Consumer willingness to pay to reduce GMOs in food and increase the robustness of GM labelling

Report to

Department of the Environment, Food and Rural Affairs

D.Rigby[Ψ], T.Young[Ψ] and M.Burton[φ]

[Ψ] Centre for Agricultural, Food & Resource Economics, School of Economic Studies, University of Manchester, M13 9PL

[φ] Agricultural and Resource Economics, University of Western Australia, Perth, Australia

May 2004

ISBN: 1 871542 46 4

CONTENTS

Summary

The findings of this report are contained in Sections 5, 6, 7 and 8 and are discussed further in Section 9. The analysis is based on survey data. The survey conducted using *Random Location Sampling*, was undertaken in England, Wales and Scotland between July and September 2003. The sample was defined as men and women, aged 16 and over, who were the main shopper for their household. Personal interviews were conducted in the home using CAPI (computer aided personal interviews). The survey produced 608 useable completed questionnaires.

The two core questions addressed in this study are:

- **What are the benefits of increasing the robustness of the GM food labelling regime?**
- **What are the benefits of a reduction in GM labelling threshold levels?**

In addition, consumer's responses to variations in the proportion of their food items containing GM ingredients were investigated, using similar methods to those used regarding the core questions.

Prior to these aspects of the analysis, respondents were asked questions regarding some general issues concerning GMOs in food, including issues of trust and current policy questions about the testing and commercial development of agricultural GMOs. It is the findings in this area that are summarised first.

General results regarding GMOs in food, trust, testing and commercial development

The study found general consistency between the views and attitudes expressed in this survey and those which have been found elsewhere such as reports from the Consumers Association, Marris *et al.,* (2001) and the GM Nation? consultation process. Significant differences were identified by social class and gender, but there are some broad assertions that can be made about the findings.

Those surveyed were found to be sceptical of the long term effects of GM crops and why they were being introduced. The question of “who gains?” is significant. Considerable scepticism was evident regarding the information received on GM issues from most sources. The only source of GM information which more than 10% of respondents say they would ‘definitely trust’ is universities/educational organisations. The government was widely distrusted on both the specifics of GM technology as well as on general food safety issues.

Views were sought on some of the key GM policy issues of the moment. Less than a quarter (23%) of those questioned thought that commercial GM crop growing should be allowed in the UK at present, with 85% indicating that they thought that more testing was required if commercial growing was ever going to take place in the UK. However, this caution over commercial development was not accompanied by a common desire to halt all GM testing. Only a quarter of interviewees thought that all GM testing should be stopped and 43% thought that GM food should be available to buy in the UK, if clearly labelled.

The findings here support the view that people are not simply 'for' or 'against' GMOs or that they think that all GM development work should simply stop. There is scepticism regarding the nature of the benefits and of the costs and risks, and in terms of who will be the main beneficiaries of the use of the technology.

The benefits of increasing the robustness of the labelling regime

Since 1997, the food labelling regime regarding GMOs has applied only to products consisting of or containing detectable GM material. That is, labelling of food products has only been mandatory where detectable GM protein or DNA, from crops or any other source, is actually present in the product. Other foods, produced from derivatives of GM crops, such as highly refined oil from GM maize or soya beans, have not required a label if they are indistinguishable from products derived from non-GM crops.

Two new EU Regulations, on GM food and feed[1] and on the traceability and labelling of GMOs, which apply fully in Member States from April 2004, extend and modify the current regulatory regime to cover both products consisting of or containing GM material and those with ingredients derived from a GM source that is not identifiable by analysis ("derived products"). Differentiated traceability and labelling requirements apply to each category of product. The main difference is that, in the case of products consisting of or containing GM material, the documents that are required to facilitate tracing of the GMO or GMOs used in the product throughout the supply chain must include information on a "unique identifier" code that enables that particular GMO or those GMOs to be distinguished from any other GMO or GMOs. The availability of such information thus enables claims made in documentation to be verified by physical analysis. No such unique codes are required in relation to the documentation for derived products, so the system of traceability relies to a far greater extent along the supply chain on faith in operators' claims about their products.

The effect of this extension of the labelling regime is summarised in Table S1 below.

[1] Regulation (EC) 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed. *Official Journal of the European Union* L 268/1, 18.10.2003

Table S1 New Labelling Requirements

	Examples	Presence of Genetically Modified DNA or protein	Label
Food/feed consisting or containing GMOs	Corn (Maize)	Yes	Corn (Genetically modified)
Food/feed ingredients produced from GMOs and containing genetically modified DNA	Corn Flour	Yes	Corn flour (produced from genetically modified corn)
Food/feed ingredients produced from GMOs but not containing genetically modified DNA	Corn Oil	No	Corn oil (produced from genetically modified corn)
Food/feed produced with GMOs	Cheese made with GM enzymes Meat from pigs fed with GM corn	No	No label

Source: IIEL (2003)

Results and Conclusions

The issue of robustness was investigated using choice modelling (CM) and the double bounded dichotomous choice contingent valuation method (CVM).

The choice modelling results allowed testing of whether, implicitly through their selection of bread options, the interviewees treated bread containing GM-derived ingredients as equivalent to non-GM bread, or to bread with GM ingredients, or as a distinctly different product. For the vast majority of respondents, their choices indicated that they treated GM-derived ingredients as no different from GM ingredients. This would imply that regulation on the basis of process, rather than product, was valued by respondents. The critical issue appears to have been not whether the product contained detectable modified genetic material, but the nature (i.e. GM or otherwise) of the crop from which it was derived.

Preferences regarding the GM nature of the bread differed by a number of socio-economic and demographic characteristics such as social class, gender, age, attitudes, and the presence of children in the household. Preliminary analysis identified only one group of respondents in the sample, those aged between 16 and 24, who treated bread with GM-derived ingredients in the same way as non-GM bread. For all other groups, the choices revealed that GM and GM-derived ingredients were regarded as the same.

The financial value that respondents placed on the avoidance of food containing GM and GM-derived ingredients was investigated using both the choice modelling and contingent valuation approaches. In each case the discounts and premia are generated in percentage terms with reference to the price of the household's usual loaf of bread.

There were large variations in these valuations across the social groups identified on the basis of class, gender and the presence of children in the household. Furthermore there were significant variations within these groups on the basis of age and attitudes.

Some average measures of the valuations and their distributions can be identified from both the choice modelling and contingent valuation results. The median willingness to pay (WTP) to avoid the GM bread is 57% from the contingent valuation results and 79% from the choice modelling results, while the mean figures are 62% and 99% respectively. It is unsurprising that those with attitudes which we characterise as more distrustful of GM food will pay more to avoid it. Hence those who think that the benefits of GM food will primarily be captured by international companies and who trust the government less on food safety issues have, *ceteris paribus*, higher WTPs to avoid GM ingredients in bread. Similarly we find that those in social classes AB and females in C1 also would pay more in both absolute, and indeed percentage, terms to avoid bread containing GM ingredients.

In addition to the finding from the choice modelling analysis that 16-24 year olds were the only group to regard GM-derived ingredients as equivalent to non-GM ingredients, there was a more general finding that age affected the extent to which people considered the GM ingredients to reduce their welfare. That is, for some social groups, there was evidence that younger people were less concerned about GM but concern increased over a certain age range before declining again in later years.

The results generated indicate there are sections of the population with extremely high WTPs to avoid food containing GM or GM-derived ingredients. It should be noted that these percentage figures are in terms of the cost of their bread which is only a small element of household food costs.

The fundamental result from this first piece of analysis is that the vast majority of consumers regard the forthcoming extension of the labelling and traceability regime to include both GM ingredients and ingredients derived from GM products as highly desirable. With the possible exception of some of the youngest in the sample, bread made with GM-derived ingredients was treated in the same manner as that made with ingredients containing detectable altered genetic material or protein. While the introduction of the new labelling regime will no doubt generate additional costs, the evidence here is that the more robust and comprehensive labelling regime will deliver significant benefits for consumers.

Some in the sample are estimated to have extremely high WTPs, and some of the methodological issues related to this are discussed in Section 9.5 of the Report. It is likely that these consumers will never knowingly consume bread containing GM or GM-derived ingredients. The fact that for these people large but statistically insignificant values were determined is at one level unimportant; the implication is that these people will, if they have a choice, avoid this type of food. However, it does make the estimation of an aggregate value of the label, even in terms of bread alone, problematic.

This complication is exacerbated by the fact that a single good is being used here for analytical purposes whereas the labelling issue is much broader. As is discussed in Section 6 of the Report and returned to in Section 9.5, the complexity of the issues investigated here required the use of specific single good, i.e. bread, and so the values

inferred from the models relate to percentage changes in the value of the household's bread. It would be inappropriate to assume that one can extend this result by aggregating it across all food types within the basket: there would be impacts on residual family income which are substantially greater than those implied for bread alone. Aggregating up to all goods from a single commodity study is therefore complicated by this budgetary impact. The aggregation problem is exacerbated by the fact that the prevalence of ingredients derived from GM crops will vary across the range of household food goods and because consumers are likely to react differently to the presence of GM (derived) ingredients in different foods (e.g. baby food as opposed to food for adults).

The benefits of a reduction in GM labelling threshold levels

The second element of the EU regulation regarding GM food and feed is a lowering of the threshold level at which food with low levels of GM content that can be shown to be adventitious or technically unavoidable requires a label. This level was previously set at 1%, but is to be lowered to 0.9%. This means that the accidental presence of GM material below the 0.9% level in food or feed does not require labelling. Labelling is still not required for food made with the aid of genetic modification technology, such as hard cheese produced with the help of chymosin from GM micro-organisms, and products such as meat and milk from animals fed on GM feed.

There will also be a 0.5% threshold for the presence of GM material that has not been approved for use in Europe, provided it has a favourable safety assessment from the relevant EU scientific committee[2]. Table 1.1 illustrates the new labelling requirements.

Results and Conclusions

The finding from both the CM and CV analysis was that consumers did not value the lowering of the threshold for inadvertent GM presence from the 1% to 0.9% level. Findings are consistent across both methods in this respect. However, respondents would value the lowering of this labelling threshold to the 0.5% and 0% levels. Indeed, the results from both methods of analysis indicate that consumers treated threshold levels of 0% and 0.5% as equivalent.

While these label threshold levels are strictly cardinal, it would appear that the respondents are not responding to level changes in that way. This suggests that those questioned are reacting positively to 'substantial' changes in the threshold level, but are doing so at a fairly coarse level. A larger sample might allow this issue of discrimination to be investigated further, but this is not possible here.

[2] Food Standards Agency: http://www.food.gov.uk/science/sciencetopics/gmfoods/gm_labelling and http://www.foodstandards.gov.uk/news/newsarchive/new_reg

In contrast to the analysis dealing with the increase in the robustness of the labelling, which found significant variation in the way in which consumers with different demographic profiles responded to the GM issue, very little variation was identified regarding the label threshold issue. Social class, age and the presence of children were all found to play no significant role in differentiating people's responses to changes in threshold levels. In the CV model there was a gender effect identified, and in both the CM and CV models the composite attitudinal variable **GMTrust** was found to have a significant effect with, unsurprisingly, those more trusting on GM issues generally placing lower values on a reduction in the label threshold to 0-0.5%.

While there is considerable similarity regarding these general characteristics of the results from the CM and CV investigations of the label threshold issue, there are substantial differences regarding the estimates of what people would be prepared to pay to secure a lowering of the label threshold to, for example, 0-0.5%.

Leaving to one side the effect of differential attitudes across the sample and their effect on the willingness to pay, the median WTPs for a lowering of the threshold to the 0-0.5% level are, for men and women, shown in Table S2.

Table S2 Median WTPs (%) to Lower GM Label Threshold to 0-0.5%

	WTP
CM Model	26.4%
CV Model	5.9 - 8.1%

When attitudes are introduced into the models, the divergence of the WTP estimates becomes considerably greater. It should be noted also that of the 246 people whose responses were used in the CM analysis, 30% of them were found to place no value on such a tightening of the labelling regime.

It is significant to note that the levels of the WTP, and particularly those from the CV model, are substantially smaller than those for GM bread which is appropriate given that bread is such a small element of the overall food basket and so there would seem to be evidence of an appropriate scale effect.

The core result from this second piece of analysis is that the majority of consumers do not regard the new labelling threshold of 0.9% for inadvertent GM presence as significantly different from the current 1% threshold. Hence they place no value on this change. However, there is, in general, a distinction made between a label threshold of 0.9/1.0% and a lower level of 0-0.5%.

The key findings from this piece of analysis are that:

- The value placed on lowering the label threshold does not vary across the sample as markedly as the valuations identified regarding label robustness. There were some differences in terms of gender and more substantial differences in terms of attitudes, but social class, age and the presence of children in the household were not found to be significant in determining WTPs.

- Estimates of the magnitude of these WTPs differed between the two methodologies employed, with the CV model producing lower WTPs. The scale of both sets of valuation estimates were of a lower order than those which were obtained regarding GM-derived ingredients in bread, which is as one would expect given that the baseline cost for the former is the weekly food bill while that for the latter is the cost of a loaf of bread.

It is interesting to note that in both the CM and CV models respondents did not distinguish between threshold levels of 0% and 0.5%. One might have expected people to view the 0% level as qualitatively different from low positive levels since it could be interpreted as meaning “GM-Free” as opposed to merely “non-GM”. This was found not to be the case for the sample as a whole nor for specific groups within the sample. It should also be noted that in the semi-structured interviews and the pilot interviews there was little awareness of the existence of any positive threshold level, with many people assuming that if the food was not labelled as such, it did not contain GM ingredients.

Given an average household expenditure of £42/week on food and alcoholic drinks, a WTP of 7% to lower the threshold at which food is labelled as containing GM ingredients to the 0-0.5% level represents less than £3/week. Given the annual aggregate

expenditure on such goods is approximately £54bn the aggregate annual value of such a lowering of the GM labelling threshold might be thought of as £2 - 4 billion. This range of values is wide and has a lower bound below that from strict aggregation. This reflects the note of caution we would sound given the emotive nature of the GM issue to many and the difficulty in deriving aggregate values when sections of the population are not prepared to trade off the GM attribute against financial gains or losses. This is something evident from past valuation studies in the area of food and health risk (see for example Donaldson *et al.* 1996; Latouche *et. al.,* 1999) where stated preference techniques have performed relatively poorly.

Variations in food levels containing GM ingredients

A third issue investigated in this study which was not directly related to evaluating the new EU Regulations regarding the GM labelling regime was the consumer response to variations in the proportion of their food containing GM ingredients. This issue was also investigated using both CM and CVM methods.

In both the CV and CM analysis there was considerable variation in preferences in terms of class, age, gender, attitudes and the presence of children in the household. Females and those who bought food for children in the household disliked the presence of GM ingredients more. There was, as with the GM labelling robustness results, some evidence in the choice modelling results of a quadratic interaction with age, that is, younger people were less concerned about GM but concern increased over a certain age range before declining again in later years.

Despite the similarities in this respect between the CV and CM model results, it was in this section of the evaluation that the most marked differences between the valuations from the two methods were evident.

The CM analysis indicated that respondents regarded the 0% and 1% of food containing GM ingredients as equivalent, and also the 25%, 50% and 80% levels of food with GM ingredients were treated the same; the category of 100% of food containing GM ingredients was distinct in terms of consumers' responses. This was not the case with the contingent valuation results – respondents' valuations were different between all the varying levels of GM content.

In addition, the differences between the CM and CV WTP estimates to avoid GM ingredients were extremely large. Table S3 displays overall sample averages from the CV model for the percentage willingness to pay, in terms of the weekly food bill, to avoid GM ingredients. The median WTPs to avoid a diet in which 5% and 50% of goods contained GM ingredients were effectively zero. The median WTP to avoid a diet in which all foods contained GM ingredients was 40%. The mean WTP figures for these three levels of food containing GM ingredients were 20%, 33% and 54% respectively.

Table S3 Median and Mean WTPs (%) to avoid GM Food: CV Model

	5% GM content	50% GM content	100% GM content
Sample Median	0	6.7 [NS]	40.3
Sample Mean	19.5	33.3	54.2

[NS] Not significantly different from zero

In addition there are considerable variations in these valuations of a diet free from varying levels of GM ingredients which are shown in Table S4. Consistent with previous findings in this study, the young and those from classes other than A or B are prepared to pay the least, and in some cases the estimates are effectively zero.

Table S4 Variations in WTPs (%) to avoid GM Food by Class & Age: CV Model

Social class	5% GM content	50% GM content	100% GM content
AB	32.2	62.4	96.0
C1	0	3.9 [NS]	37.6
C2	0	14.1 [NS]	47.6

[NS] Not significantly different from zero

As is discussed in Section 8 of the Report, the WTP estimates derived from the choice modelling study in this aspect of the study were extremely (infeasibly) large. For social classes A, B, C1 and C2 only those with a positive view on GM issues (**GMTrust =** 1) would purchase an entirely GM food basket and then only given a massive discount (50% and 92% for those without and with children respectively). All other WTPs for these social classes are unfeasibly large implying that such a change would be unacceptable.

In social classes D and E, those who are neutral on GM issues and are aged below 35 or over late 70s, and those aged 36-70 whose attitudes on GM issues we characterise as positive, would buy the GM basket of goods, but again would require a large discount between 52% and 94%. Hence the CM results indicate exceptionally, and unfeasibly, large WTPs to avoid a food basket with 100% of its items containing GM ingredients.

One issue worthy of attention here is whether there is a contradiction between the relatively large proportion of the sample who appear in the CV model to be indifferent when considering the percentage of ingredients containing GM ingredients and the relatively high CV WTPs to avoid GM bread (high in terms of percentage increases in prices that would be paid).

Section 9.5 of the Report discusses some statistical explanations for this finding. The other, potentially complementary, explanation is one of context. The CV bread analysis indicates high levels of WTP to avoid GM ingredients in bread, and relatively low levels of indifference. However, in that section of the questionnaire bread was presented as the only foodstuff containing GM ingredients. In this context, it is perhaps not surprising that respondents are prepared to pay a relatively small value to avoid it (even if it is a high percentage value of the price of bread). One could even interpret this bread analysis as equivalent to the current analysis of prevalence of GM ingredients, but at very low levels of GM content and also low levels of payment needed to avoid GM. To explore this effect one would have to conduct an experiment using a single product, but place it within the context of background GM levels, that is, run two experiments where one states explicitly that all other food is GM free, and an alternative structure where respondents are asked to value GM bread with a background GM content (e.g. 20%) stated.

Some Lessons & Questions Regarding Methodology & Results

There are a number of issues that have been raised in the course of this research regarding methodology and the associated results. These are discussed in Section 9 of the Report and summarised below.

Using a specific good or the overall food basket?

It is good practice in any valuation study to use a good with which the respondents are familiar. Focusing on a specific food good seems therefore desirable since the notion of the 'weekly food basket' is a somewhat abstract concept. Moreover, in this study the use of a single food product to assess the implications of labelling goods which contain ingredients derived from GM crops was necessary. The concepts involved in distinguishing between GM and GM-derived ingredients were so complex that they had to be explained and explored in as simple a framework as possible. In addition, since it is unlikely that all the elements in the household's "food basket" contain such ingredients, using this collection of goods as the basis for analysis would have been a flawed approach. However two problems arise with the use of the single good.

The first is that of brand loyalty which means that many or most consumers do not buy "bread" or "baked beans" or other similar simple goods, they buy specific brands. These are powerful issues in food shopping psychology and economists should try to integrate understanding of such phenomena in their work. In this study the issue was evident in the high numbers of people choosing their "usual bread" despite the attempt to convince them that all three options in the choice sets were variants of their "usual bread".

Secondly, one wishes to obtain aggregate values for policy purposes. However, it is by no means clear how consumer valuations of changes to an individual product can be generalised to other products or to the total food basket, not least since the prevalence of GM ingredients and consumers' responses to their presence are likely to vary markedly across the product range.

Information provision and the level of technical detail

It was noted above that it is good practice to use a good with which respondents are familiar. It is also desirable that the baseline, from which you are asking interviewees to value changes, is also familiar to them. There were complications here regarding both the level of technical detail and the baseline position. The semi-structured interviews, the pilots and indeed general discussion of the project indicated that very few people were familiar with the concept of ingredients being derived from GM crops but free of altered genetic material. In addition, regarding the GM label threshold issue, most people were unaware that there was a permitted level of inadvertent GM presence in food and in fact were usually surprised that this was the case.

What are the implications of the results for the choice of method from CM and CVM?

In the limited but growing number of studies which have sought to compare CV and CM estimates of WTP there have typically been divergences between the values delivered by the two methods. In this study we regard the results from the CV approach to be more feasible than those from the CM models, particularly on the issue of the proportion of goods containing GM ingredients.

As noted in Section 2 of the Report, CM has the advantage that the attribute of specific interest can be embedded within the choice sets, which serves to highlight the trade-offs made in real life and avoid undue focus on a single issue. This has been seen as an advantage over CV.

There are a number of noteworthy points in this regard. First, given the amount of technical information that it was necessary to provide to respondents regarding technical aspects of GM food, embedding the GM issue within the other attributes with no undue prominence was difficult. Indeed, it is questionable whether it is possible to do this with the GM issue in the UK at the moment because of the contentious nature of the issue and the awareness that a number of key policy decisions on GM issues are imminent.

Second, it is possible that as well as avoiding a single issue focus, the choice sets can obscure the price attribute with the result that price is not taken sufficiently taken into account. While the criticism of CV that it focuses on a single issue at the expense of

substitutes has been long established, it is also true that is does also focus on the other attribute involved in the CV question – the cost.

As a corollary, in CM the full implications of the respondent's choices (in terms of the implied WTP/WTA) are not clear when they make their selection and study design does not involve revealing to the interviewee what their choices have implied they would pay. One way round this would be to build in a theory consistent constraint that ensures that people cannot bid more than is feasible, in terms of their income or current expenditure levels. To do this would raise a number of challenging econometric problems which would take us far beyond the scope of the present project.

Section 1 Introduction and Aims of the Study

This study aims to assess the consumer benefits associated with forthcoming changes in the EU regulations regarding the labelling regime for GMOs in food and feed. Two core research questions are addressed in the context of these forthcoming changes:

- **What are the benefits of increasing the robustness of the labelling regime?**
- **What are the benefits of a reduction in GM labelling threshold levels?**

More details of the research questions are provided below, as well as more a detailed explanation of the new EU regulations regarding GMOs in food.

The work was commissioned to look specifically at consumer benefits so that these benefits could be considered alongside the costs of the new regulations which are not considered in this study. This benefit study is based on stated choice survey data from mainland Britain from 2003. The work seeks also to evaluate the relative merits of two alternative methods for producing and analysing stated choice survey data: contingent valuation and the more recently developed choice modelling.

In addition, to the evaluation of the consumer benefits of the changes to the labelling regime, and an assessment of the relative merits of the two valuation methods, a third more general research question is addressed, namely how consumers respond to changes in the proportion of their food items containing GM ingredients.

This section of the report is structured as follows: some information regarding these major changes in the EU labelling regime is provided in Sections 1.1 - 1.2, and the structure of the rest of the report is outlined in section 1.3.

1.1 Estimating the benefits of increasing the robustness of the labelling regime

Since 1997, the food labelling regime regarding GMOs has applied only to products consisting of or containing detectable GM material. That is, labelling of food products has only been mandatory where detectable GM protein or DNA, from crops or any other source, is actually present in the product. Other foods, produced from derivatives of GM crops, such as highly refined oil from GM maize or soya beans, have not required a label if they are indistinguishable from products derived from non-GM crops.

Two new EU Regulations, on GM food and feed[3] and on the traceability and labelling of GMOs, which apply fully in Member States from April 2004, extend and modify the current regulatory regime to cover both products consisting of or containing GM material and those with ingredients derived from a GM source that is not identifiable by analysis ("derived products"). Differentiated traceability and labelling requirements apply to each category of product. The main difference is that, in the case of products consisting of or containing GM material, the documents that are required to facilitate tracing of the GMO or GMOs used in the product throughout the supply chain must include information on a "unique identifier" code that enables that particular GMO or those GMOs to be distinguished from any other GMO or GMOs. The availability of such information thus enables claims made in documentation to be verified by physical analysis. No such unique codes are required in relation to the documentation for derived products, so the system of traceability relies to a far greater extent along the supply chain on faith in operators' claims about their products.

Table 1.1 illustrates the effects of these new labelling requirements. The benefits associated with the change are evaluated in this report.

[3] Regulation (EC) 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed. *Official Journal of the European Union* L 268/1, 18.10.2003

Table 1.1: New Labelling Requirements

	Examples	Presence of Genetically Modified DNA or protein	Label
Food/feed consisting or containing GMOs	Corn (Maize)	Yes	Corn (Genetically modified)
Food/feed ingredients produced from GMOs and containing genetically modified DNA	Corn Flour	Yes	Corn flour (produced from genetically modified corn)
Food/feed ingredients produced from GMOs but not containing genetically modified DNA	Corn Oil	No	Corn oil (produced from genetically modified corn)
Food/feed produced with GMOs	Cheese made with GM enzymes Meat from pigs fed with GM corn	No	No label

Source: IIEL (2003)

1.2 Estimating the benefits of a reduction in GM labelling threshold levels

The second element of the EU regulation regarding GM food and feed is a lowering of the threshold level at which food with low levels of GM content that can be shown to be adventitious or technically unavoidable requires a label. This level was previously set at 1%, but is to be lowered to 0.9%. This means that the accidental presence of GM material below the 0.9% level in food or feed does not require labelling. Labelling is still not required for food made with the aid of genetic modification technology, such as hard cheese produced with the help of chymosin from GM micro-organisms, and products such as meat and milk from animals fed on GM feed.

There will also be a 0.5% threshold for the presence of GM material that has not been approved for use in Europe, provided it has a favourable safety assessment from the relevant EU scientific committee[4].

Specific traceability requirements for products that consist of or contain GMOs are currently set out in Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms[5]. These requirements are further elaborated and extended to derived products in second new Community regulation[6], on traceability and labelling. This regulation, which is planned to come into force along with the Regulation on GM food and feed (April 18, 2004), will provide a harmonised EU system on the documentation needed to trace GM products throughout the production and distribution chains, as described above.

1.3 The Structure of the Report

In Section 2 of the report a background review is provided of attitudes within the UK regarding GM food, followed by a review of the economic methods used to assess consumer responses with particular emphasis on contingent valuation (CV) and choice modelling (CM). Section 3 comprises a formal description of the CV and CM models, outlining both the theory behind them and the method of estimation. The research process on this study is outlined in Section 4 with particular emphasis on the semi structured work and the design and revision of the structured questionnaire that formed the basis of the data collection process. Section 5 contains the findings of the survey regarding respondents' attitudes and opinions on several issues related to food, food safety, the environment and GMOs. This includes analysis of a series of 'referendum' questions on GM testing, commercial growing and the sale of GM food products in the UK.

[4] Food Standards Agency: http://www.food.gov.uk/science/sciencetopics/gmfoods/gm_labelling and http://www.foodstandards.gov.uk/news/newsarchive/new_reg

[5] OJ L 106,17,4,2001, p.1. See Article 4.6 and Annex IV.

[6] Regulation (EC) No 1830/2003. of the European Parliament and of the Council of 22 September 2003 concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC. *Official Journal of the European Union* L 268/24, 18.10.2003.

Sections 6, 7 and 8 report the analysis and results, from both CV and CM models, regarding the major research questions addressed in the study. Section 6 deals with the estimation of the benefits of increasing the robustness of the labelling regime. Section 7 focuses on estimating the benefits of a reduction in GM labelling threshold levels. Section 8 considers how consumers respond to changes in the proportion of their food items containing GM ingredients.

Section 9 summarises and discusses the results from the various sections of the report and draws conclusions regarding the core research questions set out here and also in terms of methodology and study design for future research of this kind.

Section 2 Attitudes in the UK to GM Food and Economic Methods of Analysis

2.1 Attitudes in the UK to GM food

Food containing GMOs first became available in the UK in 1997. Consumer unease and opposition to the use of GMOs in food grew in subsequent years and from 1998 the major UK food retailers began removing GM food and ingredients from their supply chain.

There have been a number of national and cross-country studies which have sought to identify attitudes regarding GM food and, in some cases, to explore the basis of these attitudes.

The Eurobarometer surveys have been conducted at intervals for several years and allow some exploration of the attitudinal patterns between countries and also over time. In 2001 Eurobarometer reported that when questioned about GM food, 71% of respondents agreed with the statement "I do not want this type of food" and 95% agreed that "I want to have the right to choose", whilst only 15% agreed that "this kind of food does not present any particular danger".

