0.2811	0.0243	0.0185
GM Non-attributes				
GM Biased	-1.2444**	0.2797	0.4887	0.2828
GM Occupation	0.2448**	-0.1150	0.1025	0.0794
GM Income	0.0000*	0.0985*	0.0000	0.0506
Organic Attributes				
ASCO	0.8796	0.1592	0.5969	0.0451
Organic Appearance	0.0093	-0.0040	0.0153	0.0132
Organic Health	-0.0064	-0.0105	0.0157	0.0133
Organic Fresh	0.0164	-0.0020	0.0158	0.0113
Organic Non-attributes				
Organic Question 2	0.3691***	-0.1477**	0.0980	0.0737
Organic Gender	-0.4332**	0.01215	0.1790	0.1636
Organic Donate	-0.7067***	0.1654	0.1863	0.1664
Organic Income	0.0000***	-0.0341	0.0000	0.0353

Model Statistics	Rockhampton	Brisbane
Log L	-786.6064	-763.2229
Adj Rho-square	0.2677	0.11726

Notes: * Significance at the 1% level, ** Significance at the 5% level, * Significance at the 10% level.**

The results for the tomato experiment reveal a significant negative *ASC* value for the GM option in both cities. This suggests there are other unobserved influences reducing the probability of choice for GM options compared to the organic and status quo option. The *ASC* value for the organic option was not significant in either city.
The *risk to human health* attribute in the Rockhampton model is significant (positive coefficient) for GM tomatoes (where the levels were negative), suggesting that consumers are concerned about increasing health risks when choosing their options.

When purchasing organic tomatoes (where health levels were positive) consumers do not value human health levels above current standards.

The *appearance* of GM tomatoes was found to be positive and significant for Rockhampton consumers, suggesting that an improvement in the *appearance* of tomatoes is positively associated with choice (ie *appearance* is an important attribute to Rockhampton consumers when purchasing GM tomatoes). The freshness of GM tomatoes (where the levels were negative) was also positive and significant suggesting that consumers are willing to pay a premium for enhanced freshness, but only when levels drop below the status quo.

Unlike the steak results only one of the split *environment* attributes (negative) had a significant influence on choice for Rockhampton consumers. The result demonstrates that consumers are concerned with environmental impacts associated with tomato production only when the impacts are worse than what would normally result from conventional tomato growing practices. Implicit prices for the *environment* (negative), *health* (GM only) and *freshness* (GM only) attributes are reported in Table 6 for the Rockhampton model only.

Table 6 Implicit Prices for Rockhampton Tomato Attributes

Variable	Value of a one unit improvement (A$)	Confidence Intervals Lower (A$)	Upper (A$)
Environment Negative	$0.08	$0.04	$0.21
GM Freshness	$0.05	-$0.01	$0.14
GM Health	$0.07	$0.02	$0.19

The organic *gender* variable for tomatoes in Rockhampton was significant and negative suggesting that Rockhampton males are more likely to purchase organic tomatoes than females. The organic Q*uestion 2* variable was also significant and positive indicating that Rockhampton consumers choosing the organic option are more likely to have purchased organic food products previously. For Brisbane consumers the organic question 2 variable was negative and significant indicating that consumers choosing organic steak are less likely to have purchased organic foods previously. The organic *donate* variable was negative and significant indicating that consumers choosing organic tomatoes were less likely to have previously donated to any environmental organization.

Income was a significant determinant of choice for both organic and GM tomatoes in Rockhampton. The likelihood of a respondent purchasing an organic or GM tomato in preference to a conventionally farmed tomato increased as their level of income increased. The GM *biased* variable in the Rockhampton model was negative and significant suggesting that Rockhampton respondents who thought the survey was biased towards the environment were less inclined to purchase GM tomatoes. The GM occupation variable in the Rockhampton model was positive and significant indicating that Rockhampton respondents were more likely to choose GM tomatoes in preference to the conventional or organic alternatives if they were employed either full or part-time.

6.3 Milk results

The results of the MNL model for the milk CM experiment are contained in Table 7.

Table 7 Results of the MNL model for Milk

Variables	coeff.		s. error	
	Rock	Bris	Rock	Bris
All Alternatives				
Price	-0.6914***	-0.9388***	0.1854	0.1444
GM and Organic Alternatives				
Produced in Region	-0.5616**	-0.0502	0.2319	0.1933
Produced Elsewhere in Qld	-0.9998***	-0.3243*	0.2473	0.1969
Produced Interstate	-0.9305***	-0.1782	0.2467	0.1911
GM Attributes				
ASCGM	-2.5183***	-1.2429***	0.9283	0.4069
GM Health	0.1034***	0.0308	0.0299	0.0209
GM Environment	0.0115	0.0460***	0.0140	0.0106
GM Animal Welfare	0.0344	0.0348*	0.0287	0.0202
GM Non-attributes				
GM Confused	1.0091**	0.1664	0.3411	0.3107
GM Unreal	-1.2167**	0.1507	0.5740	0.3063
GM Age	-0.4482***	-0.1040	0.1120	0.0806
GM Donate	1.2942***	-1.1228***	0.4650	0.3013
Organic Attributes				
ASC Organic	3.5340***	-0.3528	1.0084	0.4505
Organic Health	-0.0046	0.0446***	0.0197	0.0159
Organic Environment	0.0645***	0.0650***	0.0101	0.0078
Organic Animal Welfare	0.0066	0.0021	0.0195	0.0157
Organic Non-attributes				
Organic Question 4	0.3967*	0.1246	0.2166	0.1763
Organic Confused	-0.6406**	0.4154*	0.3037	0.2407
Organic Age	-0.1769**	0.0186	0.0779	0.0648
Organic Gender	-0.4609*	-0.3841**	0.2354	0.1901
Organic Donate	-0.4326*	0.5295	0.2293	0.1897
Organic Member	-1.0605**	0.8339***	0.4513	0.2105

Model Statistics	Rockhampton	Brisbane
Log L	-441.5961	-656.2028
Adj Rho-square	0.45163	0.27949
Chi-squared [20]	178.72	213.12

Notes: *** Significance at the 1% level, ** Significance at the 5% level, * Significance at the 10% level.

A different model to that used in the steak and tomato experiments was used: the environment attribute in this analysis was not split. The location of production attribute was split into four separate levels (*produced in region, produced elsewhere in Queensland, produced interstate and produced locally*) and dummy coded for modelling purposes. There were insufficient data to estimate the additional environmental parameters. In each model, one of the four locations of production levels (*produced locally*) was omitted to act as a base. The estimated utility function for the Rockhampton and Brisbane milk models took the following form:

Rockhampton Milk Utility Function:

$V_{ij}=$ $1.0157-0.6914(Z_{price})-0.5616(Z_{region})-0.9998(Z_{elsewhere\ in\ Queensland})-0.9305(Z_{interstate})+0.1034(Z_{GM\ health})+1.0091(Z_{GM\ confused})-1.2167(Z_{GM\ unrealistic})+0.4482(Z_{GM\ age})+1.2942(Z_{GM}$

$_{donate}$)+0.0645($Z_{organic\ environment}$)+0.3967($Z_{organic\ question\ 4}$)-0.6406 ($Z_{organic\ confused}$)-0.1769($Z_{organic\ age}$)-0.4609($Z_{organic\ gender}$)-0.4326 ($Z_{organic\ donate}$)-1.0605($Z_{organic\ member}$)

Brisbane Milk Utility Function:

V_{ij}= -1.2429-0.9388(Z_{price})-0.3243($Z_{elsewhere\ in\ Queensland}$)+0.0460($Z_{GM\ environment}$)+0.0348($Z_{GM\ animal\ welfare}$)-1.1228($Z_{GM\ donate}$)+ 0.0446($Z_{organic\ health}$)+0.0650($Z_{organic\ environment}$)+ 0.4154($Z_{organic\ confused}$)-0.3841($Z_{organic\ gender}$)+ 0.8339($Z_{organic\ member}$)

The *ASCGM* values for both the Rockhampton and Brisbane models were significant and negative, suggesting that unobserved factors reduce the probability of consumers choosing GM milk over the conventional product. The *ASC organic* variable for the Rockhampton model was positive and significant suggesting there are a number or unobserved factors increasing the likeliness of consumers choosing organic milk over the GM or conventional alternatives.

Purchasing *locally produced* milk in Rockhampton was found to be preferable to milk produced *elsewhere in the region, elsewhere in the state* or from *interstate* supplies[12]. For Brisbane consumers purchasing milk produced locally was preferable to milk produced *elsewhere in the state*. Brisbane consumers remained indifferent to milk produced *elsewhere in the region* or *interstate*. The part-worth estimates for these attributes (Table 8) reveal that if *locally* produced milk is not available Rockhampton consumers do not strongly differentiate between milk produced regionally, elsewhere in Qld or from interstate sources. These results suggest the presence of social existence values[13] where Rockhampton consumers are willing to pay a price premium for their milk in order to protect local jobs and the viability of the local industry. The smaller implicit price for milk produced *elsewhere in Qld* for the Brisbane model suggests smaller social existence values exist for that population.