The most recently published Eurobarometer survey, based on responses in 2002[7], confirms that a majority of Europeans do not support GM foods. These foods are typically judged to be not useful and to represent a risk for society. Majority support for GM foods is seen in only four countries - Spain, Portugal, Ireland and Finland. With the exception of Sweden and Austria, all the European countries exhibited moderate to large declines in support over the years 1996-1999. Since 1999, the majority of countries have shown an increase in support for GM foods with the exceptions of Germany and Finland, which are stable, and Italy, France and the Netherlands in which there have been further declines[8].

Marris *et al*., (2001) report their qualitative, focus group work in the UK, Spain, France, Italy and Germany which found that:

[7] Other examples can be found in Norton *et al.*, 1998; Smith and Riethmuller, 1999; Wirthlin Group, 2000; Baker and Burnham, 2001; Marris *et al.*, 2001; HortResearch, 2002
[8] See Gaskell *et al*. (2003).

> "Contrary to our expectations, there was an overwhelming similarity in the…results from the five countries studied, despite national differences in the amount of media coverage and the intensity of the public debate. There were some national differences in the emphasis placed on particular views, and in the examples used to support those views, *but underlying those differences, we found a broad similarity in the repertoire of arguments mobilised by focus group participants in all five countries.*"

A key result of this work was the view that people were not 'anti-science' and did not demand risk-free technological development but that, in addition to uncertainty about long-term environmental and health effects of the use of GMOs, questions were repeatedly raised regarding the distribution of the benefits of the technology.

Marris *et al*., (2001) argue that perceptions of the public's understanding of the GMO issue are flawed and riddled with misconceptions. They identify a series of 'myths' regarding consumer concerns, including: lay people are ignorant about scientific facts, they are either 'for' or 'against' GMOs; they think that GMOs are unnatural; they demand 'zero risk'; their opposition to GMOs is due to "ethical or political - factors"; and they are a malleable victim of distorting sensationalist media. In fact, they argue, the evidence points to a complex mix of attitudes and preferences regarding GMOs in food, and one which is shaped by aspects other than the simple technological details of GM food technology.

In the UK there have been a number of studies from several organisations which have used a variety of methods to investigate attitudes to the use of GM technology in food production. This has included work by the Food Standards Agency (FSA), the Consumers Association, academic studies, general opinion polls and the government's national consultation: GM Nation.

A 2002 Consumers Association survey in the UK reported that only 32% of respondents found the idea of food produced from a GM plant acceptable, with the figures for the acceptability of fish and farm animals which had been genetically modified being 11% and 13 % respectively. Indeed, the survey reported that 35% of respondents would not accept any of the food uses put to them (food produced using a GM plant, bacteria,

yeast, fish or animals), indicating the strength of general opposition to GM food among a significant section of the UK population.

The finding of Marris *et al*., (2001) that the issue of who gains from the technology is significant for many people is reflected in the Consumers Association UK survey which found that in answer to a question regarding who would benefit most from the use of GM technology in food production, interviewees most frequently identified the companies developing the technology (24%), food manufacturers (18%) and farmers (13%). Developing countries were identified by 11%, with consumers named by only 5%, behind food retailers, the government, and scientists.

MORI research (MORI, 2003) shows that support for GM food has fallen in the UK since the issue first emerged in the media spotlight in 1996. Almost one third of those questioned (31%) supported GM food in 1996, but by 1998 this had weakened to 22% and by 2003 the figure had fallen to 14%. Opposition to GM has been fairly constant since 1996 (at around 50%) but recently has dropped for the first time to 46%. This is attributed not to a rise in support, but rather a substantial increase in the proportion of undecided respondents (in 1998 MORI found that 16% were undecided but that the figure in 2003 was 33%).

The latest report on consumer attitudes to food standards for the FSA (TNS, 2004) includes findings which cast some doubt on there being widespread concern about GM food in the UK. When participants in the 2003 survey were asked which foods, if any, they were concerned about, only 8% identified foods with GM ingredients spontaneously, with other 17% choosing that food type, when shown a prompt list. Respondents were also shown a list of food issues, and asked which, if any, they were concerned about. In this case, only 38% of the sample chose GM foods. This figure was less than several other food issues selected by respondents, such as food poisoning (60%), fat, salt and sugar in food (around 50% each), the use of pesticides (46%), the use of additives (45%), and BSE (42%). As with the other food issues, the majority of those identifying GM foods as a concern claimed to have modified their eating habits as a result of that concern. The proportion choosing GM food as an issue was up on the figure for 2002 (36%) but lower than for 2000 (43%), and so no clear trend is discernible.

The FSA has also commissioned a citizens' jury exercise regarding GM food with the purpose of “testing public opinion about GM food, exploring public concerns and testing their validity, and informing the Agency's thinking about the issue.” The jury comprised 15 members of the public who considered the question: 'Should GM foods be available to buy in the UK?' The jury heard evidence from a cross-section of experts whom they were able to question as well as ask for additional evidence. The results of this process, like so much in the area of GM food, caused controversy. The summary of key findings produced by the FSA is contained in Box 2.1 which indicates that the majority of the jury thought that GM food should be available to buy in the UK. This finding was not disputed. What was subsequently controversial, to some at least (see Genewatch, 2003), was the exclusion of two unanimous findings of the jury, namely that "More time is needed to understand the long-term environmental implications of GM crops before farmers start to grow them in the UK” and that “growing GM crops in the UK would be irreversible and might eventually reduce choice".

Box 2.1 The Key Findings of the FSA Citizen's Jury

After two hours of heated deliberation, the jury presented its verdict to FSA Chief Executive Dr Jon Bell. The majority of jurors thought GM food should be available to buy in the UK because:

- They are confident in safety measures
- While some anti-GM concerns are valid, there has to be choice
- If the UK doesn't embrace new developments in science, it will be left behind, because there are demonstrable benefits from GM
-

All 15 members of the jury agreed that the following measures are vital if GM food is introduced to the UK:

- Education to keep the public informed of developments and possible problems with GM
- Effective labelling and monitoring of GM foods; for example a GM food logo to ensure that people can make a genuine to choice to eat or avoid eating GM foods

A number of jurors expressed concerns about the long-term safety of genetically modified organisms, ethical concerns, and the environmental impact of growing GM crops in the UK. Although environmental issues are outside the remit of the FSA, the concerns of jurors about environmental issues will be included in the final published report of the jury's considerations.

Excerpt from FSA Press Release "FSA citizens' jury says GM food should be available to buy in the UK" (7/4/03) Ref: R665-37.

The UK government launched the **GM Nation?** consultation process in 2002, as part of its national GM dialogue. The consultation was undertaken alongside a review of the scientific issues and an assessment of the costs and benefits of growing GM crops. The GM Nation? Report identified seven key messages that came out of the consultation process, these are highlighted in Box 2.2. There was concern expressed in some quarters that the process had been hijacked by anti-GM activists and campaign groups and as such the findings of the consultation should receive less weight. However, it should be noted that the GM Nation? Process included in-depth work with smaller groups of people, from a range of backgrounds and locations, holding a variety of views.

Box 2.2 The Key Findings of the GM Nation? Consultation

- **People are generally uneasy about GM**

"Across the different elements of the debate, participants expressed unease about GM. They were uneasy not only about issues directly related to GM technology (is GM food safe to eat? What will GM crops do the environment?) but about a range of broader social and political issues."

- **The more people engage in GM issues, the harder their attitudes and more intense their concerns**

More in-depth work with a smaller sample of the public (the "Narrow-But-Deep sample") suggested that:

"when people in the general population become more engaged in GM issues, and choose to discover more about them, they harden their attitudes to GM. Although they are more willing to accept some potential benefits from GM (especially medical benefits and other advantages for developing countries) they become more doubtful about the others and they express more concern/greater unease about all of the risks most frequently associated with GM"

- **There is little support for early commercialisation**

Work with the Narrow-But-Deep sample indicated that:

"that the general population does not share the unconditional opposition to GM of many active debate participants. However, it does suggest that the general population would prefer caution: GM crop technology should not go ahead without further trials and tests, firm regulation, demonstrated benefits to society (not just for producers) and, above all, clear and trusted answers to unresolved questions about health and the environment"

- **There is widespread mistrust of government and multi-national companies**

Both the wider debate and work with the Narrow-But-Deep highlighted:
"a series of political issues, manifested in a strong and wide degree of suspicion about the motives, intentions and behaviour of those taking decisions about GM - especially government and multi-national companies."

"The debate also highlighted unease over the perceived power of the multi-national companies which promote GM technology, and of such companies in general….When given the opportunity to engage in GM issues, people do not rely exclusively on official sources or everyday media. They choose sources which they trust and which mean something in their personal life"

- **There is a broad desire to know more and for further research to be done**

- **Developing countries have special interests**

On this issue there was a clear divergence between the views of active participants in the debate and those expressed in the Narrow-But-Deep sample. The former rejected, by a majority, the idea that GM technology would benefit developing countries: the latter supported it, and their support slightly increased after people got more engaged in GM issues.

- **The debate was welcomed and valued**

No one was allowed to be part of these groups if they had campaigned on GM issues and none of the participants attended any of the public meetings. The issues were discussed in two separate meetings for each group. The Report's authors, while accepting that a sample of 77 was too small to generalise from with complete confidence, concluded by rejecting the idea of a silent majority with different values and attitudes from an unrepresentative activist minority.

The GM Nation? Report and the consultative process that preceded it have been the subject of much discussion and debate. Some argued that the meetings and consultation process suffered from serious sample selection problem (see Campbell and Townsend, 2003), others pointed out flaws but were not dismissive of the entire process and its findings (for a comprehensive review of the process and report see Horlick-Jones *et al*., 2004)

Many empirical studies, such as those cited above, are qualitative employing, for example, ratings of 'concern' about the technology, or whether consumers would be willing to purchase it. Many of these studies explore the issues with smaller samples in more depth over a longer period of time.

The contribution of many economists to these discussions and analyses of consumer attitudes and preferences in relation to food types such as GMOs has been typically to introduce one of the established valuation techniques to seek to identify willingness to pay (WTP) or willingness to accept (WTA) a food product or type. In the next section we review how willingness to pay (accept) may be computed and what the empirical evidence on consumer acceptance of GM foods is to date.

2.2 Research Methods for Estimating WTP for GM foods

2.2.1. Contingent Valuation

Where actual market data are lacking, the contingent valuation (CV) method attempts to discover how people value changes in non-market goods or attributes by direct questioning. The name of the technique reflects the fact that these changes, and the market context in which they are to be valued, are hypothetical. When first used in the agricultural and environmental economics field, it was common to ask interviewees open-ended questions. For example, respondents might be informed that the national water pollution goal is to have 99% of freshwater rivers and lakes fit for swimming. They are then asked "how much would you be willing to contribute (£ per year) to achieve this goal?"[9] One argument against this approach is that it does not replicate choice in real markets where consumers have to accept or reject fixed prices. Researchers increasingly prefer a dichotomous choice approach in which respondents decide whether or not they would be willing to pay a price specified by the researcher. Statistical efficiency may be improved (Hanemann *et al.*,1991) by using a 'double bounded dichotomous' approach. In this case, if the first bid presented to the respondent is accepted, a second somewhat higher offer price is made. If the first bid is refused, the second bid price offered is somewhat lower. More recent developments in this area include the one and one half bound dichotomous choice format (Cooper et al., 2002), which is not discussed further here.

The CV approach is open to a number of criticisms. The underlying weakness is that as the approach is not based on actual market behaviour and, moreover, respondents may have no previous purchase experience for the good in question, it may simply be providing hypothetical answers to hypothetical questions. More specifically, there is empirical evidence that the hypothetical nature of CV surveys typically results in responses that are significantly greater than actual payments (this difference is often termed *hypothetical bias*). In this context, Murphy *et al.* (2003) cite the work of Harrison and Rutström (2002) who found that 34 of 39 CV estimates reviewed contained hypothetical bias with an average bias of about 338 percent and these results were consistent with those in a meta-analysis[10] of List and Gallet (2001). However, Murphy

[9] This example is adapted from Field (1997).
[10] A meta-analysis seeks to summarise the findings of a number of empirical studies on a common theme.

et al. (2003a) suggest that hypothetical bias may not be as significant a problem as is often thought. In a more rigorous analysis than List and Gallet (2001), they undertook a meta-analysis of hypothetical bias in 28 stated preference valuation studies which report monetary WTP and that used the same mechanism for eliciting both hypothetical and actual values. The median value of the ratio of hypothetical to actual value of 1.35 and the distribution had severe positive skewness. Some 70% of the studies examined reported a ratio of hypothetical to actual value of less than two.

Another aspect which has attracted attention in recent years is whether, for a desirable good, the WTP estimates from CV studies increase in a plausible manner with the quantity or scope of the good being offered. The apparent lack of sensitivity to scope in some CV studies has sometimes been termed 'embedding'. However, a review of the empirical evidence (Carson, 1997) suggests that the hypothesis of scope insensitivity is rejected in a large majority of the tests performed. The term embedding has also been used in the literature to refer to a sensitivity of the estimates to the order in which goods are valued. However, such an effect is consistent with economic theory since it may reflect the substitution possibilities between the goods and the reduction in disposable income that occurs with the purchase of each new good (Carson, 2000).

Other specific technical objections to CV include: i) that respondents may think they can influence the course of real events by over- or under-estimating their true valuation (*strategic bias*); ii) that there are various kinds of *design bias* in the way that information is put across to respondents. *Instrument bias* can arise where respondents react against the proposed method of payment. The chosen starting bid may skew the possible range of answers (*starting point bias*). Related issues include *social desirability bias* (whereby respondents tend to present themselves in a favourable light with respect to social norms), the closely related *yea-saying* (defined as the tendency to agree with questions regardless of content), and *protest votes*, or protest zeros, (when a respondent who has a positive WTP for a good nevertheless expresses a zero WTP response, possibly as a rejection of the legitimacy of the analysis). Where there are "untruthful" responses, for whatever reason, it is often argued that CV responses should be calibrated to try to correct for either an upward or downward bias (Carson, 2000).

Carson et al. (2001) consider several of these key areas of the debate about CV and conclude that many of the alleged problems with CV can be resolved by careful study design and implementation.

2.2.2. Choice Modelling

An alternative to CV as a way to elicit consumers' WTP for non-market goods is choice modelling (CM). The central idea behind choice modelling is that individuals can choose between alternative options that contain a number of attributes with different levels. More specifically, each respondent is presented with a number of options, each differing from the others in the choice set in respect to one or more characteristics defining the option. For example[11], if the choice set were defined over variation in the level of wetland protection, the characteristics in each choice option might be irrigation-related employment, wetlands area, presence of endangered species, and importantly, water rates (the price term). A sample choice set might be as follows:

	Option 1	Option 2	Option 3
Your annual water rates	no change	£20 increase	£50 increase
Irrigation-related employment	4,400 jobs	4350 jobs	4350 jobs
Wetlands area	1000 sq. km	1250 sq. km	1650 sq. km
Endangered and protected species present	12 species	25 species	15 species

Respondents are not asked to report how much they prefer alternatives, nor even how much they value individual changes in an attribute; they are merely asked to identify which of the options they prefer. After building up a series of such responses (each respondent in the sample would be offered a number of such choice sets) it is possible to isolate the effects that variations in individual characteristics have on changes in the price term. That is to say, it is possible to estimate the monetary trade-offs between price (here the level of water rates) and each of the other characteristics describing the

[11] This example follows the case study of Bennett *et al*. (2001).

option. Formally, the approach is based within the framework of Random Utility Theory, and there have been extensive applications in marketing and environmental valuation (e.g. Bennett, 1999; Blamey *et al*., 1998; Burton *et al.*, 2001; Morrison *et al*., 1996; Hansen and Schmidt, 1999; Adamowicz, *et al*.,1998).

Choice modelling data have usually been analyzed using multinomial, conditional or nested logit models. These standard fixed parameter models have some technical traits which may be of concern. First, the model imposes the Independence of Irrelevant Alternatives (IIA) assumption, which implies that the relative probability of two choices is independent of the attribute levels in the third. Second, the representation of heterogeneity of preferences over attributes (as opposed to the random component of utility) is restricted to those individual attributes, such as age and gender, that are measured and may be included. Finally, the data from studies such as this comprise repeated choices which may well exhibit some degree of correlation. There is, however, a class of models that address these shortcomings. These 'mixed' or 'random parameter' logit models approach variations in preferences by assuming that the underlying parameters of the estimated model (and hence preferences) are different for each individual, and that choices can be explained by identifying the parameters of the distribution from which they are drawn. These models have previously been applied to problems in transportation, the environment, energy, and marketing. Rigby and Burton (2003) estimate distributions of WTPs to avoid GM food using such models and find that the data support their use as opposed to standard conditional logit models.

The CM approach can be seen as a generalisation of discrete choice CV concerning a sequence of discrete choice valuation questions where there are 2 or more goods involved. However, in situations where changes are multi-dimensional and trade-offs between them are of particular interest, it is a much less costly and cumbersome alternative[13]. It is also more informative because respondents have multiple chances to express their preference over a range of payment amounts. In fact CM generally avoids an explicit elicitation of respondents' WTP by relying instead on choices amongst a series of alternative sets of attributes from which WTP can be indirectly inferred.

[12] For a thorough survey of CM methods and applications, see Louviere *et al*. (2000).

[13] Hanley *et al.* (1998) argue that CV 'seems best suited to valuing the overall policy package, and Choice Experiments to valuing the individual characteristics that make up policy'.

Because the attribute of specific interest can be embedded in the choice set, some of the problems associated with CV (strategic behaviour, yea-saying, etc.) can be minimised.

There are however a number of drawbacks with choice modelling (see Hanley *et al*., 1998, and Bennett and R. Blamey, 2001). Firstly, polytomous and/or multi-attribute choice tasks might place a cognitive burden upon interviewees. (Breffle & Rowe, 2002). There is a limit to how much information respondents can meaningfully handle while making a choice. Moreover, as typically the interviewee is presented with a relatively large number of choice sets both learning and fatigue effects can occur, leading to apparently irrational choices. Secondly, consumer behaviour is highly context specific (Blamey *et al.*, 2001). In particular, for 'low involvement' goods (such as the purchase of routine, staple food items), the valuation of attributes may rely on specific brands, the retailers' images or the point-of-sale context. Finally, with all stated preference methods, welfare estimates from CM are sensitive to survey design.

2.2.3. Experimental Auctions

A relatively new approach to empirical work in this area is the use of experimental auctions (or experimental markets). An experimental auction simulates a market setting in which individual choices reveal preferences for a good which typically would not be traded in an actual market. A range of auction designs have been employed to identify WTA to consume GM foods (Huffman *et al*, 2001; Huffman and Tegene, 2002; Lusk *et al.*, 2001; Rousu *et al.*, 2002, 2002a). Experimental auctions can go a long way to eliminating informational problems and can place the respondents in a situation which, although artificial, nonetheless presents real choices and, as actual money transactions are involved, should make the respondents consider their budget constraints. Moreover, by using an incentive-compatible auction mechanism, such as the Vickrey second-price auction[14], respondents reveal their true valuation of the good in question and this incentive can be reinforced in the case of a food product by requiring the winner to eat the prize.

While experimental auctions have these strengths, they are problematic in terms of providing a setting (i.e. a bidding process) with which most people are familiar and have

[14] In a Vickrey second-price auction, the person with the highest bids buys the good at the second highest price. It can be shown that the bidders' best strategy is to bid their true valuation.

tended to focus on single issue (GM vs non-GM good) rather than locating the issue of interest in a broader setting within which trade-offs are considered. Furthermore, in such a controlled market setting, concerns about the product are likely to be reduced since there is an assumption that they would not be given 'unsafe' food in such an experiment whereas there might be a perception of less control in real markets.

An important issue in all the above stated preference approaches (CV, CM and experimental auctions) is the role of information in determining respondents' preferences and their stated WTP. Recent reviews of the literature on this issue (Munro and Hanley, 2000, Kontoleon *et al.,* 2002)) suggest that information does change respondents' preferences and so estimated WTPs are to some degree information dependent. Inevitably, respondents' valuations are contingent on the information provided. The researcher should then try to provide as much information to ensure that respondents understand exactly what they are being asked to value and to allow them to make informed choices. However, when dealing with an unfamiliar and complex issue, conveying the appropriate amount of information is undoubtedly a daunting task[15].

[15] For a particularly negative view of the capacity of CV surveys to capture fully all aspects of the good being valued, see Burgess *et al*. (2000). They and other critics of the use of CV in environmental valuation have made alternative suggestions for elicitation of values based on a social process of deliberations. As Brouwer *et al.* (1999) note, "these alternatives may be questioned on their implicit value judgements regarding the legitimacy of the social-political organisation of the process of value elicitation".

2.3 Empirical evidence on WTP and GM food

Contingent valuation is the technique most commonly applied to identify WTPs to obtain or avoid specific food or food attributes, although applications of this technique to GM food are still quite rare. Recent examples are presented in Table 2.1. McCluskey *et al.* (2001) and Grimsrud *et al.* (2002) found that the WTA of Japanese and Norwegian consumers for GM food required substantial price discounts (in the order of 50-60%) if they were to accept the individual GM foods presented to them. Grimsrud et al. related consumers' WTA to their levels of self-reported risk perceptions toward GM-food, preferences for domestically produced food, levels of formal education and concern about food safety. Kaneko and Chern (2003) found that consumers were prepared to pay premiums of similar orders of magnitude to avoid GM vegetable oil, breakfast cereals and salmon. In their study consumers' perception of health risk associated with GM food also made choice of the GM product less likely but demographic variables had little impact on that choice.

CV methods were also used by Loureiro and Hine (2002), with the objective of determining consumer willingness to pay for a labelled value-added potato that could be marketed as organic, GMO-free, or Colorado grown. In marked contrast to the previous studies, they found that consumers were willing to pay only 0.164 cents/lb for GMO-free potatoes, whereas they would pay 3.137 cents/lb and 5.5228 cents/lb for organic and 'Colorado-grown' attributes respectively. The influence of socio-economic characteristics on WTP was similar for GMO-free and organic produce; younger, well-educated and rich consumers had a higher WTP, but perhaps surprisingly gender and the presence of children did not exert a significant influence. In all these studies, one may have reservations about the unrepresentativeness of the sample and the definitions of some of the variables included in the survey questionnaire.

Turning to the CM approach, Burton *et al.* (2001) was the first CM study of WTP to avoid consumption of GM food in the UK. Based on a sample of about 230 households in Manchester, they concluded that attitudes differ significantly between GM technology in which plants are modified by the introduction of genes from other plants and that in which they are modified by the introduction of genes from animals and plants. Their results also indicate that attitudes towards organic food may be taken as a useful

indicator of attitudes towards GM technology: the value sets which underlie the former appear to inform the latter also. More specifically, infrequent consumers of organic food would be willing to increase their food bill to avoid animal and plant GM technology, by 26% for males and 49% for females. These are substantial changes but may be feasible. For the group of consumers who purchased organic food occasionally, the implied increases in the food bill for a GM-free diet are of sufficient size to suggest that this group would never choose to purchase GM food, as is the case also for the more committed organic food consumers.

Burton and Pearse (2002) use the CM approach to identify consumer preferences for various hypothetical forms of genetic modification in beer, using a sample from Western Australia. Although the sample size was small (just 64 respondents), the repeated nature of the experiments meant that the preferences could be identified with some precision. The results revealed a diversified set of preferences towards genetic modification in foods: 30% of the sample would not select a beer with any GM component in its production for any of the price or health advantages offered in this experiment, whereas there was a set of respondents who required some price discount to be induced to purchase a beer that had some first-generation GM involved in its production. Overall, respondents were equally averse to first-generation modification in either plants or microorganisms but were willing to pay a premium for a product with positive health benefits.

More recently, Donaghy *et al.* (2003) reports results on using CM to estimate demand for GM and organic foods (tomatoes, milk and beef) in Australia. They explore the trade-offs between environmental, economic, ethical and social considerations. They conclude that the monetary valuations for GM health impacts support government food labelling, GM testing and other public safety initiatives. A summary of these CM studies regarding GM food is contained in Table 2.1b.

Experimental auctions are also now being used to estimate WTP for GM food and a summary of such studies is found in Table 2.1c. In the experimental study of Lusk *et al.* (2001), the WTP of (50) university students for corn chips made without GM ingredients was estimated. Some 70% of the participants stated they were unwilling to pay a premium to exchange GM chips for non-GM chips and the average premium that would

be paid was only $0.07/oz. However, 20% of participants would pay a premium of at least $0.25/oz. and 2% would pay $0.50/oz. Those who were very concerned about GM foods were 50% more likely to pay a premium than those with little concern about GM foods.

Huffman et al. (2003) report a study which is based on a more representative sample and which analyses the demand for three food items, thus permitting a distinction to be drawn between dislike of genetic modification and dislike of a particular food. They use random *n*th-price auctions[16] to see how consumers' WTP for food products changes when GM labels are introduced in a market. They find that participants in their experiments discount GM-labelled foods by approximately 14% relative to their standard-labelled counterpart. As this discount was similar across the three different products, it may be concluded that consumer demand for GM foods is significantly lower than the demand for the non-GM counterpart. The research also suggests that the discount is smaller for older than it is for younger participants and that sequencing of food labels in laboratory trials (i.e., whether the consumer first bids on foods with or without GM-food labels) has a significant effect on WTP.

Rousu *et al.* (2002) also use experimental auctions but focus on consumers' acceptance of food with zero, 1% and 5% tolerance for GM material (i.e. the acceptable percentage of GM impurity before it must be labelled as GM). The total sample size was small, just 44 adults living in Des Moines, Iowa, but their results are perhaps not unexpected: consumers would pay less for food that tolerates GM material but the discount is not significantly different for foods with 1% and 5% GM content.

A recently published study (Noussair et al., 2004) also provides empirical evidence about the effect of threshold levels of GM content on consumers' WTP. Here a Becker-DeGroot-Marchak (BDM) mechanism[17] was used to elicit WTP information for biscuits

[16] Each of k bidders submits a bid for one unit of a good; then each of the bids is rank-ordered from highest to lowest. The auction monitor then selects a random number—the n in the nth-price auction, which is drawn from a uniform distribution between 2 and k, and the auction monitor sells one unit of the good to each of the n-1 highest bidders at the nth-price. For instance, if the monitor randomly selects n = 4, the three highest bidders each purchase one unit of the good priced at the fourth-highest bid. Ex ante, bidders who have low or moderate valuations now have a nontrivial chance to buy the good because the price is determined randomly. This auction increases the probability that insincere bidding will be costly.

[17] In the BDM mechanism, each subject submits a bid in a closed envelope for the good offered for sale. A sale price is then drawn at random from a interval from zero to a price greater than the maximum possible

which differed only in their GMO content. A sample of French consumers participated in a series of auctions, where at each stage they received additional information about the GM content of each type of biscuit, general information about GMOs and finally the brand names of the biscuits. The GM content information was labelled in one stage as "GMO free" and "contains GMOs", and in a subsequent stage as "no ingredient contains more than 1% GMOs", "no ingredient contains more 1/10 of 1% of GMOs" "one ingredient is derived from an authorised genetically modified product" and "no ingredient contains any detectable trace of GMOs". It was concluded that i) the 0.1% and 1% thresholds generated significantly different bids, ii) the 0.1% was not considered equivalent to GMO-free and the 1% threshold generated higher bids than "contains GMOs", iii) 89% of the sample would purchase the product with the 1% threshold, and 96% would purchase at the 0.1% threshold, if there ere a sufficient discount in price, iv) demographic variables were in general not strongly related to bidding behaviour, and v) providing background information about GMOs had little impact on consumer behaviour.

Finally, we may note a recent meta-analysis, conducted by Hall *et al*. (2004), which attempts to summarise 22 stated preference studies (contingent valuation studies, auction experiments and choice modelling), including many of the studies cited above, that focus on WTP and WTA estimates for GM food products. Their analysis indicated an average WTP 24% extra for conventional food, in order to avoid GM food products. Consumers would require a 37% discount in order to induce them to purchase GM food without clear benefits but would be willing to buy GM food with benefits at a 9% premium.

WTP among bidders. Any subject submitting a bid higher than the sale price receives the good at the sale price. Other bidders do not receive the good and do not make a payment.