Table 8 Implicit Prices for Milk Attributes

Variable	Value of a one unit improvement (A$)		Confidence Intervals	
			Lower (A$)	Upper (A$)
	Rock	Bris	Rock	Bris
			Per 2 Litre Carton	
Produced in Region	-$0.81	Not significant	-$1.75 - -$0.22	Not significant
Produced Elsewhere in Qld	-$1.45	-$0.35	-$3.82 - -$0.78	-$0.91 - $0.00
Produced Interstate	-$1.35	Not significant	-$2.98 - -$0.65	Not significant
			Per 1% Improvement	
GM Health	$0.15	Not significant	$0.05 - $0.32	Not significant
GM Animal Welfare	Not significant	$0.04	Not significant	-$0.01 - $ 0.09
Organic Environment	$0.09	$0.07	$0.06 - $0.22	$0.05 - $0.10
Organic Health	Not significant	$0.05	Not significant	$0.01 - $0.09

Animal welfare was not found to be significant for either the organic or GM milk options in the Rockhampton model suggesting that Rockhampton consumers accept current industry standards. For Brisbane consumers the GM animal welfare variable was significant (where levels were negative) suggesting that avoiding reductions in animal welfare is positively associated with choice. Brisbane consumers are willing to

[12] Locally produced milk was the status quo with a default value of zero.
[13] Blamey et al (2000) report similar results from a CM experiment valuing remnant vegetation in Central Queensland.

pay a premium ($0.04c/carton) to improve animal welfare standards when they fall below the status quo.

The *health* attribute was found to be significant for GM milk in Rockhampton (where levels were negative) suggesting that increased health risks impact on choice (ie consumers are concerned about health risks when purchasing GM milk). The Rockhampton organic health attribute was not significant. In contrast, the Brisbane organic health attribute was positively associated with choice suggesting that consumers purchasing organic milk are willing to pay a premium to achieve food safety standards over and above the status quo ($0.05/carton per 1% unit improvement).

The *environment* attribute was also found to be highly significant when purchasing organic milk in Rockhampton and organic and GM milk in Brisbane. The mean price premium households were willing to pay to avoid a 1% increase in environmental impacts resulting from milk production was $0.09/carton in Rockhampton and $0.07/carton in Brisbane.

The Rockhampton GM and organic *confused* variables were positive and significant. Respondents that found the survey confusing were likely to choose the conventionally farmed milk in preference to GM or organic milk. The GM unrealistic variable in the Rockhampton model was significant and negative indicating a preference towards the GM option for respondents that thought the survey was unrealistic.

Rockhampton consumers who hold a membership with an *animal welfare organisation* are more likely to choose organic milk in preference to the status quo (conventionally produced milk). Conversely, Brisbane consumers who hold a membership with an *animal welfare organisation* are less likely to choose organic milk in preference to the status quo (conventionally produced milk) option. Gender was an important determinant of choice for consumers purchasing organic milk in both cities. For Rockhampton and Brisbane male consumers were more likely to purchase organic milk (dearest of the three milks) than female consumers. This unexpected result may be due to female respondents having a greater propensity to juggle a family's budget than male respondents.

For the Rockhampton model the organic *question 4* variable (respondents experience with food production) was positive and significant indicating that respondents with agricultural experience are more likely to choose the organic milk option in preference to the status quo or GM option. Income was not a significant determinant of choice when purchasing milk for either the Rockhampton or Brisbane models.

7.0 Differences between populations

Of the three experiments run in Brisbane only the steak and milk models were able to generate statistically robust models. The key product attributes chosen to predict the choice of tomato for Rockhampton residents held little relevance to Brisbane consumers. As well, some of the significant variables in the Brisbane models did not meet with a priori expectations. It is unclear why such different models have been estimated for consumer items that are reasonably uniform across the populations.

There are three main reasons why the estimated models may not be an accurate reflection of the populations sampled. The first is some significant differences were found between the group sampled in each city and the population they were drawn from[14]. These differences could have extended to the views that people held, although there is no evidence to suggest that the random selections chosen were biased in any way.

The second reason is that respondents to the survey may not have interpreted the information and tradeoffs in the choice sets consistently between city samples. It is possible that the use of "percentage change" to describe changes in attribute levels relative to the "status-quo" option may introduce some inaccuracies into the analysis. It also remains unclear how respondents' have interpreted the status-quo base and the changes offered in the choice sets, and the influence on the results of the analysis. However, it appears difficult to identify why these potential sources of inaccuracy would have affected people in Rockhampton and Brisbane differently.