Table 2.1a: Contingent Valuation Studies

	Country/food product	Sample	WTP to avoid GM foods	WTA GM foods
Contingent valuation				
McCluskey *et al.* (2001)	Japan/ noodles and tofu	face-to-face interviews of 400 consumer cooperative customers in a single city (Matsumato)		willing to purchase GM noodles with a 60% discount and GM tofu with a 62% discount.
Grimsrud *et al.* (2002)	Norway/bread and salmon			a 49.5% discount on GM bread and a 55.6% discount for GM-salmon compared to their conventional counterparts
Moon and Balasubramanian (2001)	USA & UK/breakfast cereals	3060 respondents to a US postal survey; 2568 respondents to online survey in UK	37% of US sample and 56% of UK sample WTP a premium to purchase non-GM cereals.	
Loureiro and Hine (2002)	USA/potatoes	409 respondents in supermarkets across Colorado	0.164 cents/lb. for GMO-free	
Kaneko and Chern (2003)	USA/vegetable oil, cornflakes, salmon	256 food shoppers (respondents to a pilot telephone survey)	41.2%, 31.4%, 40.9% and 52.5% of the base prices to avoid GM vegetable oil, GM cornflakes, GM-fed salmon and GM salmon respectively.	

Table 2.1b: Choice Modelling Studies

	Country/food product	Sample	WTP to avoid GM foods	WTA GM foods
Choice Modelling				
Burton *et al.* (2001)	UK/food	230 households in Manchester	Infrequent consumers of organic food would be willing to increase their food bill to avoid animal and plant GM technology, by 26% for males and 49% for females.	
Burton and Pearse (2002)	Australia/beer	64 respondents in Perth, Western Australia		30% of the sample would not select a beer with any GM component in its production for any of the price or health advantages offered.
Donaghy *et al.* (2003)	Australia/tomatoes, milk and beef	400 respondents in 2 cities in Queensland		

Table 2.1c: Experimental Auction Studies

	Country/food product	Sample	WTP to avoid GM foods	WTA GM foods
Experimental auctions				
Lusk *et al.* (2001),	USA/corn chips	50 university students	The average premium to exchange GM chips for non-GM chips was only $0.07/oz. However, 20% of participants would pay a premium of at least $0.25/oz. and 2% would pay $0.50/oz.	
Rousu *et al.* (2002)	USA. The acceptable percentage of GM impurity before it must be labelled as GM).	44 adults in Des Moines, Iowa		Consumers would pay less for food that tolerates GM material but the discount is not significantly different for foods with 1% and 5% GM content.
Huffman et al. (2003)	USA/ vegetable oil, tortilla chips, and potatoes	172 adults in 2 major Midwestern metropolitan areas (Des Moines and St Paul)	14% premium for food items they perceived as non-GM.	
Noussair et al. (2004)	France/biscuits	97 consumers in the Grenoble area.		Average bids: GMO free 16.47FF, 0.1% threshold 15.16FF, 1% threshold 14.65FF, 'with GMOs' 10.90FF

Section 3 The Theory and Estimation of Choice Models and Contingent Valuation Models

In order to address the key objectives of the study regarding changes to the EU GM labelling regime as well as inform discussion regarding methodological issues, the quantitative analysis in this study is based on two research methods: choice modelling and contingent valuation. The essential elements of each approach are described in this section of the report.

3. 1 Choice Modelling: Theory and Estimation

As noted in Section2, the central idea behind choice modelling is that individuals can choose between alternative options that contain a number of attributes with different levels. Formally, the approach is based on random utility theory, which posits that individual consumers choose alternatives that yield the greatest utility and so the probability of selecting an alternative increases as the utility associated with it increases. The individual consumer's utility level associated with the choice of an alternative, j, comprises a deterministic (observable) component (v_j) and an unobservable or stochastic component (e_j):

$$U_j = v_j + e_j \qquad (1)$$

where v_j is the indirect utility function and e_j is a random error component. It is important to note that utility is stochastic from the point of view of the researcher, not the consumer.

To motivate the discussion, consider a simple case where there are two attributes in each option: the form of technology used to produce food (Traditional or GM) and the level of the weekly food bill for the individual. If only two options are provided, the choice set could be as illustrated in Table 3.1. In selecting between these two, the respondent is asked to compare the reduced food bill with the change in technology. Option 1 is chosen if the welfare from its level of attributes is preferred to that generated by Option 2. At that level, it is tautological: the respondents choose the option they prefer. The model is given empirical content by explicitly modelling the process by which welfare is generated. In its simplest form we can specify that

$$U_j = \beta_1 GM_j + \beta_2 PAY_j + e_j \qquad (2)$$

where U_j is the utility obtained by an individual from option j; GM is a dummy variable indicating the use of GM technology and PAY is the level of food expenditure; β_1 and β_2 are parameters to be estimated.

Formally, the respondent will choose option j over an alternative k if $U_j > U_k$. The task of the statistical analysis is then to identify estimates of the β parameters so that the predicted choices, made on the basis of a comparison of the utilities predicted for each option using equation (2), match as closely as possible the actual choices revealed in the survey. McFadden (1974) has shown that the random utility model can be estimated by the conditional logit model[18].

Table 3.1: A Simple Choice Set

Attributes	Option1	Option 2
Technology	Traditional	GM technology
Weekly food bill	100% of current	80% of current

The model is implemented by choosing a particular distribution of disturbances. Typically it is assumed that the disturbances are independently and identically distributed, with a Gumbel distribution (Ben-Akiva and Bierlaire, 1999):

$$F(e) = \exp(-\exp(u)) \qquad (3)$$

where F(e) denotes the cumulative distribution function and u is normally distributed. Testing the properties of the error process can lead to significant efficiency gains, and added insight into the choice process (Hausman and McFadden, 1984; Rolfe *et al*., 1999).

The assumption of identically and independently distributed error terms leads to the variant of the logit model used in discrete choice modelling[19]. Hence the probability of person i choosing option j from N options can be expressed as:

[18] In the choice modelling literature, this version of the logit model is sometimes referred to as the multinomial logit model, although, as Greene (1997) points out, the two logit specifications differ slightly.
[19] If it is assumed that the disturbances are not independent nor identically distributed normal random variates, the more complex binary or multinomial probit model would be used Louviere (2001).

$$\text{Prob}(Y_i = j) = \frac{\exp\left[\lambda \sum_{k=1}^{K} \beta_k X_{kj}\right]}{\sum_{j=1}^{N} \exp\left[\lambda \sum_{k=1}^{K} \beta_k X_{kj}\right]} \quad (4)$$

where Y_i is a random variable denoting the choice made and X_k (k=1,..,K) are the choice attributes. λ is a scale parameter which is inversely related to the variance of the error term ($\lambda=\pi^2/6\sigma^2$, where σ^2 is the variance of the error term). Adamowicz and Boxall note that the scale parameter 'is confounded with the parameter vector and cannot be identified. Normally, …[the scale parameter] is set equal to 1.0 ...' (2001:10).

It is important to note that individual-specific characteristics can be incorporated to explain choices, but they have to do so in a particular way. Consider the following formulation, which allows the utility gained from an option to vary across individuals:

$$U_{ij}=\Sigma_k\beta_k X_{kj} + \Sigma_m\alpha_m Z_{mi} + e_{ij} \quad (5)$$

where i identifies the individual, and Z_{mi} is characteristic m of respondent i (for example, age or education) which may affect utility values. The probability that individual i will select option j is then:

$$\text{Prob}(Y_i = j) = \frac{\exp\left[\lambda(\sum_k \beta_k X_{kj} + \sum_m \alpha_m Z_{mi})\right]}{\sum_j \exp\left[\lambda(\sum_k \beta_k X_{kj} + \sum_m \alpha_m Z_{mi})\right]} = \frac{\exp\left[\lambda \sum_k \beta_k X_{kj}\right]\exp\left[\lambda \sum_m \alpha_m Z_{mi}\right]}{\sum_j \exp\left[\lambda \sum_k \beta_k X_{kj}\right]\exp\left[\lambda \sum_m \alpha_m Z_{mi}\right]} \quad (6)$$

and hence the terms in Z cancel. Because the personal characteristics are constant for all choices open to individual i they have no impact on the choices made, if they enter the utility function linearly. However, personal characteristics can be included in the analysis, if they affect the way that attributes contribute to utility, as follows:

$$U_{ij}=\Sigma_k\beta_k X_{kj} + \Sigma_k\Sigma_m\alpha_{km} X_{kj}Z_{mi} + e_{ij} \quad (7)$$

Not all of the interaction terms need to be included, and one may have some prior beliefs as to which attributes will be affected by which characteristics, but this can, to some extent, be determined empirically.

Partworths

An important aspect of the interpretation of the outcomes from choice models is the notion of a 'partworth'. The individual parameters generated by the model do not have a direct interpretation, other than in their signs or statistical significance. However, the parameters can be combined to identify monetary values associated with changes in each attribute level.

Consider again the initial example of equation (2). A shift from traditional to GM technology, *ceteris paribus,* will change utility by an amount β_1. The question can then be posed: how much would the consumer be willing to pay to attain the subsequent level of utility, while retaining the traditional technology? This willingness to pay to avoid GM technology, expressed as the change in the food bill (x), can be derived from:

$$\beta_1 * 1 + \beta_2 (PAY_1) + e_1 = \beta_2 (PAY_1 + x) + e_0 \qquad (8)$$

where, in terms of equation (2), j = 0 denotes the choice of no GM technology and j =1 denotes the choice with GM technology[20].

This can be solved to give an expected value of x[21]:

$$E(x) = \beta_1/\beta_2. \qquad (9)$$

x is the partworth associated with a unit increase in the attribute, and can be interpreted here as the maximum that the respondent would be willing to pay in the form of an increased food bill to avoid consuming GM food. In this example one might expect β_1 to be negative (i.e. the presence of GM will reduce the probability that the option will be chosen), and β_2 also to be negative (i.e. options with higher payment levels will be less likely to be chosen). Hence, there would be a positive willingness to pay to avoid GM food.

[20] An alternative approach would be to ask what level of compensation (in the form of a reduced food bill) would the consumer require to accept GM technology. Because of the linearity of the utility function, these welfare measures would be equal in magnitude but opposite in sign.

[21] It is assumed that $E(e_0) = E(e_1) = 0$.

3.2 Contingent Valuation: Theory and Estimation

An alternative, and traditional, approach to identifying values for non-market, or hypothetical goods, is the contingent valuation (CV) method which is based on direct questioning of respondents. Although at one time it was common to pose open-ended questions (e.g. "how much would you be willing to pay for ..."), researchers increasingly prefer a dichotomous choice approach. In this context, a person has described to them a good, and then they are asked if they would be willing to pay (WTP) to obtain that good at a specified price: they may only answer 'yes' or 'no'. This response may seem to be limited in its informational content as one does not know the value of the payment at which they are indifferent (i.e. the maximum value they would be willing to pay). For those who respond 'yes', one knows only that the WTP is greater than the offered value, and for those who respond 'no' one knows only that the WTP is less than the offered value. Obtaining a clearer estimate of the value relies upon assumptions about the distribution of preferences, and requires a statistical analysis of the responses.

The starting point for the analysis is a consideration of the change in utility that is induced by the prescribed change, and the level of payment (or discount) that is associated with it.

Assume that we can represent the change in utility for individual i as

$$\delta U_i = f(\delta A, V, X_i) + e_i \qquad (10)$$

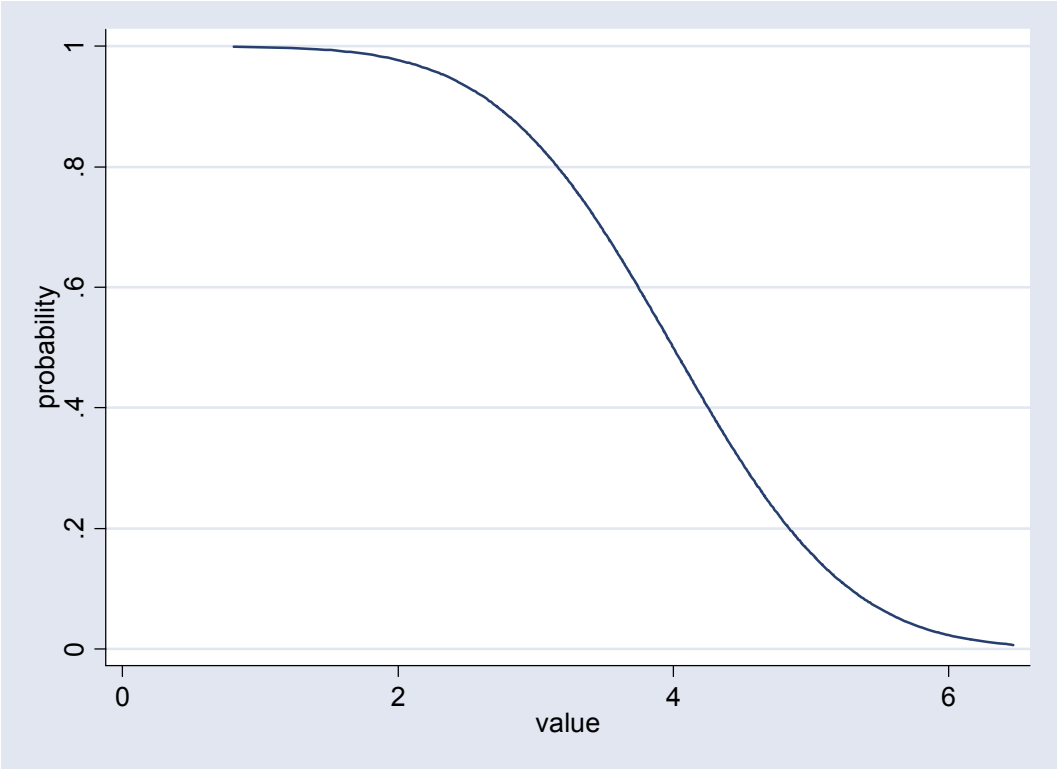
where δA is the changed attribute (GM free bread, increased environmental protection, etc.,) V is the value that is being asked for that change and X_i are individual specific attributes which may alter how an individual evaluates the proposed change. The term e_i is a random component of utility. One would expect that an individual i will accept the change (i.e. will be willing to achieve the change in A for price V) if the change in utility is positive. The presence of the error term makes this outcome stochastic from the perspective of the researcher, and one can only identify the probability that they will accept. The probabilistic model that is developed depends on the assumptions about the nature of the error term. If (as here) it is assumed to be normally distributed, then the model follows a probit functional form:

$\Pr(\text{'yes'}) = \Phi[f(A,V,X)]$
where Φ is the cumulative normal distribution.

Assuming one has data from a wide range of respondents, and that the values V that are presented to them vary, then the probit model estimates the implicit parameters of the utility function, and one can identify measures of the WTP for the specified change.

This process is most clearly shown using the response function, which is the probability that an individual will say yes for any given value asked of them:

Figure 3.1: The Response Function



If one assumes that the good being offered is valued positively, then one would expect the respondent to say 'yes' if the value required is zero, since one is being given a valued outcome at no cost. As the value required increases, the probability of the respondent saying yes will fall. The shape of the function will be determined empirically: by asking a range of individuals the same question, but for different specified values, the response function can be identified.

Once estimated, there are two alternative summary measures one can use to report the WTP in the population. The first is the median, which is the value associated with a 50% probability of accepting the good. An advantage of this measure is that it is not affected by extreme values of the distribution. An alternative is the mean value across the population, which is given by the area under the response function.

Dislike

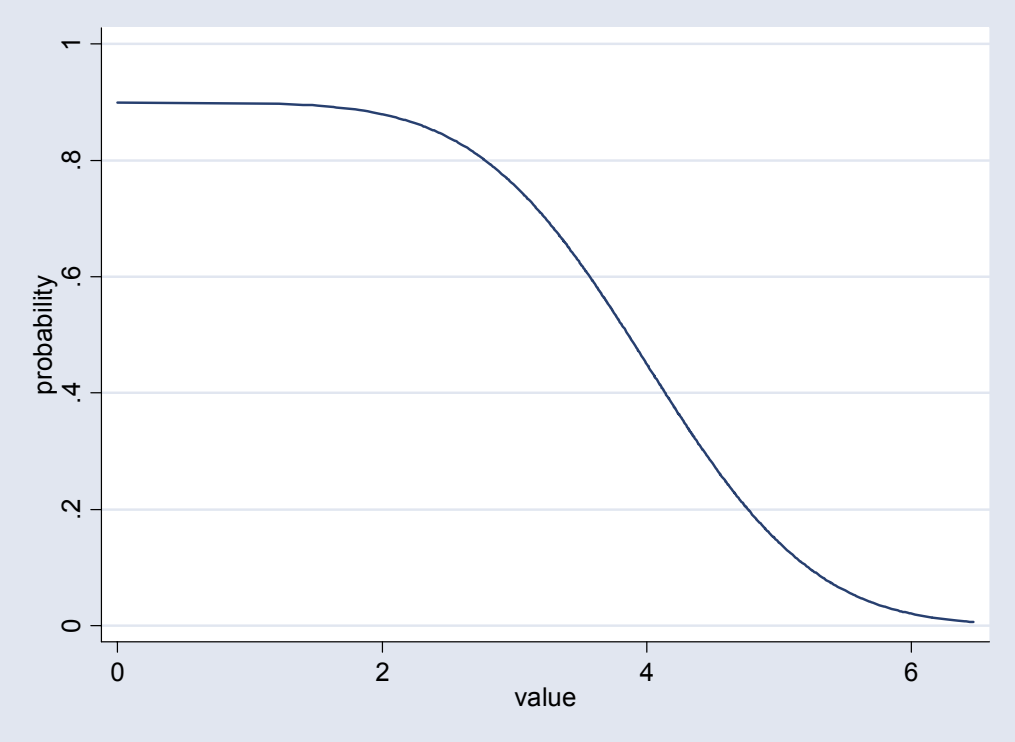
The problem has been phrased here as one of a change that is valued positively, and identifying how much one is willing to pay to achieve that change. One can, analogously,

consider changes which are seen as adversely affecting utility, and then identifying the amount that the respondent is willing to accept (WTA) to bear that change. the analysis proceeds in exactly the same manner, but requires a re-casting of the value from a payment by the respondent to a payment to the respondent.

Indifference

Indifference may occur when some portion of the population simply does not care for the product at all. Thus one may expect there to be a proportion of the population who will not say yes, even at zero prices. The implication is that the response function does not approach unity at zero value, but some lower value. This is illustrated in Figure 3.2, where 10% of the population are assumed to be indifferent. The presence of such a spike in the distribution will alter both mean and median measures of average WTP. The mean WTP is still given by the area under the function and the median will be the value that yields a 50% probability of acceptance. But note that if the level of indifference is high enough, the median WTP may be zero i.e. if 60% of the population are indifferent to the change, then one identifies a less-than 50% acceptance of the change for any infinitesimal positive value.

Figure 3.2: The Response Function, with Indifference



Double-bounded estimation

It is now common in discrete CV choice models to include an additional valuation question after the first. Thus, if the respondent gives a 'yes' to the initial question, they are presented with a follow-up question with a higher value. Those that give a 'no' are presented with a lower value in the follow-up. This additional information can then be used in the regression model to give greater precision to the estimate of the underlying parameters of the response function. Such 'double-bounded' survey designs require a more complex estimation process, to account for the two responses that have been given by each person. It also raises an issue of consistency. One would expect that the conditions governing the answer to the second question would be the same as those governing the first: that the respondent has a set of preferences for the product, and these govern the choices that they make. However, there is an extensive literature which suggests that the revealed behaviour may not be consistent across the two choices. In particular, there may be a 'starting point' bias induced on the second question by the response to the first. The causes of this phenomenon (e.g. surprise, resentment, guilt) have been speculated upon (see Hanemann and Kanninen, 1999), but the most significant implication is that the identification of the appropriate valuation of the good under consideration may be confused by the existence of two response functions, one for each response. It is therefore important to test for consistency across the two questions within the double-bounded model. The approach taken here follows that of Cameron and Quiggin (1994) who estimate bivariate probit models for the two responses made, starting with the assumption that preferences differ across the two choices, and then formally testing whether they are the same.

One can categorise the possible responses into 4 groups: yes-yes, yes-no, no-yes and no-no. Analogous to the probit model, the probability of each of these responses can be defined as:

$$\Pr(\text{'yes-yes'}) = 1-\Phi[f(V)] - \Phi[f(V_u)] + \Phi[f(V),f(V_u);\rho]$$
$$\Pr(\text{'yes-no'}) = \Phi[f(V_u)] - \Phi[f(V),f(V_u);\rho]$$
$$\Pr(\text{'no-yes'}) = \Phi[f(V)]- \Phi[f(V),f(V_d);\rho]$$
$$\Pr(\text{'no-no'}) = \Phi[f(V),f(V_d);\rho]$$

Where $f(V)$ is the function associated with the first response, and $f(V_u)$ and $f(V_d)$ are the functions associated with the second round, higher and lower responses respectively. $\Phi[f(V),f(V_u);\rho]$ is a bivariate normal distribution, with correlation coefficient ρ. It is possible to specify the functions for the first and second rounds as independent functions, and then formally test to see if they are equivalent to each other. If it is the case that both functions are equivalent, and $\rho=1$ then there is an identical WTP distribution generating both responses.

Having set out the underlying theory and the estimation methods for the two core economic analytical methods used in this study, the next Section of the report sets out the various stages of the research process. Following that, the findings of the study are presented in Sections 5 through to 9.

Section 4 The Research Process in this Study

The research process comprised a series of stages:

- Literature Review
- Refinement of research questions
- Interviews on purchase decisions, testing of definitions and associated revisions
- Pilot Survey and associated revisions
- Main Survey:
    - Main Survey Phase I – initial preliminary check on results from choice sets and CVM questions and associated revisions
    - Main Survey phase II

The output of the literature review was contained in Section 2. The subsequent stages of the research process are described below.

4.1 Refinement of research questions

The original focus of the project was on two discrete research questions concerned with GMOs in food:

- Estimating the benefits of a reduction in GM labelling threshold levels
- Estimating the benefits of increasing the robustness of the labelling regime

Following discussions with DEFRA, a third element was included in the research, namely to analyse consumer reactions to changes in the proportion of their food items containing GM ingredients.

On the basis of the literature review (Section 2), past choice modelling work by the authors in this area, and discussions with the market research company researchers, it was decided that these issues should be explored in slightly different ways within the choice modelling framework.

One of the issues to be decided when analysing consumer responses to changes in the composition of their food, for example the presence of GM or GM-derived ingredients, is how this food is to be described. For example, is one to consider food in general ("the weekly food shop") or a specific food item? It was decided to deal with the 3 research issues identified above using different options in this regard.

Specifically, in assessing valuations of the increased robustness of the GM labelling regime (to require labelling of products containing ingredients derived from GM crops but not containing altered genetic material) it would be difficult to convey the issue meaningfully to respondents in terms of the "average" food product or basket of goods. It was thought that the distinctions between GM, GM-derived ingredients and non-GM food was more amenable to explanation in the context of a specific good.

The chosen good should be one with which everyone was familiar, which everyone included in their food shopping and for which the notion of GM crop ingredients, as well as ingredients derived from GM crops but free of altered DNA, was meaningful. Bread was chosen as it fitted all these requirements. Specifically, it was possible to explain GM and GM-derived ingredients using bread since it may contains grain from GM crops and/or refined oil processed from GM crops. This questions surrounding label robustness and GM derived products was therefore examined by looking at responses to changes in the composition of the respondents' bread.

For the analysis of the benefits of a reduction in GM labelling threshold levels, it was decided that the concepts involved were suitable for a scenario in which food was described in general terms. Hence when describing and evaluating changes in the threshold at which GM labelling is required, the focus was on the household's weekly food purchases.

Similarly, describing and analysing consumer reactions to changes in the proportion of the household's food items containing GM ingredients was, obviously, suitable for description in terms of the household's weekly food.

In order to undertake the choice modelling work it was therefore necessary to convey information regarding the following key concepts:

- Distinctions between GM, GM-Derived and Non-GM food
- Threshold levels at which food with low levels of adventitious GM content requires a label
- Household food with varying levels of food containing GM ingredients

In addition, given the use of a specific food product, bread, information was required on attributes of bread (other than price and the GM or otherwise nature of its ingredients) which shape the consumers' purchase decision. Similarly, other attributes were required in order to establish meaningful choice sets for the analysis of responses to changes in label thresholds and to changes in the percentage of food products that contain GM ingredients. To this end, a series of semi-structured interviews were undertaken by a food psychologist in different parts of the UK.

4.2 Interviews on purchase decisions and testing of definitions.

Eight individual (face to face) depth interviews with main household shoppers were undertaken to address the following objectives:

- to understand in detail what are shoppers primary concerns when buying food
- to ascertain the respondent's level of understanding of technical phrases, such as 'GM', 'GM-derived', 'Non-GM' and 'GM free' and how consumers could be helped to understand these terms.
- to evaluate and improve definitions for such terms.
- to identify additional attitudes which may be relevant to the subsequent questionnaire.

In order to gauge respondents' understanding of different aspects of GMOs and food, they were presented with a series of alternative descriptions and examples of GM related terms. Explaining genetic modification in a concise yet accurate manner is a difficult task, particularly given the strong reactions the use of the technology generates among some sections of the population. In addition this research required the explanation of a number of related complex

terms concerning derivatives of GM crops, threshold levels for labelling, and so forth. Alternative definitions and explanations were presented to interviewees on the following issues:

- **What is Genetic Modification (GM)?**
- **What is GM Food?**
- **What is GM-Derived Food?**
- **What is Non-GM Food?**
- **What is GM-Free Food?**

Over the course of the interviews the definitions and examples used were revised. This sometimes required a rather radical re-think of the information the researchers had initially thought would be most suitable. For example, it was thought that use of the term DNA should be avoided to try an avoid and excessive level of scientific terminology and complexity. As a result an initial definition of food derived from GM crops included the following:

GM Derived Food
Involves GM processes or ingredients but contains *no GM material*
For example:

- Oil derived from GM maize is identical to oil from conventional maize: the difference is in the plant from which it has been made.

Interviewees identified a series of questions including "*What is meant by GM processes?"* and *"What is GM material?" a*nd a discussion regarding genetic material, genes, DNA and processing ensued.

A process of revision and testing resulted in the removal of the term "GM material" and including the term DNA. For example:

GM-DERIVED FOOD

- Food with ingredients that come from a GM crop, where the ingredient has been processed to such an extent that the DNA is broken into fragments.
- It's no longer possible to detect that the ingredient has come from a GM source.

For example:

- *Soy oil, made from GM Soya beans, can't be distinguished from soy oil made from non-GM beans.*
- *Corn oil, made from GM corn, can't be distinguished from corn oil made from non-GM corn.*

This process continued regarding the various definitions and examples related to GM food.

In addition to this testing and iterative revision of definitions, terminology and examples, interviewees were asked to discuss the factors that shape their regular bread purchase decisions. As a result of these interviews the factors that were identified as suitable for inclusion as attributes, alongside price and GM type, in the bread choice sets were 'Shelflife' and 'Fibre Content'.

4.3 Choice Set Design

The research addressed three distinct issues concerning GMOs in food. As a result there were 3 streams of choice sets and parallel contingent valuation (CV) questions. It was deemed an excessive demand on interviewees to address all three issues and hence the survey was split. All respondents were presented with bread choice sets and CV questions concerning GM, GM-derived and non-GM food. Half the respondents were presented with GM label threshold choice sets and CV questions. Half the respondents were presented with choice sets and CV questions concerning the proportion of their food items containing GM ingredients.

A schematic plan of the survey, incorporating this split-structure is shown in Table 4.1 which is followed by a description of the attributes and levels for the 3 types of choice sets.

Table 4.1: The Survey Structure

Stream	A	B
Numbers	300	300
Bread	Yes	Yes
Label Thresholds	Yes	
Overall GM Content		Yes

4.4 Attributes and Levels

Following the literature review, discussions with the market research company representatives, the semi structured interviews and the pilot interviews (discussed below) the following choice set attributes and levels were used:

4.4.1 Bread

Attribute	Levels
Price (%)	-67, -50, -33, -17, Usual, +17, +33
GM Type	Non-GM, GM-Derived, GM
Shelflife	Usual, Usual + 1 day, Usual + 2 days, Usual + 3 days
Fibre Content	Usual, Usual + 10%, Usual + 30%, Usual + 50%

A typical bread choice set took the form:

	Bread 1	Bread 2	Bread 3
	Usual brand	**Usual brand - alternative option 2**	**Usual brand - alternative option 3**
Price	**100%**	**100%**	**-50%**
GM Type	**Non-GM**	**GM-Derived**	**Non-GM**
Shelflife	**Usual shelflife**	**Usual shelflife**	**Usual +2 days**
Fibre Content	**Usual fibre content**	**Usual +30%**	**Usual +10%**
Which bread do you prefer ? (tick one ➳)	□	□	□

4.4.2 GM Label Threshold

Attribute	Levels
Cost (weekly food bill, %)	-50, -40, -30, -20, -10, Usual, +10, +20
GM content allowed before label needed (%)	0, 0.5, 0.9, 1, 2, 5
Amount of food with pesticide residues (%)	0, 5, 10, 30, 50, 100
Food Origin	Anywhere, Mainly Europe, Mainly UK

A typical label threshold choice set took the form:

	FOOD BASKET 1	FOOD BASKET 2	FOOD BASKET 3
	Usual basket	**Alternative basket - option 2**	**Alternative basket - option 3**
Cost (weekly food bill)	**100%**	**-20%**	**+10%**
GM content allowed before label needed (%)	**1%**	**5%**	**0%**
Amount of food with pesticide residues	**Usual level (30%)**	**0%**	**Usual level (30%)**
Food Origin	**Any**	**Mainly Europe**	**Mainly UK**
Which do you prefer ? (tick one ➳)	□	□	□

4.4.3 Proportion of Food containing GM Ingredients

Attribute	Levels
Cost (weekly food bill, %)	-50, -40, -30, -20, -10, Usual, +10, +20
% of food products that contain GM ingredients	0, 1, 25, 50, 80, 100
Amount of food with pesticide residues (%)	0, 5, 10, 30, 50, 100
Food Origin	Anywhere, Mainly Europe, Mainly UK

A typical GM content choice set took the form:

	FOOD BASKET 1	FOOD BASKET 2	FOOD BASKET 3
	Usual basket	**Alternative basket - option 2**	**Alternative basket - option 3**
Cost (weekly food bill)	**100%**	**-20%**	**+10%**
Percentage of food products that contain GM ingredients (%)	**1%**	**100%**	**0%**
Amount of food with pesticide residues	**Usual level (30%)**	**0%**	**Usual level (30%)**
Food Origin	**Any**	**Mainly Europe**	**Mainly UK**
Which do you prefer ? (tick one ➳)	□	□	□

4.5 Questionnaire Structure

The questionnaire comprised a series of sections, with the following overall structure:

- **Introduction**
- **Attitudinal Questions**
- **Factual Questions regarding Biotechnology**
- **Bread Choice Sets & associated CV Questions**

Either:

- **Label Threshold Choice Sets & associated CV Questions**

Or:

- **Overall GM Content Choice Sets & associated CV Questions**

- **Referendum Questions on Testing, Field Trials & Commercial Growing**
- **Collection of Demographic Information**

Given the need to avoid overloading respondents, the attributes and levels described above and the choice set statistical design, each of the three choice set sections was split into three groups of 4 choice sets. Each of the 600 respondents was therefore presented with a total of 8 choice sets, as is indicated in the schematic outline in Table 4.2

Table 4.2: Questionnaire Structure

Stream	**A**			**B**		
Group	**A1**	**A2**	**A3**	**B1**	**B2**	**B3**
Numbers	100	100	100	100	100	100
Bread Choice Sets	4	4	4	4	4	4
Label Threshold Choice Sets	4	4	4			
GM Content Choice Sets				4	4	4

4.6 Piloting

The next stage in the survey process was piloting the questionnaire amongst a sample of 16 main household shoppers, from differing socio-economic backgrounds. These interviews were done by professional market research interviewers, and in each case a researcher was present.

The pilot interviews yielded data that could be used for initial analysis, allowing the choice sets and contingent valuation questions to be evaluated. In addition there was a discussion and de-brief with each interviewee in order to identify areas of confusion or lack of understanding. In addition to general issues of understanding, vocabulary, etc., some specific questions were addressed in this piloting phase:

- How long each question takes and how long the questionnaire as a whole takes to complete
- What respondents understand the purpose of the survey to be (specifically, how would they describe it to a friend?)

- What they understand to be the actual meaning of each question (in order to gauge whether the questions actually measure what they are supposed to measure)
- What were particular areas of difficulty (e.g. specific questions or general comprehension, etc.)
- Whether the vocabulary used throughout is easy to understand (and to elicit alternative ways of expressing meaning where appropriate).

The view of the market research company and the principal investigators was that while the pilots were extremely useful in fine tuning the questionnaire, the interviews generally worked well in terms of (i) interview length and (ii) interviewee comprehension. The process threw up interesting and unexpected sources of confusion on the part of some respondents, but the revisions that were implemented largely concerned descriptions, presentation, and terminology rather than the substantive core of the questionnaire. In addition to the feedback from the pilot interviews, comments were received on the draft questionnaire from the Peer Reviewer of the project, as well as from DEFRA representatives.

Specific Issues which emerged during the Pilot:

1. The length of questionnaire

Despite initial concerns regarding the length of the draft questionnaire this did not prove a problem. Given that the main survey was to administered using CAPI (computer-assisted personal interviews), completion times were expected to be even quicker than those of the pilots.

2. Cognitive capacity of respondents

Although in general respondents in the pilots appeared to understand what was required of them in completing the choice sets, it was felt that some would benefit from having some practice before completing the core choice sets the data from which were to be used in subsequent analysis.

Two practice choice sets were therefore inserted before the core choice sets were presented. The first was a trivial example asking interviewees to choose a car from two options each with different attributes (price, colour, engine size and air conditioning), the second was a bread example which led into the core bread choice sets.

3. Changes to the choice sets.

The bread choice sets, which dealt with GM, GM-derived and non-GM ingredients, were initially specified with a 'status quo' bread choice, always available to respondents. Whilst the attribute levels for **GM Type** (non-GM), **Shelflife** (usual) and **Fibre Content** (Usual) for this status quo option were apparent, the price was more problematic. This baseline loaf was initially specified as a standard white sliced loaf of bread, with a price of 60p. This proved unsatisfactory. It became apparent that there was a wide variety in the types of bread bought, and therefore considerable variation in the price of the 'status quo' loaf.

In order to avoid the problem that the respondent may not normally pay the 'average' price for a loaf of bread (60p) a question was added asking what price the respondent usually paid for their bread and this was used as the basis of all the prices in the subsequent bread choice sets, in the same way that the household's weekly food bill was used as the basis of all costs and discounts in the other two choice set sections.

In addition, because of a tendency in the pilots for people to choose the status quo bread repeatedly, added emphasis was added to the questionnaire that all breads presented were variants of the respondents' current bread.

4.7 The Survey

The survey was conducted in England, Wales and Scotland between July and September 2003. The sample was defined as men and women, aged 16 and over who were the main shopper for their household. Main shopper is defined as those who personally select half or more of the items bought for their household from supermarkets and food shops.

The survey was conducted using *Random Location Sampling.* This proceeded as follows: firstly regions were stratified so that the number of sampling points in each region matches the proportion of the population living in each region. Then within each region Enumeration Districts (EDs) were selected at random. This selection is cross-checked with the ACORN

geodemographic classification system to ensure that the EDs selected are not skewed and corrections made, if necessary.

Interviewers are given all the addresses in the ED and instructed to start at a particular address and to skip 3 houses after achieving an interview. Quotas were set on working status, sex and age. Social class quotas were deemed unnecessary given the use of the ACORN system. Seventy different sampling points were used with a requirement for 9 interviews within each Enumeration District. A sample comprising 608 respondents was achieved.

Personal interviews were conducted in the home using CAPI (computer aided personal interviews). The use of CAPI allowed the statistical design of the choice sets and the contingent valuation questions in which changes in price were specified as percentage changes from baseline bread prices and household food bills to be converted into respondent-specific cash amounts on the basis of the interviewee's answers.

In addition, CAPI allowed certain questions to be asked only of certain people. For example, if someone always chose a non-GM option in the bread choice sets, the system would prompt for a de-brief question on why this was the case only for these people.

The survey was structured to have a break when 200 interviews were completed. This allowed the principal investigators the opportunity to conduct some basic analysis of the choice set and CV results and to make any changes deemed necessary before the subsequent 400 interviews were conducted. This process yielded some minor changes to the choice set attribute levels. For example in the bread sets, the price attributes were modified to include a higher price increase of 33% rather than the previous maximum of 17%.

There was an additional issue with the bread choice sets which was the incidence of people always choosing the status quo option in these choice sets. On the basis that this may be a brand loyalty issue, despite the existing information specifying that all brand offered were variations on their current brand, an additional statement was inserted before these choice sets reminding the respondent that we were not asking them whether they would switch brand, and that all the breads offered were their current brand.

The only significant change to the questionnaire between Phases I and II of the survey was to the bread CV question. Analysis of the responses to this question regarding discounts to consume the loaf containing GM-derived ingredients indicated very few were prepared to consume despite large discounts, and it was thought by the market research company staff that people were inferring that, given such discounts, the quality of the bread must in some way be inferior and hence were not prepared to consume. In the second wave of the survey, this question was therefore switched to a WTP, rather than a WTA question, i.e. what would you be prepared to pay to secure the non-GM loaf.

This section of the report has set out the research process, leading to the survey which delivered 608 useable responses from main household shoppers in England, Wales and Scotland. The subsequent sections of the report deal with the findings from that survey.

Section 5 General Findings from the Survey: Attitudes, Trust, GM Testing and Commercial Growing

In addition to being presented with choice sets and contingent valuation questions which constitute the core of the questionnaire, other pieces of information were collected.

Respondents were asked for their responses to a number of statements concerning food, biotechnology, regulation and related issues. In this way it was hoped to understand better the attitudes within the sample. A series of referendum style questions on GM crop testing, commercial growing, and GM food labelling were asked. Finally, a series of factual questions regarding biotechnology and policy, some taken from the survey Eurobarometer, were asked.

5.1 Attitudes

Respondents were asked to give their responses to a number of statements concerning food, shopping, biotechnology, regulation and related issues. In this way it was hoped to better understand the average attitudes within the sample as well as variation in them across different social groups.

The format of this section of the questionnaire was of the form:

	Strongly disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Strongly agree
Statement					

with interviewees asked to indicate which of the 5 possible responses most accurately reflected their views. Here the focus is on responses to 12 of the attitudinal statements. The distribution of responses to these statements are presented in Figures 5.1(a) to 5.1(l).

Figure 5.1: Attitudes in the Sample

Figure 5.1a

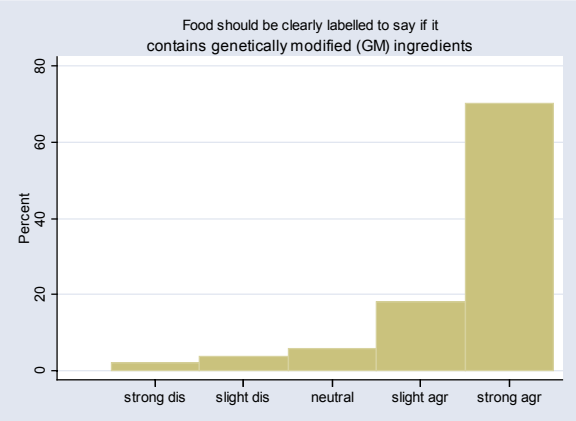


Figure 5.1b

Figure 5.1c

Figure 5.1d

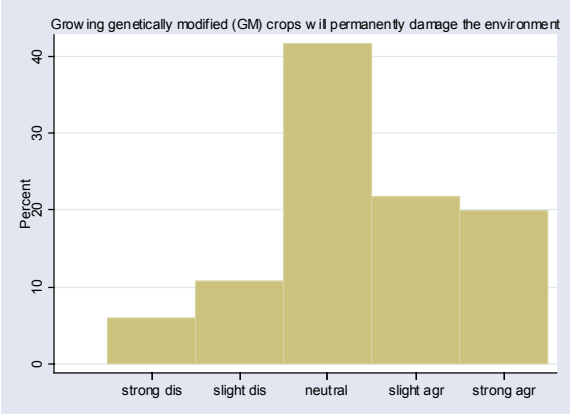


Figure 5.1e

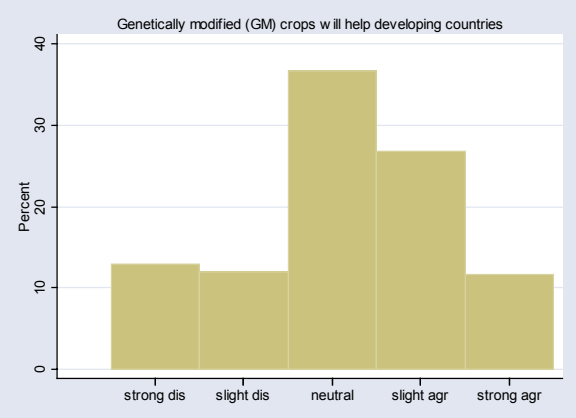


Figure 5.1f

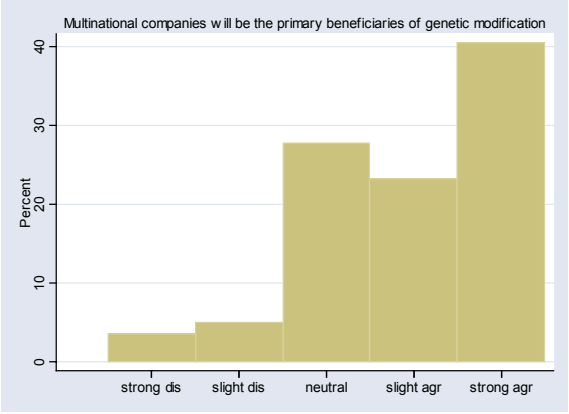


Figure 5.1g

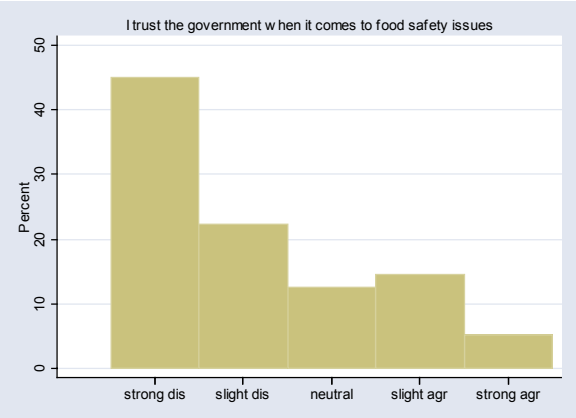


Figure 5.1h

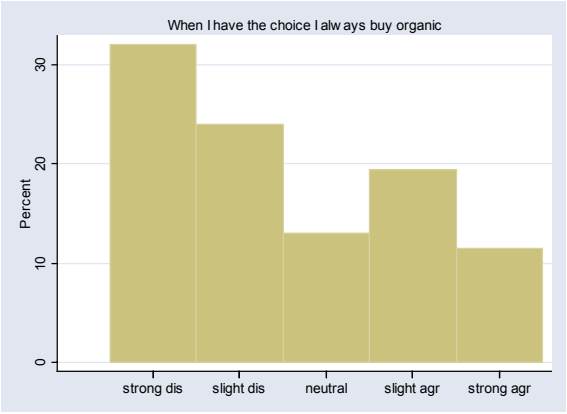


Figure 5.1i

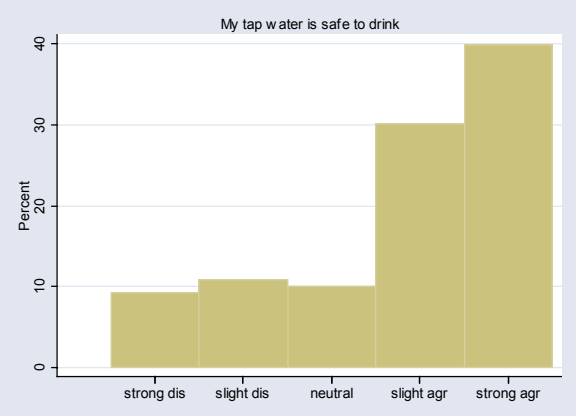


Figure 5.1j

Figure 5.1k

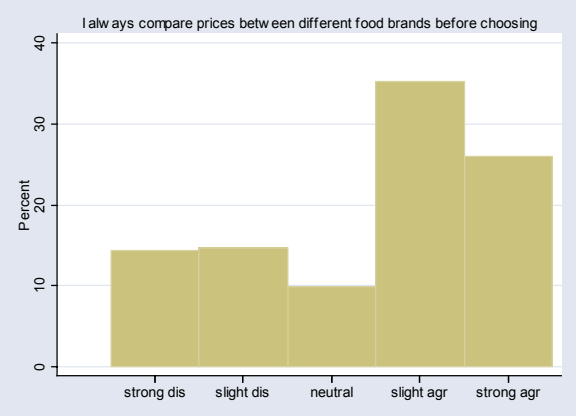
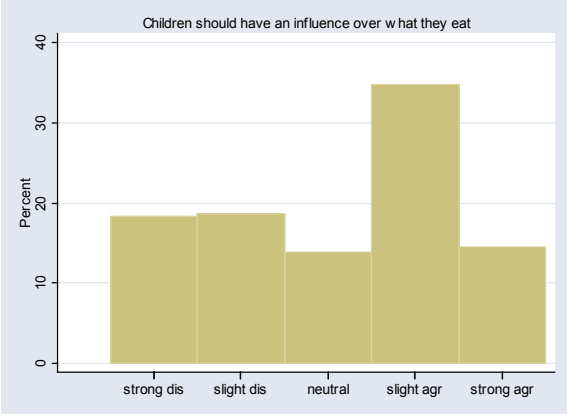


Figure 5.1l



There are a number of striking features. The majority of respondents (88%) think[22] food should be clearly labelled where there are GM ingredients but only 57% say they read food labels carefully. Most (61%) always compare prices when food shopping and claim more interest in ethically responsible products (56%) than in organic foods (31%). Over a third (35.4%) do not believe that GM food is safe to eat.

On the impact of GM crops, 41.6% of the sample think they will permanently damage the environment, while the same percentage are non-committal. 38.5% think that the developing countries will benefit but a similar number (36.7%) are equivocal. What is clearer is that most (63.7%) believe that multinational companies will be the primary beneficiaries of the development of GM food. This pattern mirrors the views identified in the GM Nation? consultation and is consistent with the findings of Marris *et al*., (2001) regarding the distribution of benefits from the development of GM food. Of the 608 people in the sample, 67% said they did not trust the government on food safety issues with only 20% indicating they did trust the government on this issue.

It has been noted in the literature[23] that attitudes to food safety and environmental issues may vary with income and it would have been interesting to explore the relationship between attitudes and income class in this dataset. However, a large number (160) of respondents chose not to provide information on their household income, thus reducing the value of such an investigation. Nevertheless, the data on income class (which was coded in the way presented in Table 5.1) were closely correlated with social group (Table 5.2). As there was a full dataset on respondents' social group, the relationship between attitudes and social group could be explored in some detail.

[22] Those answering "strongly agree" and "slightly agree".
[23] More specifically, it is usually posited that the demand for food safety and environmental quality increases with income. See, for example, Swinbank (1993), Kinsey (1993), and Freeman (1979).

Table 5.1: Income Classes

	Code
Up to £6,499	1
£6,500 - £11,499	2
£11,500 - £17,499	3
£17,500 – £24,999	4
£25,000 - £34,999	5
£35,000 - £44,999	6
£45,000 - £54,999	7
£55,000 - £74,999	8
£75,000 - £99,999	9
£100,000 – £124,999	10
£125,000 – £149,999	11
£150,000 – £199,999	12
£200,000+	13
Refused	-1

Table 5.2: Declared Income Class by Social Group

Social group	No.	Mean	s.d.	min.	max.
AB	87	6.14	2.21	1	10
C1	138	4.18	1.90	1	12
C2	103	3.56	1.62	1	8
D	67	3.18	1.66	1	9
E	52	1.75	0.84	1	5

Using the Kruskal-Wallis test[24] of equality of populations, we find significant differences by social group for 7 of these 12 attitudes discussed above. The variation in mean scores for these seven attitudinal variables is shown in Table 5.3.

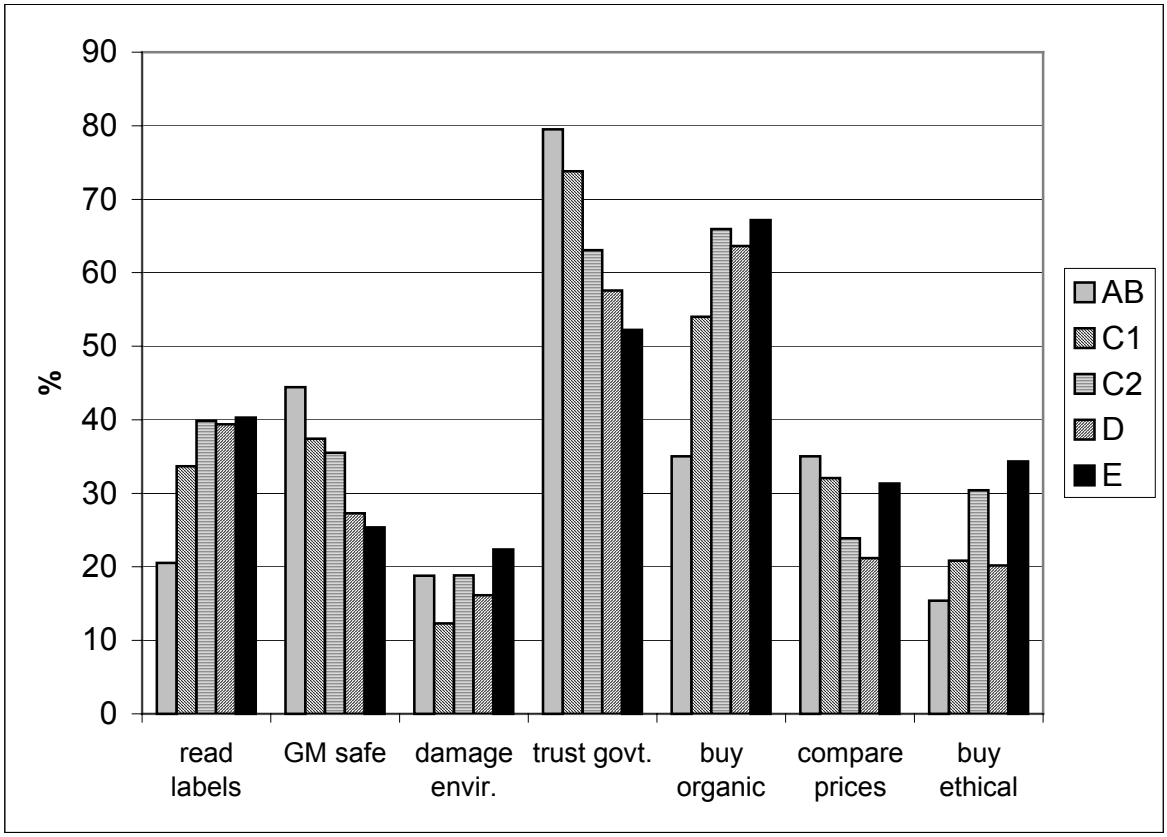
[24] The Kruskal-Wallis test is a generalisation of the Mann-Whitney test for 2 sub-samples.

Table 5.3: Mean Scores on Attitude Statements by Social Group*

	Social Class				
	AB	**C1**	**C2**	**D**	**E**
I read ingredients labels very carefully	3.78	3.38	3.12	3.07	3.04
GM food is safe to eat	2.47	2.66	2.74	3.01	3.01
GM crops will permanently damage the environment	3.52	3.50	3.30	3.35	3.09
I trust the government on food safety issues	1.74	1.98	2.25	2.39	2.55
When I have the choice I always buy organic	3.16	2.62	2.26	2.27	2.22
I always compare prices between different food brands	3.20	3.30	3.57	3.73	3.54
When I have the choice I always try and buy ethically responsible products	3.73	3.52	3.26	3.47	3.12
* responses can range from 1 “strongly disagree” to 5 ”strongly agree”					

The differing distribution of attitudes by social group is illustrated in Figure 5.2, which presents the proportion in each social group who slightly or strongly *disagree* with each of these statements. A higher proportion of the AB and C1 groups read labels carefully, choose organic and ethically responsible products, are less concerned with making price comparisons, have less trust in the government on food safety issues, and are less confident of the safety of GM food.

Figure 5.2: Proportions slightly or strongly dis*agreeing* with the statement, by Social Group



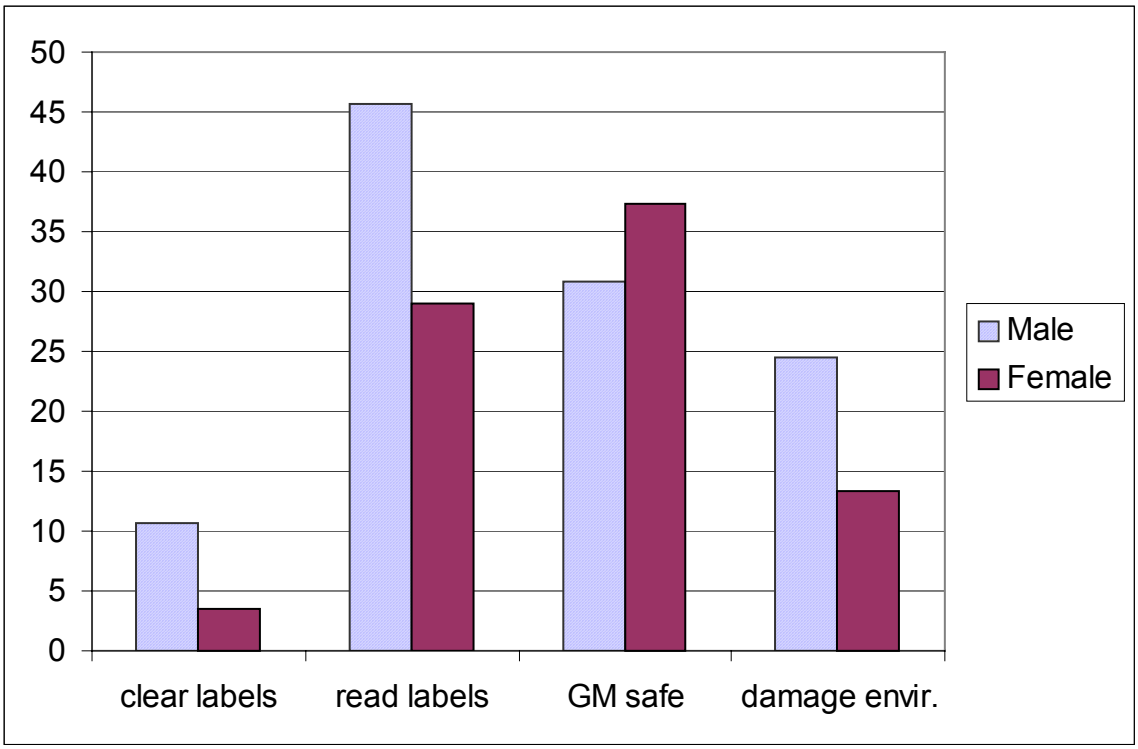
In addition to these differences across the social classes, some attitudes were found to also differ significantly between male and female respondents. Specifically, on the basis of a Mann-Whitney test of equality of populations by gender, we reject the null hypothesis of equality for 4 of the 12 attitudinal questions being considered here. The differences in mean scores are illustrated in Table 5.4.

Table 5.4: Mean Scores on Attitude Statements by Gender*

	Male	**Female**
Food should be clearly labelled if it has GM ingredients	4.33	4.59
I read ingredients labels very carefully	2.90	3.49
GM food is safe to eat	2.90	2.66
GM crops will permanently damage the environment	3.16	3.49
* responses can range from 1 “strongly disagree” to 5 ”strongly agree”		

Figure 5.3 presents the proportion of respondents, by gender, slightly or strongly *disagreeing* with each of the statements which were found to generate statistically different responses. Fewer males were concerned about food labelling, considered GM food unsafe and believed that GM crops would permanently damage the environment.

Figure 5.3: Proportions slightly or strongly *disagreeing* with the statement, by Social Group



5.2 Responses to 'referendum' questions

To gauge the views of respondents on some broad, policy-relevant GM issues, a set of four "referendum" questions were put to them (after all choice sets and contingent valuation questions had been answered). The questions, answer formats and the percentage selecting each option are shown in Table 5.5.