The third reason is that the structure of choice behaviour may have varied between the sample groups, thus affecting model estimation. Rolfe and Bennett (2003) show how responses that are embedded within an internal decision rule make model estimation problematic. For example, if respondents only make choices on the basis of the labels offered (conventional, organic or GM), then it means that they are not responsive to varying levels of cost or other attributes. The outcome would be that those attributes would not have significant contributions to resulting models of choice behaviour.

There is strong evidence of embedding behaviour driving choice responses in the experiments reported in this paper. In Table 9, the number of consistent responses given for each product type is reported. These report the situations where a participant has made the same choice across each of the four choice sets on offer. For example, 44% of Rockhampton respondents and 24.8% of Brisbane respondents always chose the conventional (status quo) alternative in the steak experiment.

This analysis of choice behaviour confirms that the labels are very important in driving choice behaviour. However, there is no major difference between Brisbane and Rockhampton respondents in terms of overall embedding response rates. However, Brisbane respondents were more likely than Rockhampton respondents to exhibit embedding behaviour with regard to organic or GM alternatives, while Rockhampton respondents were more likely to uniformly choose the conventional alternative. Because it is the organic and GM alternatives that have varying attribute levels in the choice sets offered, a higher proportion of embedding responses implies that there is less responsiveness of choice to variations in the attributes. Therefore it appears that differences in embedding behaviour between the two populations can help to explain the differences in model results. Further modelling is required to test this explanation.

[14] The random sampling approach chosen did exclude some groups – e.g. people in nursing or aged care homes.

Table 9 Rates of uniform responses across choice sets

		Rockhampton	Brisbane
Rocky		% of consistent responses	% of consistent responses
Steak	Conventional	44.0	24.8
	Organic	8.7	16.2
	GM	8.2	12.6
	Total	60.9	53.6
Tomatoes	Conventional	37.2	20.7
	Organic	16.4	15.8
	GM	13.0	13.1
	Total	66.7	49.5
Milk	Conventional	52.7	30.6
	Organic	11.1	19.8
	GM	2.9	7.7
	Total	66.7	58.1

8.0 Conclusions

The CM experiments reported in this paper provide information of some indirect use values associated with the production of steak, tomatoes and milk. Consumer demands vary according to the levels of the different attributes and the production system employed (ie organic, conventional or GM). When purchasing these products, consumers typically make trade-offs between a number of environmental, economic, ethical and social considerations. This research has attempted to quantify these interrelationships using CM. The results only apply to steak, tomatoes, and milk and it is unclear whether values can be extrapolated to other foods. Questionnaires were only collected in Rockhampton and Brisbane, and it is yet to be determined if the same values are held by a wider population.

The analysis reported suggests that Rockhampton and Brisbane consumers are concerned about the environmental consequences of agriculture, and value reductions in these impacts, particularly where deterioration in the condition of the environment is otherwise to occur. Rockhampton and Brisbane consumers also expressed a willingness to pay a price premium to improve the condition of the environment to levels above the status quo through their purchases of steak and milk.

Food safety issues were of more importance to Rockhampton consumers (steak, tomatoes and milk) than Brisbane consumers (milk only) and predominately when the risk of illness from consuming one of these products falls below current standards. The one exception was organic milk in Brisbane. Here consumers were willing to pay a premium for improvements to health risk above the status quo. The results support the argument that Rockhampton consumers are more inclined to be concerned with current food safety standards for these products than Brisbane consumers.

Animal welfare issues were found to be significant for Brisbane and Rockhampton steak consumers, but only when animal welfare standards fall below the current status quo. Consumers did not value highly improvements in animal welfare levels above current standards. Animal welfare issues were also of concern to Brisbane residents purchasing milk and only when animal welfare levels fell below the status quo. The results suggest that current industry standards and regulations governing the humane treatment of dairy and beef animals are adequately addressing consumer expectations regarding animal welfare issues.

The location of production attributes was significant for Rockhampton consumers purchasing milk more so than for Brisbane consumers suggesting the presence of stronger social existence values for regional centres compared to metropolitan cities. The Rockhampton consumers did not, however, differentiate between milk produced beyond the local area, in Queensland or interstate.

Respondents' willingness to pay a price premium in order to avoid worsening environmental impacts provides some economic justification for a precautionary approach when considering high-risk environmental activities. Similarly the part worth estimates for GM health impacts support government food labelling, GM testing and other public safety initiatives.

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