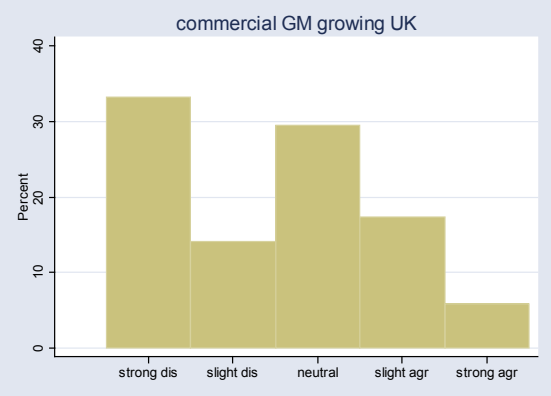
Table 5.5: Referendum Questions and the distribution of responses (%)

	Strongly disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Strongly agree
The growing of GM crops for commercial sale should be allowed now in the UK	33	14	29	17	6
If GM crops are to be grown for commercial sale in the UK, more testing needs to be done first	2	3	10	20	65
Ideally, all work on GM crops, including testing, should be stopped	20	28	26	10	15
GM food is currently available for sale in the UK if labelled, how much do you agree or disagree that GM food should be available to buy?	18	12	28	31	12

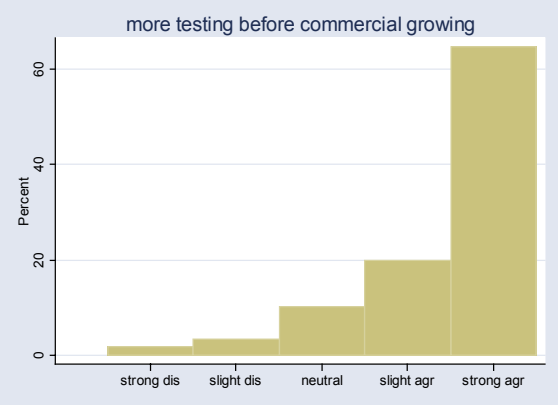
Figures 5.4a – 5.4d show the patterns of answers given. Only 25% of respondents thought that all GM research should stop but a large majority (85%) felt that there should be more testing before commercial growing of GM crops should be allowed. Less than a quarter of the sample (23%) felt that commercial growing of GM crops should be allowed in the UK at the time of interview. Moving from testing and commercial growing in the UK to the sale in UK shops of GM food (wherever it is grown), almost 43% of respondents thought that GM food should be available to buy if it were clearly labelled.

Figures 5.4a – 5.4d: Referendum Question Responses

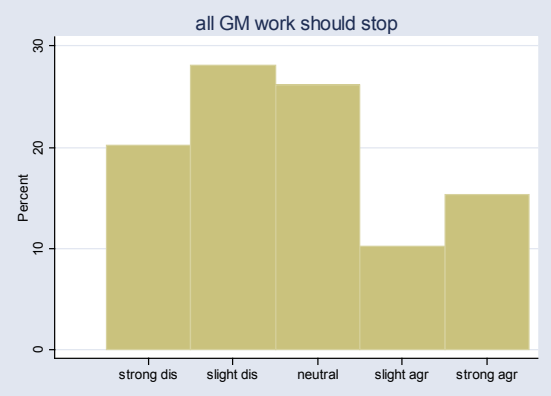
Figures 5.4a



Figures 5.4b



Figures 5.4c



Figures 5.4d

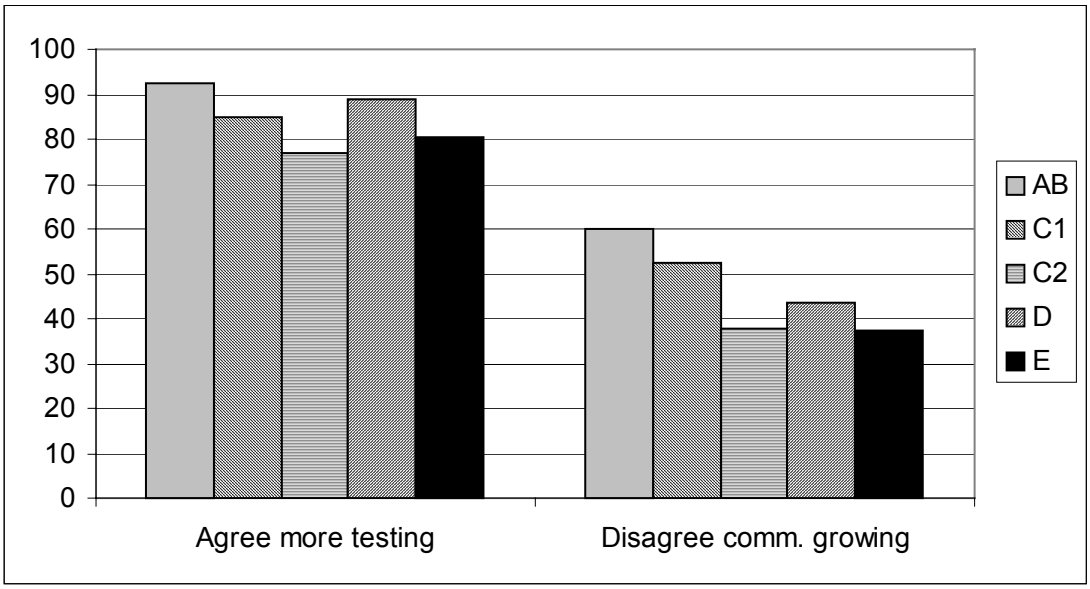
The pattern of responses to two of these 'referendum' questions (more testing before commercial growing; commercial GM growing in UK) was found to be significantly different between social classes. The mean scores for these two questions for each social class are shown in Table 5.6.

Table 5.6: Mean Scores on Referendum Questions by Social Group*

	AB	C1	C2	D	E
If GM crops are to be grown for commercial sale in the UK, more testing needs to be done first	4.58	4.44	4.26	4.47	4.36
The growing of GM crops for commercial sale should be allowed now in the UK	2.17	2.37	2.68	2.59	2.81
* responses can range from 1 "strongly disagree" to 5 "strongly agree"					

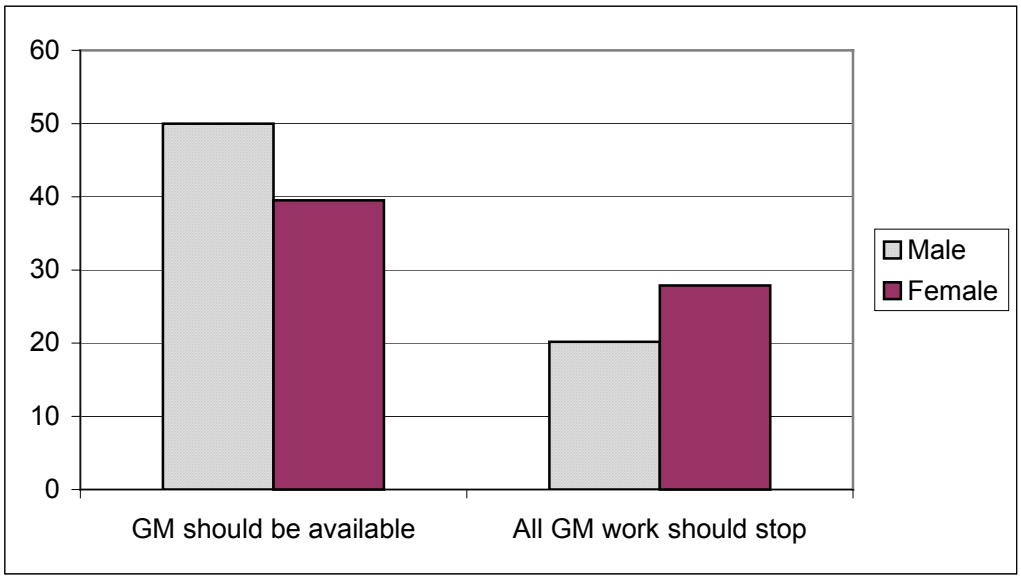
As further indication of social class differences in this regard, Figure 5.5 shows the percentage of respondents in each class slightly or strongly *agreeing* that "if GM crops are to be grown for commercial sale in the UK, more testing needs to be done first" and slightly or strongly *disagreeing* that "the growing of GM crops for commercial sale should be allowed now in the UK".

Figure 5.5: Responses to Referendum Questions, by Social Class



Significant gender differences in the pattern of responses to two of the referendum questions were also found. These differences are shown in Figure 5.6, with males more likely to agree that GM food should be available to buy if clearly labelled and less likely to agree that all GM testing should stop.

Figure 5.6: Significant differences in referendum responses by gender



5.3 Trust regarding information about GM

Respondents were asked to what extent they felt they could trust[25] information about GM from a variety of sources including different news media, firms, environmental groups, universities and the government (see Figure 5.7(a) – 5.7(j)).

These clearly show that few respondents had trust in the government or firms on GM issues (60.4% definitely or probably did not trust the government, 61.2% did not trust firms). Universities and environmental groups are however trusted in the main (68.3% and 56.3% respectively would probably or definitely trust them). In terms of the media, most respondents trust TV documentaries and the broadsheets (57.7% and 68.3% respectively) but 66.9% do not trust the tabloid press. Only this latter finding varies significantly by social class with those in social groups A, B and C1 on average less confident about GM information from tabloid newspapers. No significant gender difference were identified regarding the trustworthiness of these various sources of information on GM.

[25] With the notable exception of game theorists, economists rarely consider the impact of trust on economic decision-making. In the context of CV analysis, Blamey (1998) and Brouwer *et al.* (1999) consider how trust in the institutional context (and in particular trust in the government and its agents to deliver the proposed change in the non-market good) may affect valuations.

Figure 5.7: Trust regarding Information about GM from Different Sources

Figure 5.7(a)

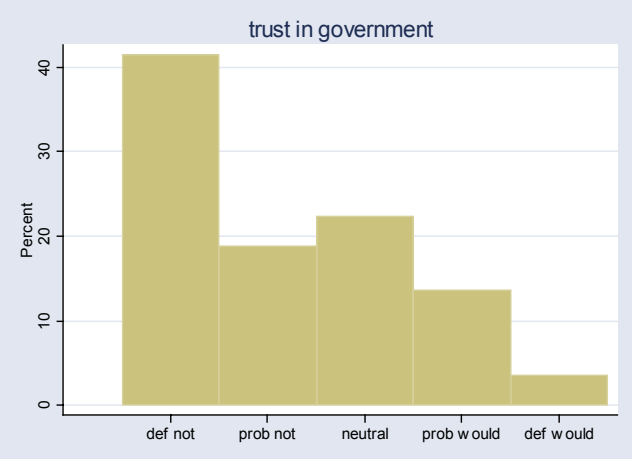


Figure 5.7(b)

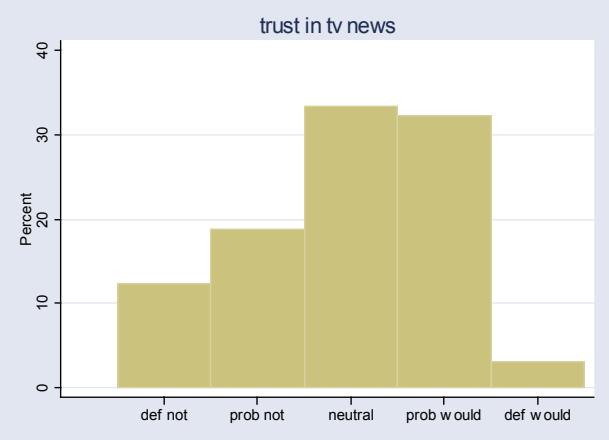


Figure 5.7(c)

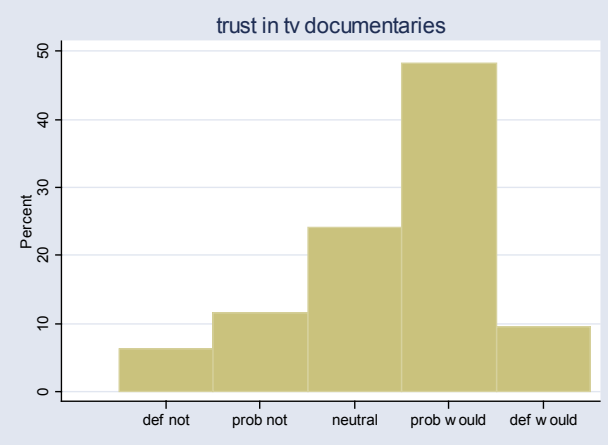


Figure 5.7(d)

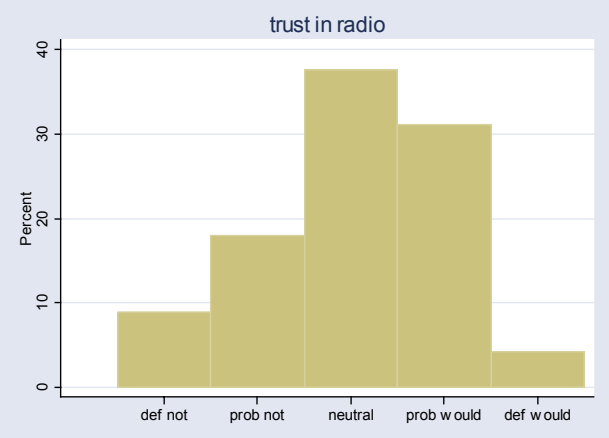


Figure 5.7(e)

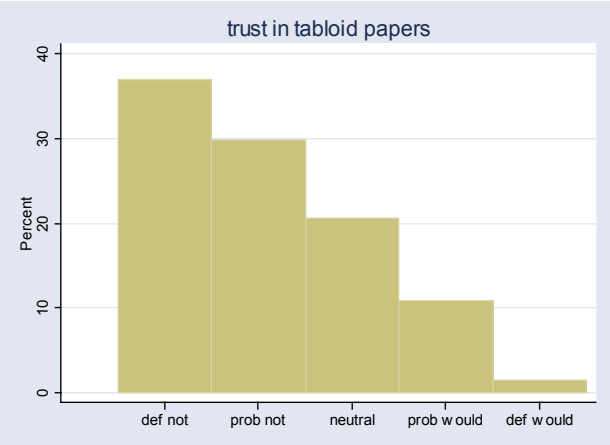


Figure 5.7(f)

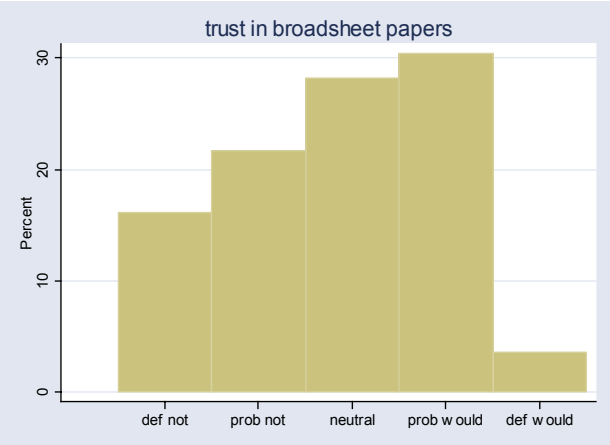


Figure 5.7(g)

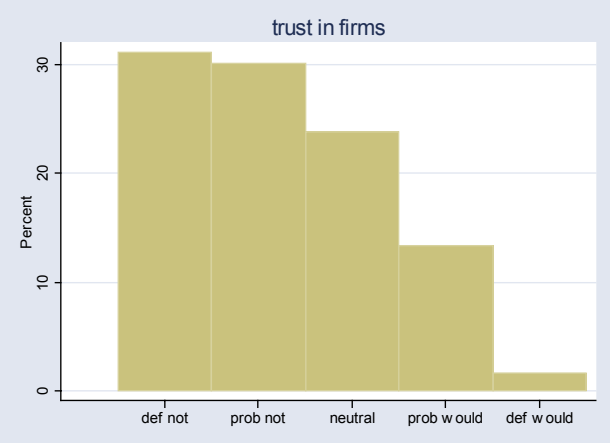


Figure 5.7(h)

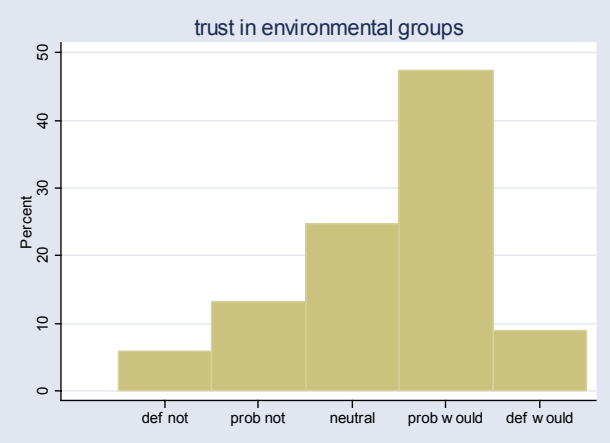


Figure 5.7(i)

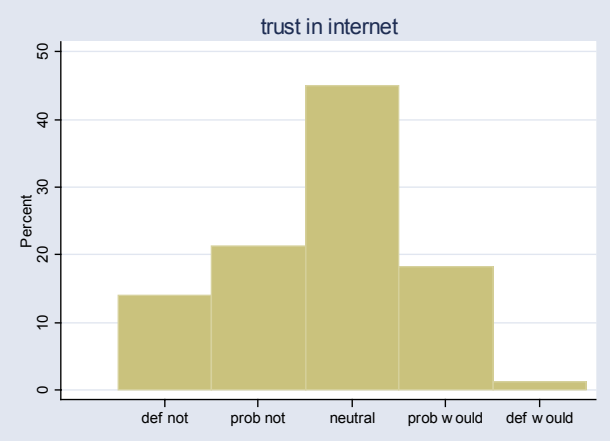
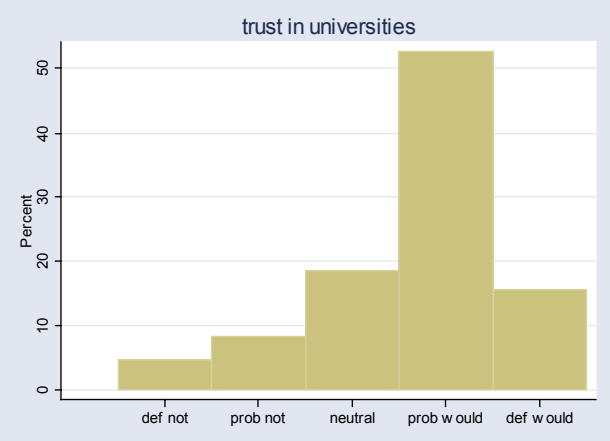


Figure 5.7(j)



5.4 Knowledge of GM Technology

To get some insight into how knowledgeable respondents were regarding GM technology, they were asked whether the following four statements were ‘true’, ‘false’ (respondents could also indicate ‘don’t know’):

1. ordinary tomatoes do not contain genes whereas genetically modified tomatoes do
2. if people eat genetically modified fruit, their genes could also become modified
3. it is possible to transfer animal genes to plants
4. GM crops are grown for commercial sale in the UK at present

The distributions of responses are depicted in Figures 5.8. For the first 3 of these statements, it is clear that there was considerable uncertainty (in each case, over half the sample answered ‘don’t know’), although for those electing to answer, correct responses outweighed incorrect ones. For the final question, almost half the sample gave an incorrect answer, indicating that they thought that GM crops were being commercially grown in the UK at present

Figures 5.8(a) to Figure 5.8 (d): Knowledge of Biotechnology Issues

Figure 5.8(a)

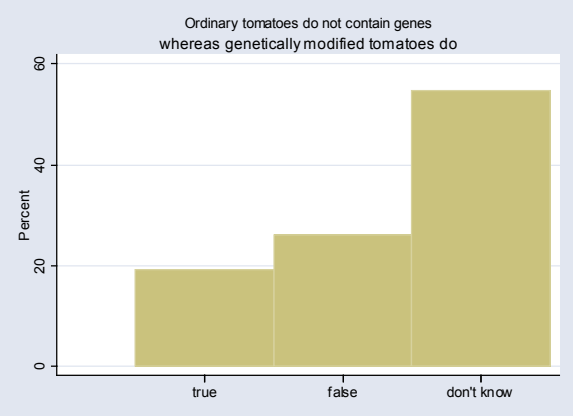


Figure 5.8(b)

Figure 5.8(c)

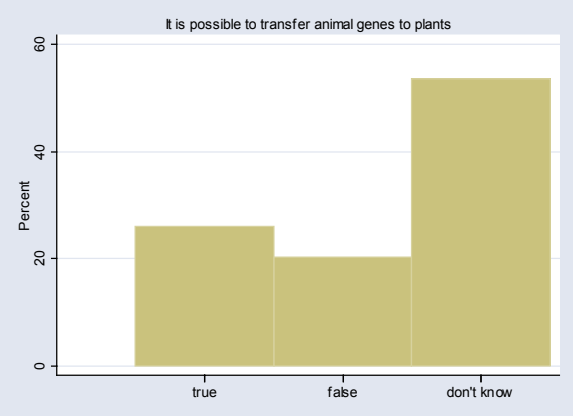
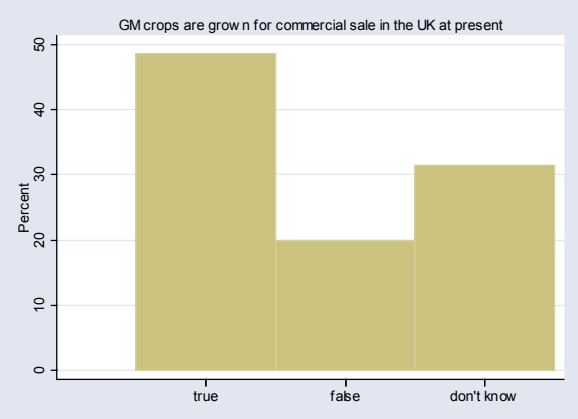


Figure 5.8(d)



The first three[26] of the four knowledge questions used in this survey were also included in Eurobarometer surveys of 1996, 1999 and 2002. Table 5.7 presents the percentage of correct answers in this study in comparison to these Eurobarometer studies . The pattern of responses which emerges is very similar to that in our survey. In our sample 42% and 46% correctly reject the first two statements and 26% correctly state that is possible to transfer animal genes into plants.

[26] Note that the third of these questions is worded slightly differently in this survey.

Table 5.7: Percentage Correct Answers in Past Eurobarometer Surveys & This Study

	1996	1999	2002	This Study
Ordinary tomatoes do not contain genes, while genetically modified tomatoes do	35	35	36	42
By eating a genetically modified fruit, a person's genes could also become modified	48	42	49	46
It is *impossible* to transfer animal genes into plants	27	26	26	26

Source: Gaskell, et al. (2003)

Gaskell et al. (2003) comment on what might be considered a high proportion assenting to the "menacing image propositions" in the first two statements. They argue that "[this] does not necessarily mean that [the respondents] actively held such views before being asked the question in the survey interview. It is likely that many would not have thought about the issue before. Hence, a more realistic interpretation is that when asked these questions about the unfamiliar area of genetics, their general unease and possible anxieties about the technology leads them to assume the worst when asked about specific issues. This is much the same process as stereotyping. If a stereotype as a general evaluation is negative, then the holder is likely to impute negativity to all specific aspects of the object in question, including those of which they were previously unaware".

5.5 Conclusions

We find considerable consistency between the views and attitudes expressed in this study and those which have been found elsewhere. While there are some differences by social class and gender, there are some general assertions that can be made about the views expressed.

People are sceptical of the long term effects of GM crops and also, crucially, of why they should be introduced. The question of "who gains?" is significant. There also appears to be considerable scepticism regarding the information received on GM issues from most sources,-with the only sources of GM information which more than 10% of respondents

say they would ‘definitely trust’ being universities/educational organisations. The government appears to be widely distrusted on both GM and food safety issues.

Most respondents were unconfident regarding the three biotechnology questions they were asked, with most indicating this by simply answering “don’t know” rather than guessing. For 2 of the 3 questions the numbers answering correctly were in line with past Eurobarometer surveys, but for one there is a higher rate of correct answers in this study.

Regarding some of the key GM policy issues of the moment, there were interesting patterns of answers given. Only 23% of those questioned thought that commercial GM crop growing should be allowed in the UK at present, with 85% indicating that they thought that more testing was required if commercial growing was ever going to take place in the UK. Despite this broadly cautious or anti-GM pattern of views, only 25% of interviewees thought that all GM testing should be stopped and 43% thought that GM food should be available to buy in the UK, if clearly labelled, with 28% undecided on this issue.

There are parallels with the results here and some other research, including that by Marris et al, (2001) and the GM Nation? consultation. The findings here support the view that people are not simply 'for' or 'against' GMOs or that they think GM work should simply stop. There is scepticism regarding the nature of the benefits and of the costs and risks, and in terms of who will be the main beneficiaries of the use of the technology. The responses given indicate that people are wary of the information given from most sources regarding GM technology and are not simply malleable ‘victims’ of the media.

These attitudes are reflected in the majority view that commercial growing of GM crops should not proceed in the UK at present, but that further GM testing and should continue and indeed is required before any commercial growing takes place. The more detailed deliberative work in the GM Nation? consultation concluded that:

> “The general theme which emerged from the reconvened discussion groups was a preference for caution: GM technology should not go ahead without further trials and tests (preferably in closed conditions), firm regulation, and, above all, clear and trusted answers to unanswered questions about health and the environment”

These findings, which the authors characterised with the expression “Wait At The Amber” are broadly echoed in the attitudinal sections of this survey.

Section 6 Results: The Robustness of GM Labelling: Bread

In the following Sections of the Report each of the three phases of the main survey are considered in turn, namely:

- Estimating the benefits of increasing the robustness of the labelling regime
- Estimating the benefits of a reduction in GM labelling threshold levels
- Analysing consumer reactions to changes in the proportion of their food items containing GM ingredients.

In this section, the analysis of the benefits of increasing robustness of the labelling regime is reported, with a specific focus on a single commodity, bread. Results from both the choice modelling and contingent valuation approaches are presented and discussed. As some specifications of the models here and in the analysis of the other research questions incorporate composite attitudinal variables generated by a separate factor analysis of selected attitudes, this derivation of these composite variables is presented in Section 6.1.3. The section concludes by highlighting some key findings but a full summary of results and a discussion of their implications can be found in Section 9.

6.1 The Choice Modelling Results

All 608 respondents participated in this phase of the questionnaire dealing with increasing the robustness of the GM food labelling regime. This was analysed using choice sets including different bread options which included distinctions between GM, GM-derived and non-GM ingredients.

There was a non-GM, 'status quo', option available in all bread choice sets presented to respondents. One of the cornerstones of the choice modelling approach is that respondents consider the varying levels of attributes when making their choices. If they do not do this, and instead choose the same option repeatedly whatever the level of attributes in the other options available, then these responses can not contribute to the statistical analysis of how changes in attribute levels affect choices and hence how they are valued.

In the case of the bread choice sets, the number of respondents always choosing the status quo was considerable, as is shown in Table 6.1 with 45% of the sample choosing the current version of their usual brand.

Table 6.1: The 'status quo' issue

	Frequency	Percentage
Choices Vary	334	54.93
Status Quo	274	45.07
Total	608	100.00

The socio-economic characteristics of these two sets of respondents are presented in Table 6.2. Proportionately more of those always choosing the status quo option are from social classes C2, D, and E. Respondents in this group are somewhat older than the rest of the sample and the group contains proportionately more females.

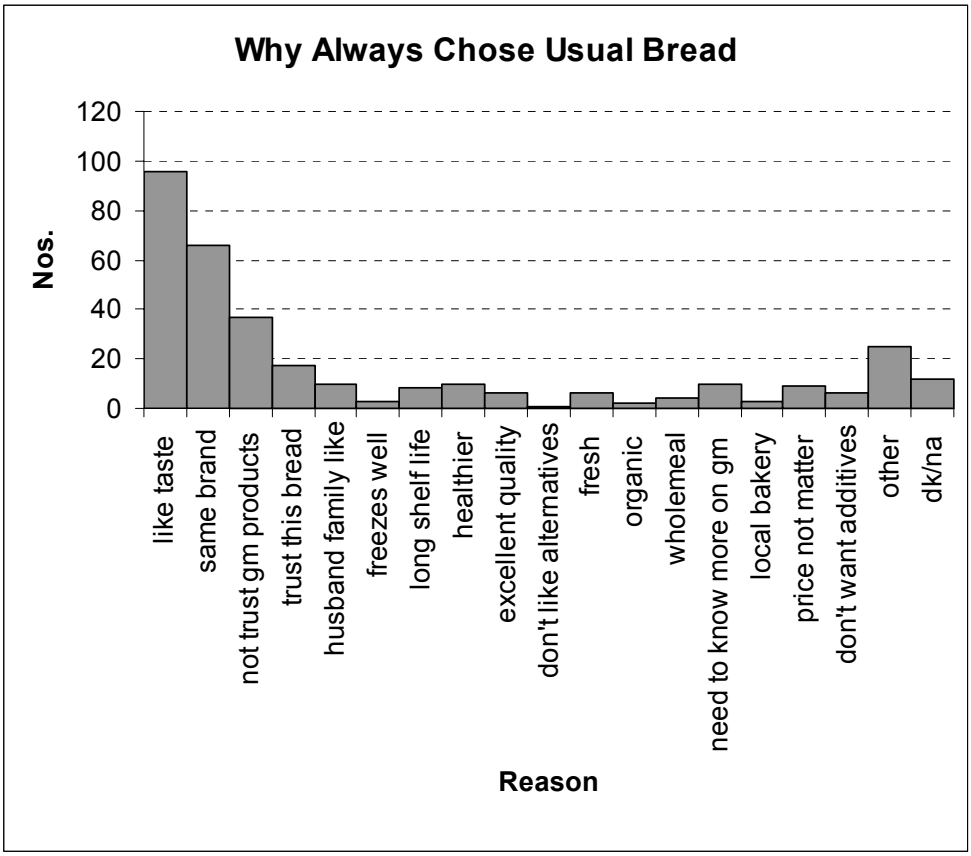
Two possible causes for the pattern of status quo responses were immediately obvious. It might be that respondents found the choice sets too complex and used the 'status quo' as a cognitive shortcut. If this were the case, then one would expect a similar behavioural response in the other choice set sections in the survey. Alternatively, it could be that the use of a specific good (the household's typical loaf of bread) caused these respondents to choose their current bread on the basis of some notion of brand loyalty - despite explicit indications in the interview that all three options on offer should be viewed as variants of their usual brand. As will be seen in Section 7, the number always choosing the 'status quo' option was small in the GM label threshold choice sets, which suggests that the status quo choices here are related to brand loyalty rather than complexity. This issue, and the implications for the future studies of this kind are discussed in Section 9.

Table 6.2: A Comparison of the Respondents who always chose the Status Quo with the Rest of the Sample (% in each demographic group).

	Those who always chose the 'status quo'	Rest of sample
Social group		
AB	18.25	20.06
C1	28.47	32.63
C2	23.36	22.16
D	16.42	16.17
E	13.50	8.98
Gender		
male	27.74	33.53
female	72.26	66.47
Age group		
16-24	4.01	10.48
25-34	14.96	20.36
35-44	18.61	22.46
45-54	20.44	17.66
55-64	21.90	11.38
65+	20.07	17.66
Children in the household		
yes	45.99	45.51
no	54.01	54.49

Every respondent who always chose the status quo option in this phase of the choice sets was asked why this was the case. Their answers were then grouped together under general headings, and these reasons are show in the Figure 6.1.

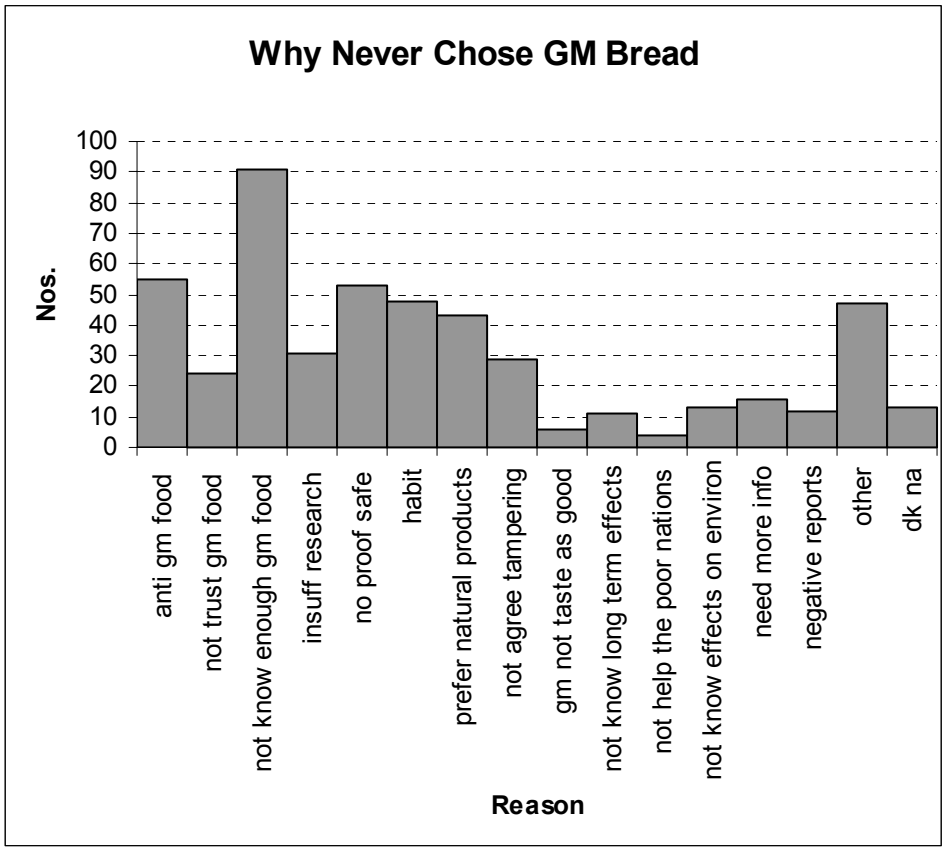
Figure 6.1



Of the 331 reasons[27] given by people for always choosing their usual bread, only 36 were directly related to distrust or scepticism regarding GM food. Most of the reasons referred to the taste or other qualities of their usual bread. In these cases people were not prepared to think these aspects could be maintained while the attributes in the choice sets varied. As such, this group opting for the status quo may not be necessarily be regarded as a blanket rejection of GM food. This picture is complicated however, by the fact that everyone (those always choosing the status quo option and others) who never chose a GM option were asked a question as to why they never chose a GM bread. Their answers are displayed in Figure 6.2. These answers were considerably more focused on the GM issue rather than brand, taste etc. As such, unpicking the precise causes of this 'status quo' effect is difficult. It raises the question would these people switch brand if there usual bread was made with GM ingredients?

[27] respondents could give more than one reason.

Figure 6.2



The group of respondents who always chose the status quo option were excluded from the subsequent analysis, since their responses can provide no information regarding the valuation of changes in the levels of attributes.

6.1.1 Estimating Choice Models

The choice sets presented to respondents (see Section 4) were defined over the attributes and levels shown in Table 6.3.

Table 6.3: Attributes and Levels

Attribute		**Levels**
Price (%)	**[price]**	-67, -50, -33, -17, Usual, +17, +33
GM Type	**[gm1, gm2]**	Non-GM, GM-Derived, GM
Shelflife	**[shelf]**	Usual, Usual + 1 day, Usual + 2 days, Usual + 3 days
Fibre Content	**[fibre]**	Usual, Usual + 10%, Usual + 30%, Usual + 50%

As a first analysis of the data, the most simple model was estimated, employing only the attributes of the choice sets: price, shelflife, fibre and the presence of GM in the choice sets. The latter is represented by **gm1** (a dummy variable denoting the presence of GM-derived ingredients) and **gm2** (for GM ingredients). This model gives an indication of (i) whether changes in attribute levels significantly affect choices made, and (ii) whether an increase in their level make the choice of an option more or less likely.

The model in Table 6.4 show positive coefficients on **Shelf** and **Fibre**, indicating that options with higher levels of these attributes are more likely to be chosen. Conversely, the negative coefficients on the **Price** and the **gm1** and **gm2** variables indicate that increases in these attributes make options less likely to be chosen. In all cases these variables are found to be significant in affecting choices ('z' statistics >2 in all cases).

A common aspect of choice modelling applications is determining whether there are impacts on utility that are associated with an option as a whole, rather than the individual attribute levels which comprise the option. This is only relevant when there is an obvious interpretation of the option in question. There is such an interpretation of the status quo option included in every choice set in the survey. It is therefore possible to test whether respondents may have a tendency to simply select the current position, irrespective of the attribute levels of the other options used. A dummy variable, **sq**, is defined, taking a value of 1 if the option is the *status quo*, and zero otherwise. The estimated coefficient was found to be insignificant (the results are not presented here), implying that there is no tendency within the sample to select this option, irrespective of attribute levels. Note that those who *always* selected the status quo have been excluded from this analysis.

This simple model can be used to test whether respondents as a whole treated food with GM-derived ingredients as the same as that with GM ingredients, the same as non-GM food, or as different from both food types. The coefficient[28] on gm1 and that on gm2 are strongly significant and negative with a similar size (-1.17 and -1.23). A chi-squared test indicates that these two coefficients are not significantly different from each other and so the gm1 and gm2 variables could be replaced in the model by a single dummy variable (**gm)**, which takes a value of 1 when either GM-derived or GM bread is present in the option, and a value of 0 for non-GM bread. The conclusion then is that, in the aggregate model, consumers are treating bread with ingredients derived from GM crops but free of altered DNA as equivalent to bread made with GM ingredients.

Table 6.4: A Simple Model

```
Conditional (fixed-effects) logistic regression   Number of obs   =
4008*
                                                  LR chi2(5)      =     283.07
                                                  Prob > chi2     =     0.0000
Log likelihood = -1326.2096                       Pseudo R2       =     0.0964
------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |   -.013533   .0016969    -7.98   0.000    -.0168588   -.0102071
         gm1 |  -1.173403   .1155523   -10.15   0.000    -1.399882    -.946925
         gm2 |  -1.236503   .1105204   -11.19   0.000    -1.453119   -1.019887
       shelf |   .0883855   .0336812     2.62   0.009     .0223717    .1543994
       fibre |   .0077662   .0020228     3.84   0.000     .0038015    .0117308
------------------------------------------------------------------------------
```

*** There are 334 respondents choosing from 3 options in each of 4 choice sets.**

This testing of the extent to which people discriminate between different levels of an attribute can be extended to shelflife and fibre attributes in the choice sets. While the simple models indicate that increases in shelflife and fibre content increased the likelihood of an option being chosen, the extent to which levels are distinguished and whether increases beyond a certain level cease to affect choices can be investigated.

[28] Recall that the estimated coefficients have no direct interpretation. Their signs and statistical significance are, however, important.

regarding shelflife, it was found that consumers did not value an additional day before bread went stale, but that they did prefer bread with 2 days additional shelflife. Whilst there was an effect associated with additional shelflife, bread with three additional days of shelflife was found not to make bread more likely to be chosen. Whilst choice modelling is based on independence of attributes, it might be the case that consumers thought that bread with such an extended shelflife may have other characteristics that they considered less desirable. This was something that some respondents identified in the de-brief during the pilot phase of the survey: some mentioned that they associated additional shelflife with the presence of preservatives and other additives to the bread. As a result a single variable representing 2 additional days of shelflife (**Shelf2**) was used in subsequent models.

A similar investigation was undertaken regarding fibre. It was found that consumers positively valued all additional levels of fibre (10%, 30% and 50%). However, respondents valued the +10% and +30% levels equally, and hence these levels were collapsed. People valued an increase to 50% more fibre in their bread more highly than the 10-30% level. As a result the 3 levels of fibre were collapsed to two (**fibre1030** and **fibre50**) which were used in subsequent models. The first model specification incorporating these aggregations is presented in Table 6.5.

Table 6.5

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4008
                                                  LR chi2(5)      =     290.35
                                                  Prob > chi2     =     0.0000
Log likelihood = -1322.5688                       Pseudo R2       =     0.0989

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |   -.013264   .0016081    -8.25   0.000    -.0164158   -.0101121
          gm |  -1.190552   .0830988   -14.33   0.000    -1.353423   -1.027681
      shelf2 |   .3803338   .1134529     3.35   0.001     .1579703    .6026973
   fibre1030 |   .2600378   .0976698     2.66   0.008     .0686086     .451467
     fibre50 |   .5131683   .0997477     5.14   0.000     .3176664    .7086702
------------------------------------------------------------------------------
```

6.1.2 Differentiated Models

The estimated models so far are specified in terms of attribute levels only. However, it was considered likely that the socio-economic differences among the sample were likely to affect the way in which changes in the attribute levels affect choices. On the basis of past studies a number of factors such as age, gender, attitudes, income, class were considered as possibly affecting the impacts of changes in attribute levels on welfare. As was explained in Section 3, such factors can not be simply entered into the choice model, since for example the effect of person's gender on a series of choices will be constant over all those choices. Hence such factors enter in the model by altering the impact of specific attributes.

A series of models were estimated to identify where demographic factors significantly affected the way in which changes in attributes changed utility and hence choices. Those identified as significant included:

- Social Class
- Gender
- Presence of children in the household
- Age
- Attitudes

To make the analysis easier to follow, the inclusion of these factors and the testing[29] to see which attributes they interact significantly with are shown in two stages. First, the role of class, gender and the presence of children in the household are explained. Then the roles of age and attitudes are introduced.

All respondents were categorised into one of five social class groups (1-AB, 2-C1, 3-C2, 4-D and 5-E). In addition, respondents were either male or female and they either did or did not have children in the household for whom they bought food. This led to a maximum of 20 different segments (Class * Gender * Children) in the sample. A process of testing ascertained which of

[29] The Likelihood Ratio (LR) test was adopted for this purpose. Specifically, the LR statistic is computed as $-2(LL_1 - LL_0)$ and is distributed as χ^2_g, where LL_0 and LL_1 are the values of the unrestricted and restricted log likelihood functions respectively, and g denotes the number of restrictions.

these segments treated the GM attribute differently from each other. This led to the identification of three groups whose responses to the GM variables were significantly different from each other:

Group 1: Class AB, and Class C1 females

Group 2: Class C1 males, Classes C2, D and E - with children

Group 3: Class C1 males, Classes C2, D and E – without children

As is shown by the model in Table 6.6, the level of disutility generated by a GM option in their choices declines from the first to the third of these three groups. This is consistent with some previous findings that females are more negative in their attitudes toward GM food and that the presence of children increases a parent's distrust of GM food.

Table 6.6: Segmented Model

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4008
                                                  LR chi2(7)      =     328.14
                                                  Prob > chi2     =     0.0000
Log likelihood = -1303.6771                       Pseudo R2       =     0.1118

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |  -.0134869   .0016207    -8.32   0.000    -.0166633   -.0103104

      grp1gm |  -1.700314   .1260213   -13.49   0.000    -1.947311   -1.453317
      grp2gm |  -1.083804   .1471432    -7.37   0.000      -1.3722   -.7954091
      grp3gm |  -.7376225   .1189569    -6.20   0.000    -.9707737   -.5044713

      shelf2 |   .3773515   .1140327     3.31   0.001     .1538514    .6008515

   fibre1030 |   .2580543   .0984801     2.62   0.009     .0650368    .4510718
     fibre50 |   .5204855   .1004839     5.18   0.000     .3235407    .7174304
------------------------------------------------------------------------------
```

Age was initially considered through the use of discrete age groups, and this showed an interesting pattern. It was found that the people in the youngest age group (16-24) were least hostile toward GM bread options, indeed this group was the only segment identified in the population for whom bread containing GM-derived ingredients was treated the same as non-GM bread. In addition although people in the oldest age group (65+) were found to be negatively disposed to GM and GM-derived bread, they were the least concerned about it of all the age

groups over 24 years of age. The implication is that there is a non-linear non-monotonic relationship between age and preferences towards GM.

This was further explored by adding **age** and **age^2** variables (where age is defined in years) to the choice model. The effects of these terms could then be tested to see if both, either or none of them were significant for the three segments identified above. Age and age^2 were found to be significant for both Group1 and Group2, implying a quadratic effect with people initially neutral or only moderately unreceptive to GM food with dislike of GM food increasing with age over a certain range before beginning to decline again. For Group 3, no significant age effect was found. These results are presented in Table 6.7.

Table 6.7: A model with Age and Age^2 terms

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4008
                                                  LR chi2(11)     =     363.38
                                                  Prob > chi2     =     0.0000
Log likelihood = -1286.0539                       Pseudo R2       =     0.1238

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------

       price |  -.0136864   .0016371    -8.36   0.000    -.0168952   -.0104777

      grp1gm |   3.117891   .9266773     3.36   0.001     1.301637    4.934145
     grp1age |  -.2150214   .0422334    -5.09   0.000    -.2977973   -.1322455
    grp1age2 |    .002097   .0004312     4.86   0.000     .0012519    .0029421

      grp2gm |   1.029086   .6575743     1.56   0.118    -.2597355    2.317908
     grp2age |  -.0808456   .0282837    -2.86   0.004    -.1362806   -.0254105
    grp2age2 |   .0007844   .0002765     2.84   0.005     .0002426    .0013263

      grp3gm |  -1.089964   .1473756    -7.40   0.000    -1.378815   -.8011129

      shelf2 |   .3635585   .1144115     3.18   0.001     .1393161    .5878009

   fibre1030 |   .2606322   .0994768     2.62   0.009     .0656613    .4556032

     fibre50 |   .5492642   .1016507     5.40   0.000     .3500325     .748496
------------------------------------------------------------------------------
```

Including Attitudes in the Model

As was discussed in Section 2, when completing the survey questionnaire, respondents were asked to record their response to a series of attitudinal questions. The analysis then turned to whether if stated attitudes were included in the model, they changed the way in which GM attributes affected welfare and hence the likelihood of an option being chosen. As there are a large number of attitudes which would be potential candidates for inclusion, some means of aggregation had to be found.

6.1.3 Composite Attitudinal Variables

To investigate how stated attitudes may affect the way in which attributes affect choices and hence WTP, two composite attitudinal variables, denoted "**GMTrust**" and "**EnvCons**" were generated from the original data.

i) *GMTrust*

In a factor analysis using the principal-components factor method, we found a single common factor for the 5 attitudinal variables related to GM and trust in the government on food safety issues. The factor loadings were strongly positive on "GM food is safe to eat" (q44), "GM crops will help developing countries" (q49), and "I trust the government when it comes to food safety issues" (q418), and strongly negative on "Growing GM crops will permanently damage the environment" (q46), and "Multinational companies will benefit most from genetic modification" (q410). The factor loadings were as follows:

Attitudinal question	Factor loading
q44	0.79403
q46	-0.73973
q49	0.57384
q410	-0.51144
q418	0.55737

Each respondent can then be assigned a score on this composite attitudinal variable. In this case, a positive score on this factor[30] would be associated with a positive view of GM technology

[30] Factors are normalised to have mean 0 and standard deviation of 1. So if G denotes the factor before normalisation, with mean μ and standard deviation, σ, then the normalised factor GMTrust = (G – μ)/ σ.

and confidence in the government on food safety issues, while a negative score would imply a negative or sceptical view of GM and of the role of government in matters of food safety.

ii) *EnvCons*

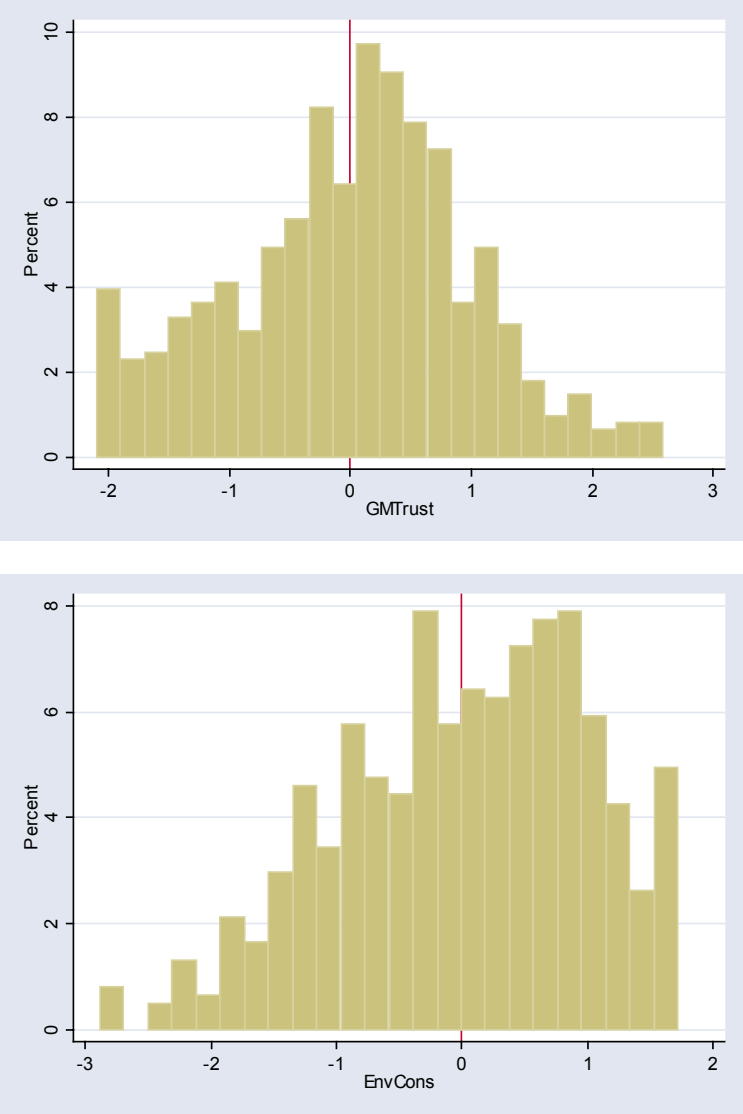
The same type of analysis was conducted on the following 5 attitudinal variables: "I try to avoid artificial ingredients" (q45), "I try to recycle as much waste as possible" (q414), "When I have the choice I always buy organic" (q419), "I try to buy environmentally friendly products" (q420) and " When I have the choice, I always try and buy ethically responsible products (e.g. Fair Trade)" (q425). Again these variables could be aggregated to a single common factor, with factor loadings being positive on each variable and of similar magnitude. More specifically, the estimated factor loadings were as follows:

Attitudinal question	Factor loading
q45	0.68451
q414	0.65253
q419	0.61034
q420	0.75392
q425	0.68883

Again each respondent is assigned a score on this composite factor. A positive score here suggests awareness or concern about 'green' and ethical issues, a negative score would suggest that little value is placed on such matters.

Each respondent was then given a score on each of the two composite factors. They range from -2.09 to 2.58 for 'GMTrust' and from -2.89 to 1.73 for 'EnvCons'. Their distributions are presented below in Figure 6.3 for the full sample.

Figure 6.3: The distributions of scores for the Composite Attitudinal Variables



Subsequent analyses using both the CM and CV approaches will explore whether these composite attitudinal variables (GMTrust and EnvCons), when incorporated into the models, significantly affect consumer choice. The main value of including these variables is that they reveal an internal consistency in the revealed preferences of the respondents in terms of the CV or CM estimated responses and the attitudinal questions, i.e. the choices that are being made are consistent with their declared attitudes. They may also be of value in identifying 'clusters' within the population who will hold similar valuations of non-GM commodities. However, it must be admitted that the researcher is still left without a clear understanding of the *causal* processes at work.

The CM model for bread, including attitudes

For all three social segments identified the attitude factor score for the composite variable GMTrust was included to see whether it, alongside age, affected the way in which GM variables affected welfare. In all three cases the coefficient estimate for the GMTrust term was positive, meaning that as this attitude score increases (i.e. people 'trust' GM food more), the negative effect of the presence of GM ingredients is reduced. The full model is shown in Table 6.8.

Table 6.8: A model with Attitudes Added

Conditional (fixed-effects) logistic regression Number of obs = 4008
Log likelihood = -1226.756 Pseudo R2 = 0.1642

choi	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
price	-.014463	.0016909	-8.55	0.000	-.0177771	-.0111488
grp1gm	1.811517	1.002811	1.81	0.071	-.1539576	3.776991
grp1gmtrust	1.118961	.1389172	8.05	0.000	.846688	1.391233
grp1age	-.1659286	.0455808	-3.64	0.000	-.2552653	-.0765919
grp1age2	.0016132	.0004644	3.47	0.001	.000703	.0025234
grp2gm	.6412676	.6746442	0.95	0.342	-.6810108	1.963546
grp2gmtrust	.5733275	.1387063	4.13	0.000	.3014681	.8451868
grp2age	-.074782	.0288512	-2.59	0.010	-.1313293	-.0182346
grp2age2	.0007417	.0002823	2.63	0.009	.0001885	.0012949
grp3gm	-1.327145	.1674513	-7.93	0.000	-1.655344	-.9989465
grp3gmtrust	.6278369	.1620859	3.87	0.000	.3101544	.9455193
shelf2	.3625431	.116026	3.12	0.002	.1351363	.58995
fibre1030	.2436423	.1020378	2.39	0.017	.0436519	.4436327
fibre50	.6004029	.1043524	5.75	0.000	.3958761	.8049298

Hence the way in which the presence of GM ingredients in the bread affected people's welfare was moderated by their class, gender, age, attitudes and whether there were children present in the household.

6.1.4 Partworths / Willingness to Pay

As was discussed in Section 3, the coefficients from conditional logit choice models have no direct interpretation other than in their significance and sign. However, the ratio of a parameter to the price variable gives a willingness to pay for that attribute. In this section of the study the price attributes were specified as percentage changes in price from the respondent's usual bread price. Hence the WTPs generated by the model are expressed as percentages, but for each individual can be converted back to a monetary value using their stated usual bread price.

The estimated WTPs regarding GM ingredients will vary with age and attitude as well as social segment. These are shown in Table 6.9 and Figure 6.4 for Group 1 and Table 6.10 and Figure 6.5 for Group 2. Group 3's WTPs, which vary only with attitude not with age, are shown in Table 6.11.

For Group 1, the WTPs in all cases are negative indicating that people are prepared to pay to avoid the GM bread or would require substantial compensation to be induced into buying such bread. These WTPs are displayed for 3 illustrative attitudinal scores: GMTrust (+1), GMTrust (0) and GMTrust (-1), indicating a positive, neutral and negative view of GM issues respectively. Some WTPs are insignificant[31] over certain age ranges for certain groups and they are not displayed in the table.

For the mean attitude **GMTrust (0)** the WTP is insignificant between age 16 and 18. With an attitude score **GMTrust (1)** the WTP is insignificant until age 28, whilst those strongly hostile to GM food, **GMTrust (-1),** the WTP to avoid the GM food is significant at all ages.

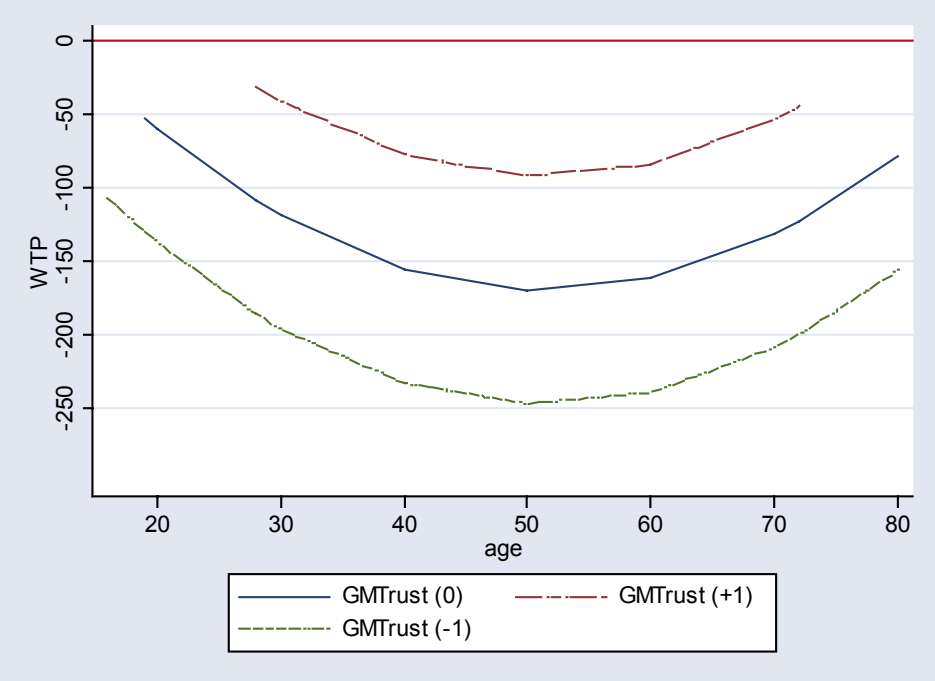
[31] The significance of all WTPs is calculated at the 5% level.

Table 6.9: WTP for GM bread. Group 1: Class AB, and Class C1 females*

Age	GMTrust (0)	GMTrust (1)	GMTrust (-1)
16			-107.12
19	-52.46		-129.83
20	-59.59		-136.95
28	-108.54	-31.17	-185.90
30	-118.54	-41.18	-195.91
40	-155.19	-77.83	-232.56
50	-169.54	-92.17	-246.90
60	-161.57	-84.20	-238.94
70	-131.30	-53.93	-208.66
72	-122.57	-45.20	-199.93
80	-78.72		-156.08

* Insignificant estimates are not tabulated

Figure 6.4: WTP for GM bread Group 1



The WTP for those in Group 2 (Table 6.10, Figure 6.5) follows a similar pattern but at each level of GMTrust, the average size of WTP and range of variation are smaller than for Group 1. For Group 3 (Table 6.11) there were no age effects and hence for this group only attitudes moderate the GM effects.

Table 6.10: WTP for GM bread. Group 2: Class C1 males, Classes C2, D and E - with children*

Age	GMTrust (0)	GMTrust (1)	GMTrust (-1)
16			-64.90
20	-38.56		-78.20
30	-64.62	-24.98	-104.26
40	-80.43	-40.79	-120.07
50	-85.98	-46.34	-125.62
60	-81.28	-41.63	-120.92
70	-66.31	-26.67	-105.95
80	-41.09		-80.73

* Insignificant estimates are not tabulated

Figure 6.5: WTP for GM bread Group 1

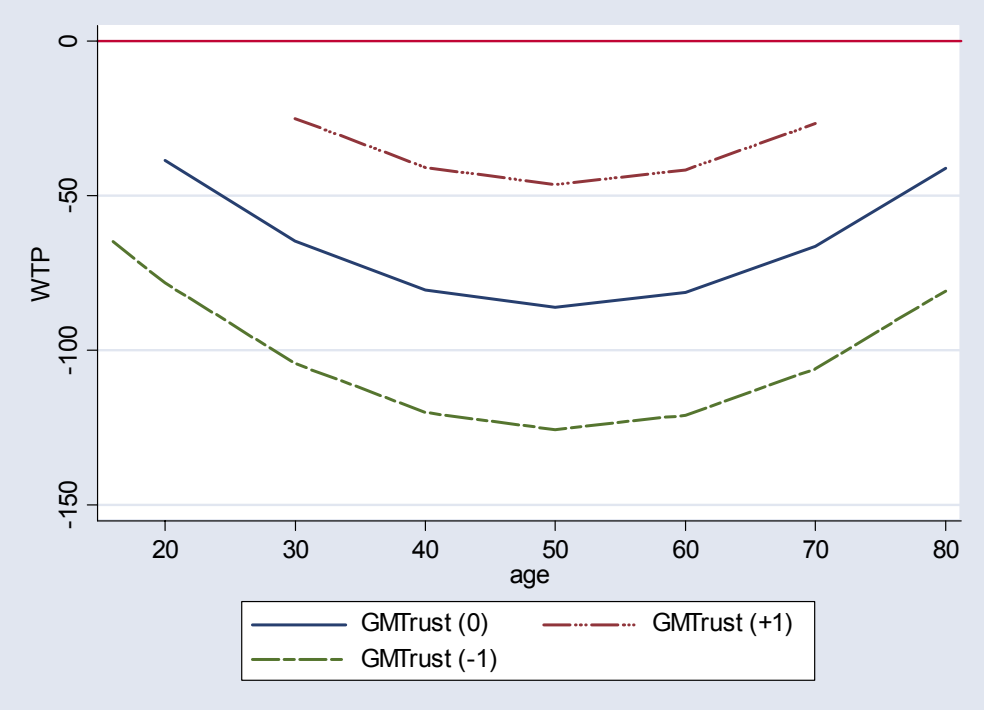
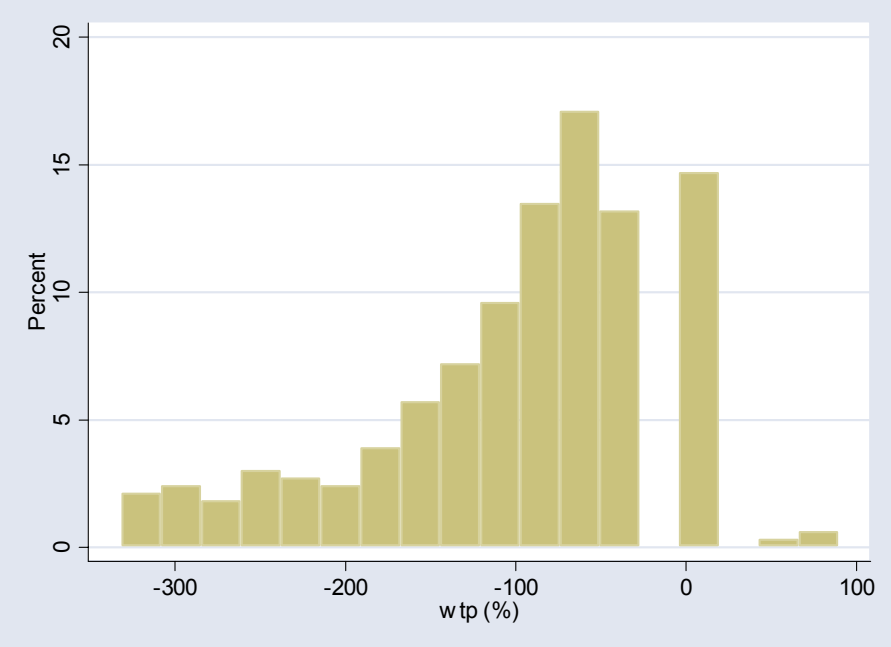


Table 6.1: WTP for GM bread. Group 3: Class C1 males, Classes C2, D and E – without children

Age	GMTrust (0)	GMTrust (1)	GMTrust (-1)
	-91.76	-48.35	-135.17

The distribution of these WTPs, for all groups in the sample, are shown in Figure 6.6.

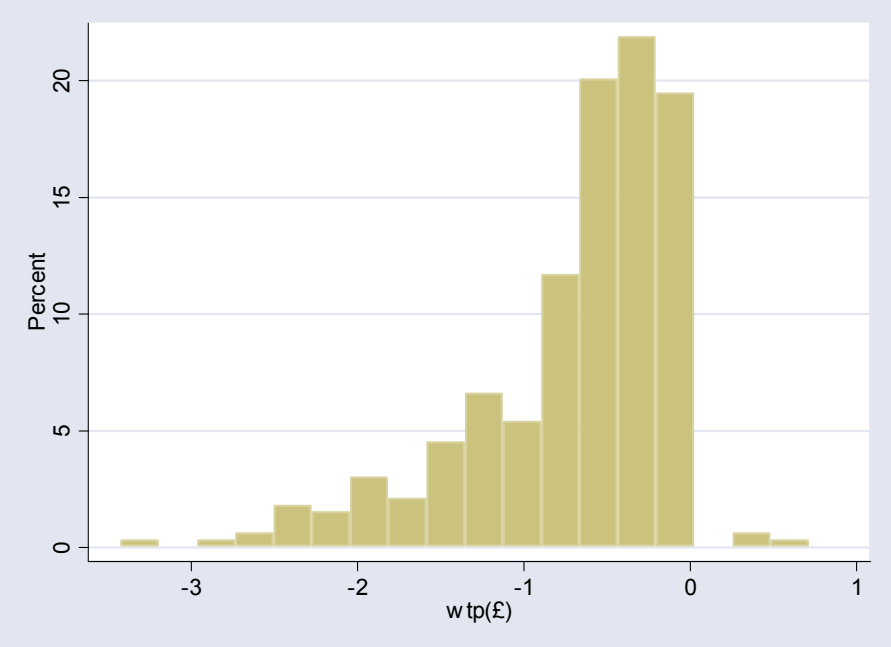
Figure 6.6: The distribution of percentage WTPs for the sample as a whole



The median WTP for the sample is 79%, which may be interpreted as the discount required to induce purchase, or the premium consumers will pay to avoid the GM product. A 16% market share would be achieved for the GM bread with a discount of 10%.

These percentage WTPS may be converted into cash equivalents via the respondent's answer regarding the cost of their usual bread price, the distribution of these is shown in Figure 6.7

Figure 6.7: The distribution of WTPs (£) for the sample as a whole



The implications of these results from the choice modelling estimation are considered in Section 6.3, after the CV results on this research question are presented, and in more detail in Section 9 which summarises and discusses all the results from the study.

6.2 The Contingent Valuation Results

The survey questionnaire included a double-bounded dichotomous choice question designed to gauge respondents' WTP for non-GM bread. Specifically, the structure of this question was as follows:

> Thinking carefully about how much you spend on food each week…
>
> If offered two loaves of your current brand bread, one made with non-GM ingredients and the other made with GM-derived ingredients would you buy the non-GM loaf if it cost *(17%, 25%, 42%)* more ?
>
> **If NO, ASK:**
> Would you buy the non-GM loaf if it cost *(12%, 20%, 33%)* more?
>
> **If YES, ASK:**
> Would you buy the non-GM loaf if it cost *(20%, 33%, 50%)* more?

It should be noted that this question does not address the specific issue of GM-derived ingredients. GM-derived ingredients and GM ingredients are treated as equivalent, as the results of the CM analysis confirm. The respondents are being asked their WTP for non-GM bread.

The amount initially presented to the respondent was selected at random, and then the follow-up amount depended on the level and response in the first question. For example, if the respondent said 'no' to an initial offer of 17%, s/he was then asked the same question for 12%, probing the level of increment that s/he was prepared to pay to get the non-GM bread. If the respondent said 'yes' to an initial offer of 17%, s/he was then offered 20%, to see if a higher valuation were acceptable. The distribution of responses to the initial and follow-up questions is shown below with most responses falling into the 'yes-yes' and 'no-no' categories (61% and 26% respectively):

	Round 2		
Round 1	no	yes	Total
no	105	19	124
yes	36	249	285
Total	141	268	409

It should be noted that respondents were not presented with the percentage values in these questions, rather they were presented with monetary values derived from their stated average price of bread. However, in the analysis that follows, it is the percentage value that is used, i.e. one is identifying the proportionate markups that are relevant for the individuals.

Estimation Results

The starting point is to specify separate preference functions, allowing different coefficients, for each of the two rounds of questions (see Section 3.2 on CV theory). In the first set of results, only demographic variables are included as modifiers, and the composite attitudinal variables defined in Section 6.1.3 are excluded. Of the demographic variables, only social class and gender are significant.

Table 6.12

```
Seemingly unrelated bivariate probit              Number of obs   =        409
                                                  Wald chi2(12)   =      37.07
Log likelihood = -394.84846                       Prob > chi2     =     0.0002

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1      |
       Value |  -.0131315   .0058979    -2.23   0.026     -.024691   -.0015719
        scc1 |  -.6841842   .2113008    -3.24   0.001    -1.098326   -.2700422
        scc2 |  -.6629291   .2206753    -3.00   0.003    -1.095445   -.2304134
         scd |  -.7336875   .2386202    -3.07   0.002    -1.201374   -.2660006
         sce |  -.5866942   .2670763    -2.20   0.028    -1.110154   -.0632342
         sex |   .2502081   .1405737     1.78   0.075    -.0253114    .5257276
       _cons |   1.043896   .3235364     3.23   0.001      .409776    1.678015
-------------+----------------------------------------------------------------
Round 2      |
       Value |  -.0173276   .0051687    -3.35   0.001     -.027458   -.0071972
        scc1 |  -.7378373   .1971402    -3.74   0.000    -1.124225   -.3514495
        scc2 |  -.5246518   .2096548    -2.50   0.012    -.9355677   -.1137358
         scd |  -.8240799   .2243396    -3.67   0.000    -1.263777   -.3843824
         sce |  -.6011628   .2518711    -2.39   0.017    -1.094821   -.1075045
         sex |   .3088808   .1344192     2.30   0.022      .045424    .5723376
       _cons |   .9765142   .3084982     3.17   0.002     .3718689    1.581159
-------------+----------------------------------------------------------------
     /athrho |   1.862981   .2622634     7.10   0.000     1.348954    2.377008
-------------+----------------------------------------------------------------
         rho |   .9529535   .0240967                      .8738062    .9829132
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  183.674    Prob > chi2 = 0.0000
```

The initial block of variables relates to the first round questions, and the variable **Value** denotes the price premium for that round; the second block of variables relate to the second round questions, with Value defined conformably. **Rho** is the estimate of the covariance in the error terms across the two rounds: if these were formed strictly by identical preferences, the covariance would be equal to unity. A value of Rho less than unity implies some degree of random variation in the selection across the two rounds.

The coefficients on Value are as expected: as the level of premium demanded increases, the probability of purchasing the non-GM bread declines. There is also some differentiation according to social class. Visual inspection of the coefficients suggests that they are similar

across the two rounds. The model in Table 6.13 formally checks this by re-estimating the model imposing consistency coefficients.

Table 6.13

```
Seemingly unrelated bivariate probit              Number of obs   =        409
                                                  Wald chi2(6)    =      28.47
Log likelihood = -399.82375                       Prob > chi2     =     0.0001

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1      |
       Value |  -.0168955   .0052876    -3.20   0.001     -.027259    -.006532
        scc1 |   -.717436   .1906422    -3.76   0.000    -1.091088   -.3437843
        scc2 |  -.5803686   .2014153    -2.88   0.004    -.9751353   -.1856019
         scd |  -.7900389   .2171701    -3.64   0.000    -1.215685   -.3643933
         sce |  -.5975829   .2434313    -2.45   0.014    -1.074699   -.1204662
         sex |   .2875983   .1297288     2.22   0.027     .0333346    .541862
       _cons |   1.035092    .294698     3.51   0.000     .4574948    1.61269
-------------+----------------------------------------------------------------
Round 2      |
       Value |  -.0168955   .0052876    -3.20   0.001     -.027259    -.006532
        scc1 |   -.717436   .1906422    -3.76   0.000    -1.091088   -.3437843
        scc2 |  -.5803686   .2014153    -2.88   0.004    -.9751353   -.1856019
         scd |  -.7900389   .2171701    -3.64   0.000    -1.215685   -.3643933
         sce |  -.5975829   .2434313    -2.45   0.014    -1.074699   -.1204662
         sex |   .2875983   .1297288     2.22   0.027     .0333346    .541862
       _cons |   1.035092    .294698     3.51   0.000     .4574948    1.61269
-------------+----------------------------------------------------------------
     /athrho |   1.761474   .2489872     7.07   0.000     1.273468    2.24948
-------------+----------------------------------------------------------------
         rho |   .9426674   .0277317                      .8547349    .9780035
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  173.724    Prob > chi2 = 0.0000
```

The test of these restrictions is given by a log-likelihood ratio test. The test value is 9.95, which is lower than the critical value of the $\chi^2_{(6,0.05)}$ =12.59, implying that the restrictions can be imposed, and that the responses can be rationalised by a single set of preferences.

These results assume that attitudes towards percentage changes in the price of bread are the same across the whole sample, i.e. that a 20% increase in price is viewed in the same way by all respondents. However, it may be the case that those who have a higher overall food expenditure may be prepared to accept a higher percentage increase in price to purchase non-GM bread, since bread is a staple, making up a diminishing proportion of food expenditure at higher incomes. One way to include such an effect is to moderate the coefficient on the Value variable by the level of food expenditure. Hence, as reported in Table 6.14, a new variable, Value*Bill, is included in the model. One would expect that at higher expenditure levels the impact of the increase in the price of bread will be diminished and if this hypothesis is correct, Value*Bill will have a positive coefficient. It is clear from the Table that the effect is indeed of the

expected sign and also significant, with the implication being that the higher the food expenditure in the household, the greater the WTP to secure GM-free bread.

Table 6.14

```
Seemingly unrelated bivariate probit              Number of obs   =        409
                                                  Wald chi2(7)    =      34.34
Log likelihood = -396.58164                       Prob > chi2     =     0.0000
------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1&2    |
       Value |  -.0264945   .0064807    -4.09   0.000    -.0391965   -.0137925
  Value*Bill |   .0001764   .0000696     2.53   0.011       .00004    .0003128
        scc1 |  -.6854103   .1920608    -3.57   0.000    -1.061843    -.308978
        scc2 |  -.5679471   .2029322    -2.80   0.005    -.9656869   -.1702073
         scd |  -.7318072   .2193255    -3.34   0.001    -1.161677   -.3019371
         sce |  -.5055184   .2470006    -2.05   0.041    -.9896307   -.0214062
         sex |    .260298    .130745     1.99   0.046     .0040425    .5165535
       _cons |   1.057726   .2963629     3.57   0.000     .4768657    1.638587
-------------+----------------------------------------------------------------
     /athrho |   1.780149   .2594202     6.86   0.000     1.271695    2.288604
-------------+----------------------------------------------------------------
         rho |   .9447112   .0278931                      .8542564    .9796422
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  172.397    Prob > chi2 = 0.0000
```

So far, the heterogeneity within the population has been captured by the inclusion of gender and social class variables. However, one also has information about the attitudes of the respondents on a range of issues. Following from Section 6.1.3, the factors identified as determinants of choice were included and both *GMTrust* and *EnvCons* were found to be significant. The results for the restricted model are reported in Table 6.15 (again, tests of the restricted and unrestricted models indicated that preferences were stable across the rounds).

Table 6.15

```
Seemingly unrelated bivariate probit              Number of obs   =        409
                                                  Wald chi2(9)    =      87.12
Log likelihood = -359.19872                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1&2    |
       Value |   -2.71816   .6956169    -3.91   0.000    -4.081544   -1.354776
  Value*Bill |   .0184577   .0074912     2.46   0.014     .0037752    .0331402
     GMTrust |  -.4673533   .0734312    -6.36   0.000    -.6112757   -.3234308
     EnvCons |    .288886   .0720232     4.01   0.000     .1477231    .4300489
        scc1 |   -.579213   .2094433    -2.77   0.006    -.9897144   -.1687117
        scc2 |  -.2219477    .225159    -0.99   0.324    -.6632512    .2193558
         scd |   -.420503   .2370109    -1.77   0.076    -.8850358    .0440297
         sce |  -.1081268   .2689025    -0.40   0.688     -.635166    .4189123
         sex |   .1420782   .1377053     1.03   0.302    -.1278192    .4119757
       _cons |   1.178143   .3239553     3.64   0.000     .5432019    1.813084
-------------+----------------------------------------------------------------
     /athrho |    1.56996    .230403     6.81   0.000     1.118378    2.021542
-------------+----------------------------------------------------------------
         rho |   .9170194   .0366515                      .8070041    .9655183
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  127.807    Prob > chi2 = 0.0000
```

Introducing these alternative measures of heterogeneity into the model leads to a marked reduction in the impact of social class and gender variables, although social class C1 remains significantly different from the baseline AB. This is perhaps not surprising, as one may expect that the attitudes may well be mirrored by these social class variables. This is, to some extent true as shown in Section 5, but around only 10% of the variability on the attitude indices can be explained by the class gender or age variables, so they are not perfect correlates for each other.

6.2.1 Partworths/WTP

We proceed here by comparing the estimates of WTP that are derived from both forms of models, those that include attitudes and those that do not. The median WTP is associated with the value that generates a 50% probability of acceptance. Recall from Section 3.2 that

Pr('yes') = $\Phi(\alpha+\beta A)$, then Pr('yes') =0.5 when $\alpha+\beta A = 0$ or $A^* = -\alpha/\beta$.

In the more general case, where covariates are included, α may be extended to include the other variables included in the model, using sample means for the variables. Alternatively, one

can generate median values for sub-groups within the population. Both approaches are reported here.

Turning first to the median WTP in the version of the model without the foodbill effect (Table 6.13 above), the median WTP for the sample as a whole to obtain non-GM bread is a 58% increase in price (with a standard error of 9.6), for the sample as a whole, and the sample mean WTP is 63%. Note that these have been evaluated as if there is a representative consumer who has the 'average' characteristics across the sample (e.g. reflecting the proportion of the sample in each social class, etc.).

Alternatively, one can identify the median WTPs for particular sub-groups within the population as is shown in Table 6.16.

Table 6.16: Median partworths, by gender and class

Class	Male	Female
AB	78.3	95.3
C1	35.8	52.8
C2	43.9	60.9
D	31.5	48.5
E	42.9	59.9

Derived from Table 6.13

If one allows for the effect of the household's food bill on values, then for the sample as a whole, evaluated at mean values of the exogenous variables, the median WTP to obtain non-GM bread is a 57% increase in price (s.e. 9.5), and the mean 62%. These values, shown in Table 6.17, are very close to the result obtained in Table 6.16, which one would expect.

Table 6.17: By Class and Food Bill, the estimated WTPs(%) are:

Class	Bill=35	Bill=50	Bill=100
AB	77.7	89.3	178.2[NS]
C1	43.9	50.5	100.8 [NS]
C2	49.7	57.2	114.1 [NS]
D	41.6	47.8	95.6 [NS]
E	52.8	60.7	121.1 [NS]

Derived from Table 6.14.
[NS] denotes not significant at 5%

Note that at median food bill level (£50) there is no real change, but as the bill gets large, so do the WTP estimates: respondents in social class AB spending a £100 a week on food are willing to pay an extra 200% on their bread to avoid GM material. However, there are relatively few members in this group and the confidence interval for the group is large, that is, the estimated WTPs are large but imprecise.

If one brings in the attitudinal variables and allows for the effect of the food bill on Value, then, for the sample as a whole, evaluated at mean values of the exogenous variables, the median WTP to obtain non-GM bread is a 64% increase in price (s.e. 11.8). The mean WTP, again evaluated at average values, is 68%. These are close to the population averages obtained from the previous two models, suggesting that estimates of WTP across the sample as a whole are not greatly affected by the inclusion of additional variables. They do however, have a considerable impact on the estimate of the median for particular individuals, when the attitude variables change. This is revealed in Table 6.18, which gives median WTP for females, for a range of attitude levels.

Table 6.18: Median WTP by attitude and food bill level, females.

Attitudes	Bill=35	Bill=50	Bill=100
Mean	56.8	65.6	135 [NS]
GMTrust= -1	79.4	91.7	188 [NS]
GMTrust= +1	34.3	39.6	81.5 [NS]
EnvCons= -1	42.9	49.5	102 [NS]
EnvCons= +1	70.8	81.7	168 [NS]

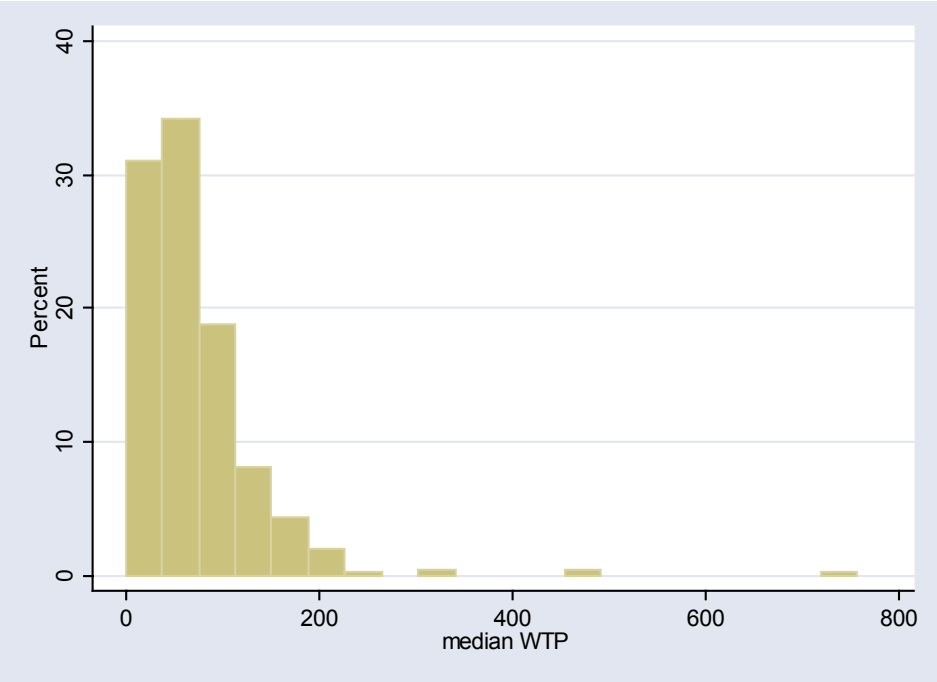
Derived from Table 6.15.
Attitude variable set to zero if not explicitly under consideration.
[NS] denotes not significant at 5%

As noted in Section 6.1.3, the attitudinal variables are calculated with a mean of zero, and values of -1, and +1 are at approximately the 20th percentiles. Shifts in the attitude variables

cause both statistically, and economically, significant changes in WTP for GM foods. Again, at high food expenditures, WTP becomes high, but statistically imprecise.

Finally, the median WTP for non-GM bread for the whole sample is presented in Figure 6.8.

Figure 6.8: Median WTP for non-GM bread for the sample as a whole



6.3 Summary & Key Conclusions

The choice modelling results presented here have indicated that all respondents, with perhaps the exception of the very young (16-24), treat GM-derived ingredients the same as GM ingredients and hence there is implicit support for the extension of the EU labelling regime to include products derived from GM ingredients as well as products with modified genetic material evident.

The estimated median WTP is 79% of bread price (this represents a median WTP of 49p/loaf) but WTP varies with social class, age, the presence of children and attitudes to GM and trust in the regulatory process on food issues.

The contingent valuation analysis, which focuses on the respondents' WTP for non-GM bread, generates a median WTP of 64%, again with considerable variation across social class, gender and the size of the household's weekly food bill.

A fuller discussion of the these results and the implications of the similarities and differences between the CM and CV results is found in section 9 where there is a full discussion of the study's results.

Section 7 Estimating the Benefits of a Reduction in GM Labelling Threshold Levels

Of the 608 respondents, 270 were questioned about the GM label threshold issue (the remainder took part in that section of the survey on overall GM content of food). As in the previous phase of the analysis, the GM label threshold was investigated through choice sets and accompanying double-bounded contingent valuation questions. These were preceded by some explanatory information.

7.1 Choice Modelling Results

As was explained in the description of the study process (Section 4), the choice sets concerning GM label thresholds comprised the following attributes and levels:

Attribute		**Levels**
Cost (weekly food bill, %)	**[price]**	-50, -40, -30, -20, -10, Usual, +10, +20
GM content allowed before label needed (%)	**[gmlvl]**	0, 0.5, 0.9, 1, 2, 5
Amount of food with pesticide residues (%)	**[pest]**	0, 5, 10, 30, 50, 100
Food Origin	**[orig]**	Anywhere, Mainly Europe, Mainly UK

As with the bread choice sets, a 'status quo' option was identified (usual cost, 1% label threshold, 30% of food with pesticide residues virtually all of it within safety limits, any location for food source). The issue of respondents always choosing the 'status quo' option was highlighted in Section 6 in the context of the bread choice set results. In the case of the level of GM content in food at which labelling is required, this issue was far less extensive as Table 7.1 shows, with only 24 cases (9%) always choosing the status quo. This suggests that the status quo issue arose in the bread choice sets as a result of factors such as brand loyalty rather than as a reaction to the complexity of the choice sets. These 24 interviewees were excluded from the choice modelling analysis.

Table 7.1: The 'status quo' issue

	Frequency	Percentage
Choices Vary	246	91.11
Status Quo	24	8.89
Total	270	100.00

A simple choice model is shown in Table 7.2. Increased prices, a higher GM content permitted without a label and more pesticide residues on food all decrease the likelihood of an option being chosen. In addition, food produced more locally increases the probability of an option being selected.

Table 7.2: A Simple Model

```
Conditional (fixed-effects) logistic regression   Number of obs   =       2952
                                                  LR chi2(4)      =     410.61
                                                  Prob > chi2     =     0.0000
Log likelihood = -875.72921                       Pseudo R2       =     0.1899

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |   -.010302    .002361    -4.36   0.000    -.0149295   -.0056745
       gmlvl |  -.3417907   .0464163    -7.36   0.000     -.432765   -.2508163
        pest |  -.0294868    .002305   -12.79   0.000    -.0340044   -.0249692
        orig |   .1231205   .0590786     2.08   0.037     .0073285    .2389124
------------------------------------------------------------------------------
```

In the context of this simple model, the choice data were investigated to see the extent to which respondents distinguish between attribute levels. These tests indicated that people were indifferent within certain ranges of attributes. In terms of the GM labelling threshold, respondents treated the

0% and 0.5% thresholds as equivalent. Similarly, the 0.9% and 1% thresholds were treated the same. Regarding pesticide residue levels, it was found that the following residue levels were treated as distinct categories: 0-5%, 10-30%, 50%, and 100%.

An estimated model which incorporates these aggregations is shown in Table 7.3. To avoid co-linearity, it is necessary to omit one of the levels of the attributes from the estimation - the omitted level acts as the baseline against which the effects of the other levels on the probability of option selection are evaluated. The baseline levels used here are 10-30% for pesticide residues (given that 30% is the current level), and 0.9-1% for the GM labelling threshold (based on the threshold prior to the new EU regulation using 1%).

In this new model specification, the way in which the variable representing the origin of one's food (**origin**) enters the model is slightly changed. The raw variable with 3 levels ('Anywhere', 'Mainly Europe', 'Mainly UK') was statistically insignificant when entered into this model. It is replaced by a dummy variable (**ori2)** taking a value of 1 for 'Mainly UK' and a value of 0 otherwise. This **ori2** variable is positive and marginally significant (at the 7% level), indicating that people preferred options with their food mainly being UK in origin, but were indifferent to whether their food came from mainly Europe or 'anywhere'.

Table 7.3: A More Aggregated Model

```
Conditional (fixed-effects) logistic regression   Number of obs   =       2952
                                                  LR chi2(8)      =     489.46
                                                  Prob > chi2     =     0.0000
Log likelihood = -836.30651                       Pseudo R2       =     0.2264

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |   -.019574   .0027628    -7.08   0.000    -.0249891   -.0141589
       gm005 |   .4933703   .1383937     3.56   0.000     .2221237    .7646169
        lgm2 |  -1.188101   .2131351    -5.57   0.000    -1.605838   -.7703638
        lgm5 |  -.3128677   .1931996    -1.62   0.105    -.6915319    .0657966
      pest05 |   .9207307   .1253071     7.35   0.000     .6751334    1.166328
      pest50 |  -.8408503   .2130367    -3.95   0.000    -1.258395   -.4233061
     pest100 |  -1.930697   .2468293    -7.82   0.000    -2.414474   -1.446921
        ori2 |   .2582154   .1402965     1.84   0.066    -.0167607    .5331914
```

While consumers were found to be indifferent to a lowering of the labelling threshold to 0.9%, a lowering of the threshold to 0% or 0.5% was found to have a significant impact on consumer welfare. A slackening of the threshold limit to 2% was found to affect welfare significantly and

negatively. A further slackening of the threshold limit to 5% produces what appears to be an anomalous result, with the effect on welfare being negative but marginally significant (10%) and lower in magnitude than a move to a 2% threshold limit.

An investigation into the effects of gender, age, class and the presence of children in the household revealed minimal effects. There was, however, a significant difference in the way that men and women valued a reduction in pesticide residues to the 0-5% level, represented by the variables **pestm05** and **pestf05** (Table 7.4).

Table 7.4

Conditional (fixed-effects) logistic regression — Number of obs = 2952; LR chi2(9) = 494.87; Prob > chi2 = 0.0000; Log likelihood = -833.59766; Pseudo R2 = 0.2289

choi	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
price	-.0196106	.0027659	-7.09	0.000	-.0250316	-.0141895
gm005	.4992072	.1387546	3.60	0.000	.2272532	.7711611
lgm2	-1.175474	.2130531	-5.52	0.000	-1.593051	-.7578977
lgm5	-.312779	.1931717	-1.62	0.105	-.6913886	.0658307
pestm05	.6440257	.1717229	3.75	0.000	.307455	.9805964
pestf05	1.063183	.1405483	7.56	0.000	.7877135	1.338653
pest50	-.8398474	.2134148	-3.94	0.000	-1.258133	-.421562
pest100	-1.928879	.2470082	-7.81	0.000	-2.413006	-1.444752
ori2	.2423461	.140596	1.72	0.085	-.0332169	.5179091

As with the analysis of the bread choice sets, the effects of age and attitudes were also investigated. Two composite attitudinal factors were investigated in the label threshold models. The first, **GMTrust**, was discussed in Section 6.1.3. This factor was found to influence significantly the way in which consumers valued a lowering of the threshold at which GM labelling is required to 0-0.5% (Table 7.5). As the attitudinal score increased, implying more 'trust' in GM food safety and the regulatory process, the valuations of a tighter threshold decreased. Similarly, the extent to which welfare is reduced by increasing the level of GM presence permitted without a label to 2%, is reduced as the scores for the GMTrust attitude score increase. That is, the negative coefficient of -

1.20 on the **lgm2** variable is moderated by the +0.34 coefficient associated with increases in this composite attitude score.

Changes in the GMTrust attitude score were found not to significantly affect the way in which people valued variations in the level of pesticide residues on food. However, the second composite attitude, EnvCons, was found to affect the way in which women valued reductions in the level of food containing pesticide residues to the 0-5% level. Hence the baseline welfare gain from such a reduction in pesticide residues (represented by the 1.06 coefficient on the variable pestf05) is affected by variation in this attitude score. A unit increase in the EnvCons composite attitude score further increases this benefit by 0.47.

The effects of age were investigated in a similar manner to that in the analysis of GM/GM-derived bread, namely using discrete age groups and also using age and age^2 terms to test for linear and quadratic age effects. However, no significant age effects were identified.

Table 7.5: Adding Attitudes

```
Conditional (fixed-effects) logistic regression   Number of obs   =       2952
                                                  LR chi2(12)     =     542.87
                                                  Prob > chi2     =     0.0000
Log likelihood = -809.59983                       Pseudo R2       =     0.2511

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |  -.0197793   .0027858    -7.10   0.000    -.0252394   -.0143191

       gm005 |    .522307   .1415249     3.69   0.000     .2449234    .7996907
gm005gmtrust |  -.4356644   .0921185    -4.73   0.000    -.6162134   -.2551155
        lgm2 |  -1.202838   .2164828    -5.56   0.000    -1.627136    -.778539
 lgm2gmtrust |   .3415101   .1907152     1.79   0.073    -.0322849    .7153051
        lgm5 |  -.2934751   .1956046    -1.50   0.134    -.6768531    .0899028

     pestm05 |   .7055126   .1745967     4.04   0.000     .3633094    1.047716
     pestf05 |    1.06085   .1435901     7.39   0.000     .7794186    1.342281
  pestf05pca2|   .4700851   .1127503     4.17   0.000     .2490985    .6910717
      pest50 |  -.9015831   .2171059    -4.15   0.000    -1.327103   -.4760634
     pest100 |  -1.978349    .249766    -7.92   0.000    -2.467882   -1.488817

        ori2 |   .3013739    .142861     2.11   0.035     .0213715    .5813764
------------------------------------------------------------------------------
```

7.1.1 Partworths / Willingness to Pay

As was discussed in Section 3.1, the coefficients from conditional logit choice models have no direct interpretation other than in their significance and sign, indicating whether they affect the likelihood of an option being chosen and, if so, whether they increase or decrease the option's probability of being selected. However, the parameters can be combined to identify monetary values associated with changes in each attribute level.

The ratio of a parameter to the price variable gives a willingness to pay for that attribute. In this section of the study the price attributes were specified as percentage changes in the level of the respondent's weekly household food bill. The WTPs generated by the model are therefore in percentage terms, although for each individual these can be converted back to a monetary value by their answer to the question regarding the usual weekly food bill.

Unlike the WTPs from the model on GM and GM-derived ingredients in Section 6, these label threshold WTPs do not vary with age, class and the presence of children. There is some variation, for certain attribute levels, as a result of the influence of gender (but on changes in pesticide residues only) and attitudes.

These WTPs are displayed in Table 7.6 for 3 illustrative GMTrust attitudinal scores: +1, 0, -1, where +1 represents a more positive attitude to GMs, -1 is more sceptical view of GM issues and 0 is the mean composite attitudinal score. These attitudes affect the WTPs for a tighter labelling regime for adventitious presence of GM material, or WTA for allowing a higher GM presence in food without a label.

As Table 7.6 indicates, these attitudinal effects cause the WTPs to be insignificant[32] for certain ranges of values of the GMTrust attitude score. While the WTPs for a lowering of the label threshold to 0-0.5% are significant for the GMTrust values of 0 and -1, they are insignificant for GMTrust values of +1.

[32] The significance of all WTPs is calculated at the 5% level.

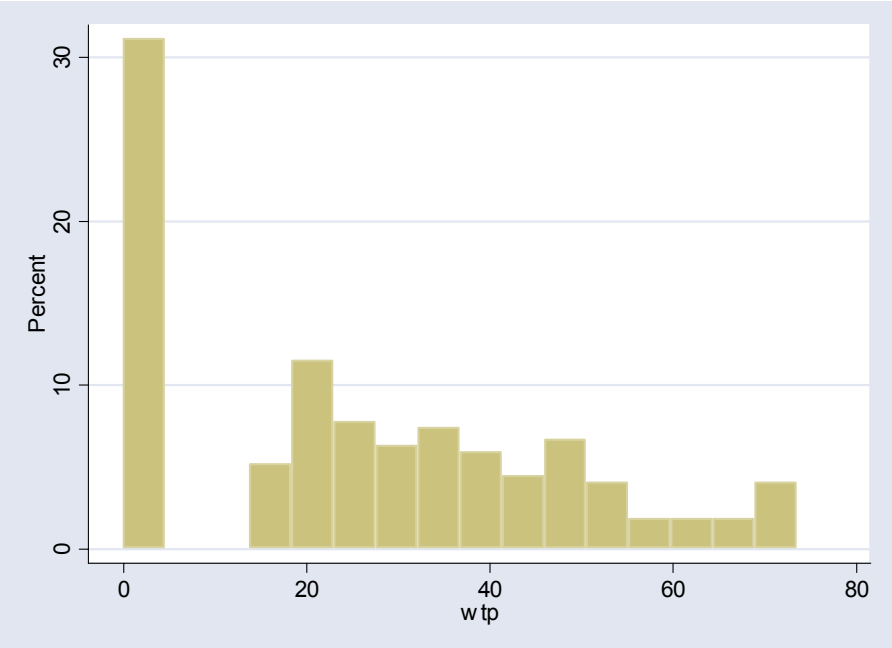
Table 7.6: WTP GM label changes

	GMTrust (0)	GMTrust (1)	GMTrust (-1)
Threshold Level			
0-0.5%	26.41	4.38^{NS}	48.43
2%	-43.55	-60.81	-78.08

^{NS} denotes not significant at 5%.

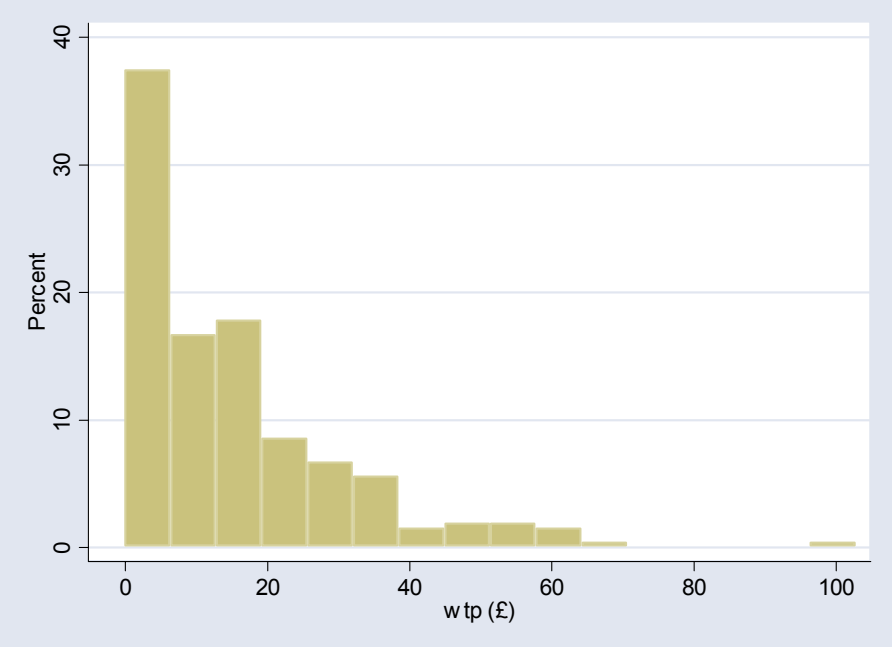
While the WTPs for 3 discrete values of GMTrust are shown in Table 7.6, there is however a continuum of values. It was found that the threshold value of GMTrust at which the WTP for a tightening of the labelling regime became insignificant was 0.5, that is, when the attitude score was $\geq$ 0.5 the WTP was insignificant. This means that 31% of the sample did not place a significant value on a reduction of the label threshold to the 0 to 0.5% level. With these insignificant WTPs considered as zero values, the distribution of WTPs for a lowering of the label threshold to 0-0.5% is shown in Figure 7.1. The median value of this WTP to secure a threshold of 0-0.5% is 23.9%, and the mean value is 25.7%.

Figure 7.1: The distribution of WTPs(%)



These percentage WTPs can be considered in terms of changes to the weekly household food costs. The distribution of these cash equivalents is shown in Figure 7.2, which again shows the concentration of people with a zero WTP, with an overall median value of £11.8/ week.

Figure 7.2: The distribution of WTPs(%)



7.2 Contingent Valuation Results

A CV question which was intended to identify whether respondents place a value on changes in the threshold at which labelling of food containing GM ingredients is required, was included in the questionnaire. The structure of the question was as follows:

> Currently, if an ingredient has more than 1% GM content it must be labelled as GM. This means that even if you buy food with no GM label, it may contain ingredients with up to 1% GM content.
>
> Lowering the threshold below 1% means that less GM ingredient is allowed in non-GM food. This may involve greater costs.
>
> Thinking carefully about how much you said you spend on food each week,
>
> If the threshold for labelling were reduced from 1% to *(0.9%, 0.5% or 0%)*, would you be willing to pay *(AMOUNT, EQUIVALENT TO 3.3%)* /week extra for your food?
>
> **If NO, ASK:**
>
> For the same change in the threshold from 1% to *(0.9%, 0.5% or 0%)*, would you be willing to pay *(AMOUNT, EQUIVALENT TO 1.7%)*/week extra for your food?
>
> **If YES, ASK:**
>
> For the same change in the threshold from 1% to *(0.9%, 0.5% or 0%)*, would you be willing to pay *(6.7%)*/week extra for your food?

The structure of this question bears some similarity with the previous question, insofar as respondents are asked if they are prepared to pay a fixed amount to achieve a change in labelling threshold. However, here the level of the proposed threshold also varies, as it will be of policy interest to see how values alter across a range of alternative label thresholds. The distribution of responses is presented in Table 7.7. Compared to the distribution for the previous CV question (Section 6.2) there are fewer 'yes-yes' and 'no-no' responses (48% and 24% respectively).

Table 7.7: Distribution of Responses to CV Label Threshold question

	Round 2		
Round 1	no	yes	Total
no	65	22	87
yes	52	131	183
Total	117	153	270

The basic structure of the estimation is the same as in the analysis of the robustness issue: the proposed change (of both label threshold level and food bill) induces a change in utility, and acceptance of the change will depend on expected utility increasing. In defining the change in utility one now has to consider both the change in payment requested, and the proposed change in the label threshold.

To accommodate the changes in the threshold levels, there is a more limited range of variation in the food bill employed in this phase of the analysis. All respondents are initially asked if they are willing to pay an extra 3.3%, and then it is increased to 6.7% or reduced to 1.7%, depending on their response. This has some implication for the estimation, as is noted below.

In the first model presented below (Table 7.8), only gender, social class and age were included to capture heterogeneity across the population, and of these only gender is statistically significant. However, convergence problems required that the coefficients on gender be restricted to be equal across both rounds of the question, and so this is in fact a partially restricted model. Included as explanatory variables are both the value offered (**Value**), and the level of change in the label threshold (**Lab%**). However, in this initial, "unrestricted" model there is no variation in the Value across the first Round: all are offered a 3.3% cost change. As a result, in this model, one obtains no estimate of the coefficient on Value from the first round. However, in the second round, the coefficient is negative as expected, as is the coefficient on the label threshold label (**Lab%**): as the percentage threshold becomes smaller, the more likely respondents are to pay the suggested amount.

Table 7.8: A Simple Model

```
Seemingly unrelated bivariate probit              Number of obs   =        270
                                                  Wald chi2(4)    =      92.66
Log likelihood = -322.23272                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1      |
      Value  |       --         --
       Lab%  |  -.4634414    .208335    -2.22   0.026    -.8717706   -.0551123
         sex |   .3370632   .1483369     2.27   0.023     .0463282    .6277981
       _cons |   .1032456   .2807555     0.37   0.713    -.4470251    .6535162
-------------+----------------------------------------------------------------
Round 2      |
     Value   |  -.1522742   .0164664    -9.25   0.000    -.1845477   -.1200008
       Lab%  |  -.3399169    .190313    -1.79   0.074    -.7129235    .0330896
         sex |   .3370632   .1483369     2.27   0.023     .0463282    .6277981
       _cons |   .5573203   .2860904     1.95   0.051    -.0034066    1.118047
-------------+----------------------------------------------------------------
     /athrho |    3.03711   9.640629     0.32   0.753    -15.85817     21.9324
-------------+----------------------------------------------------------------
         rho |   .9954077   .0883422                              -1           1
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  2.12305    Prob > chi2 = 0.1451
```

One can now apply the test that the coefficients are the same across both rounds (conditional on the restriction applied to gender already). One complication is the absence of Value from the first Round estimation. However, one can infer what the appropriate restriction should be, through the intercept term. If the restriction is true, then the probability generated by the first round function should be identical to that generated by the second round. The estimate of the constant for the first round therefore has to reflect the missing impact of a 3.3% Value being requested, which can be expressed in a more complex restriction:

$$\_cons(\text{Round 1}) = \beta(\text{Value})*3.3 + \_cons(\text{Round 2})$$

The restriction is accepted, with a LR test statistic of 1.26, compared to a critical χ^2 value of 5.99.

The resulting model is presented in Table 7.9.

Table 7.9

```
Seemingly unrelated bivariate probit              Number of obs   =        270
                                                  Wald chi2(2)    =      10.41
Log likelihood = -322.89082                       Prob > chi2     =     0.0055
------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1      |
       Value |
         Lab% |  -.3627824   .1877622    -1.93   0.053    -.7307895    .0052248
         sex |   .3367494   .1482992     2.27   0.023     .0460884    .6274105
       _cons |   .0612808   .2778902     0.22   0.825    -.4833739    .6059356
-------------+----------------------------------------------------------------
Round 2      |
       Value |  -.1516061   .0193571    -7.83   0.000    -.1895453    -.113667
         Lab% |  -.3627824   .1877622    -1.93   0.053    -.7307895    .0052248
         sex |   .3367494   .1482992     2.27   0.023     .0460884    .6274105
       _cons |   .5615811   .2910581     1.93   0.054    -.0088823    1.132044
-------------+----------------------------------------------------------------
     /athrho |   2.478676   2.397231     1.03   0.301     -2.21981    7.177163
-------------+----------------------------------------------------------------
         rho |   .9860352   .0664864                     -.9766744    .9999988
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  3.43925    Prob > chi2 = 0.0637
```

For any given increase in food bill, the higher the threshold, the less likely respondents are to say ‘yes’. For any given threshold, the higher the increase in bill, the less likely they are to accept.

However, note that Lab% is only just significant, meaning that they are responding to the change in the threshold, but only just. Although this variable is strictly cardinal, it may well be the case that the respondents are not responding to changes in the variable in that way. It is possible to test whether there is a non-linear response to the levels in Lab%, and indeed this is found to be the case as the model in Table 7.10 indicates: respondents are not distinguishing between 0.9% and 1% label thresholds (or at least, the data cannot detect such an effect) and they are treating 0% and 0.5% as equivalent. This suggests that they are reacting positively to ‘substantial’ changes in threshold, but doing so at a fairly coarse level. A larger sample may allow one to discriminate at a finer level, but this is not possible here.

Table 7.10

```
Seemingly unrelated bivariate probit              Number of obs   =        270
                                                  Wald chi2(2)    =      12.18
Log likelihood = -322.00708                       Prob > chi2     =     0.0023

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Round 1      |
       Value |      - -
      LabDum |   .3619907   .1542121     2.35   0.019     .0597406    .6642407
         sex |   .3496756   .1473366     2.37   0.018     .0609012      .63845
       _cons |  -.3631582   .2673829    -1.36   0.174    -.8872191    .1609026
-------------+----------------------------------------------------------------
Round 2      |
       Value |  -.1525815   .0194173    -7.86   0.000    -.1906387   -.1145243
      LabDum |   .3619907   .1542121     2.35   0.019     .0597406    .6642407
         sex |   .3496756   .1473366     2.37   0.018     .0609012      .63845
       _cons |   .1403608   .2785908     0.50   0.614    -.4056672    .6863887
-------------+----------------------------------------------------------------
     /athrho |   2.520859   2.794926     0.90   0.367    -2.957095    7.998813
-------------+----------------------------------------------------------------
         rho |   .9871577   .0713255                     -.9946129    .9999998
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =   3.4971    Prob > chi2 = 0.0615
```

A further issue is the inclusion of the attitudinal variables. Again, the use of these variables reduces the significance of the other demographic variables (here, gender). The test of whether there are any shifts in preferences across the two rounds reveals differences for the first time in this study. However, the effect seems to be restricted to the **EnvCons** variable. In the second round the coefficient increases significantly, implying that the response is becoming more polarised across this variable. However, for ease of discussion, the results presented below are for the model where all coefficients are constrained to be the same across both rounds.

Table 7.11

```
Seemingly unrelated bivariate probit              Number of obs   =        270
                                                  Wald chi2(3)    =      34.92
Log likelihood = -309.82999                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
yes9a        |
       value |
      LabDum |   .4583929   .1565193     2.93   0.003     .1516207    .7651651
     GMTrust |  -.1909279     .07456    -2.56   0.010    -.3370628    -.044793
     EnvCons |   .3014217   .0749389     4.02   0.000     .1545441    .4482993
       _cons |   .1771967   .1351898     1.31   0.190    -.0877705    .4421639
-------------+----------------------------------------------------------------
yes9bc       |
       value |  -.1600835   .0207081    -7.73   0.000    -.2006705   -.1194964
      Labdum |   .4583929   .1565193     2.93   0.003     .1516207    .7651651
     GMTrust |  -.1909279     .07456    -2.56   0.010    -.3370628    -.044793
     EnvCons |   .3014217   .0749389     4.02   0.000     .1545441    .4482993
       _cons |   .7054721   .1647569     4.28   0.000     .3825544     1.02839
-------------+----------------------------------------------------------------
     /athrho |   2.394801   2.266804     1.06   0.291    -2.048054    6.837656
-------------+----------------------------------------------------------------
         rho |   .9835056   .0741623                     -.9672699    .9999977
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  6.41962    Prob > chi2 = 0.0113
```

7.2.1 Partworths / Willingness to Pay

The median WTP (as a percentage of food budget) in order to achieve a shift in the label threshold from 1% to 0.0/0.5% varies by gender as follows:

Threshold (from 1% to 0.0 & 0.5%)	
Male	5.9
Female	8.1

Derived from Table 7.10

When attitudes are included, the median WTP for the same change in label threshold becomes:

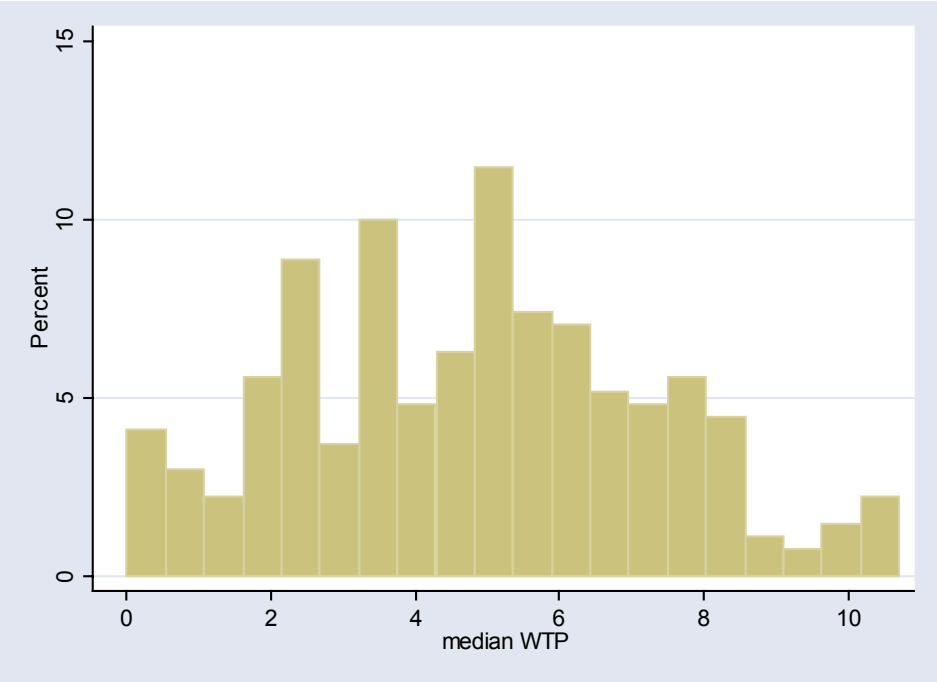
Threshold (from 1% to 0.0 & 0.5%)	
GMTrust= -1	8.28
GMTrust= 0	7.22
GMTrust= 1	6.07
EnvCons= -1	5.24
EnvCons= 0	7.23
EnvCons= 1	9.21

Derived from Table 7.11
Attitude set to zero if not explicitly under consideration.

It is significant to note that the levels of the WTP are substantially smaller than those achieved for Bread. This may be anticipated, as bread is such a small element of the overall food basket and so there would seem to be evidence of an appropriate scale effect. It is also noteworthy that the inclusion of the food bill in the label threshold model was not statistically significant, i.e. there is no evidence that those on higher food bills are prepared to pay a higher percentage increase in food bill to achieve tighter labelling standards.

Again, the population average median and mean WTP can be calculated, for both versions of the model. For the model without attributes, the median WTP is 7.16 (0.6) and the mean WTP is 7.6; when attributes are included in the model, the equivalent values are almost identical: 7.27 (0.6) and 7.65. Figure 7.3 presents the median WTP for the respondents.

Figure 7.3: The distribution of Median WTPs



7.3 Summary & Key Conclusions

The results from both the CV and CVM models indicate that the EU directive to lower the GM labelling threshold to 0.9% has no value to consumers. The results from both sets of models indicated that people viewed the 0.9% threshold as equivalent to the current 1% level threshold

However, respondents, on average, do value a lowering of the label threshold to the 0%-0.5% . In the CM analysis the estimated (median) WTP for this change was 24% of their food bill., although a third of respondents did not value the change at all. In the CV analysis is was substantially lower (about 7%) but still significant.

Unlike the results regarding an increase in the robustness in the labelling regime to include GM-derived products, there was little variation in these results across demographic factors, with the exception of the role of the composite attitudinal factor in the CV model

The CV and CM results indicated that respondents treated a threshold of 0% as the same as one of 0.5%. This is perhaps surprising, as one might expect the “GM free” level to be considered qualitatively different from any positive threshold level indicating the presence of GM material.

For a relaxation of the threshold level (to 2%) respondents would require compensation . The WTP values estimated for slackening and tightening the threshold regime are not, however, symmetric.

A fuller discussion of the these results and the implications of the similarities and differences between the CM and CV results is found in Section 9 where there is a full discussion of the study’s results.

Section 8 Analysing consumer reactions to changes in the proportion of food items containing GM ingredients.

8.1 Choice Modelling Results

The preferences of 338 of the 608 respondents in the survey were investigated concerning the overall level of goods in their diet containing GM ingredients. This issue was investigated through choice sets and accompanying double-bounded contingent valuation questions.

As was explained in Section 4 regarding the study process, the choice sets comprised the following attributes and levels:

Attribute		**Levels**
Cost (weekly food bill, %)	**[price]**	-50, -40, -30, -20, -10, Usual, +10, +20
Percentage of food products that contain GM ingredients (%)	**[gm]**	0, 1, 25, 50, 80, 100
Amount of food with pesticide residues (%)	**[pest]**	0, 5, 10, 30, 50, 100
Food Origin	**[orig]**	Anywhere, Mainly Europe, Mainly UK

Since there was uncertainty regarding the precise level of food products containing GM ingredients that respondents were consuming (some may consume only organic food, while others may be consuming a high level of processed food which could contain many ingredients derived from GM crops) there was no status quo option that could be used across the choice sets and respondents.

Estimating Choice Models

The simple model give an indication of (i) whether changes in attribute levels significantly affect choices made, and (ii) whether an increase in their level makes the choice of that option more or less likely.

Table 8.1: A Simple Model

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4056
                                                  LR chi2(4)      =     386.14
                                                  Prob > chi2     =     0.0000
Log likelihood = -1292.2547                       Pseudo R2       =     0.1300

------------------------------------------------------------------------------
       choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
      price |  -.0096538   .0018065    -5.34   0.000    -.0131944   -.0061132
         gm |  -.0157067    .001151   -13.65   0.000    -.0179626   -.0134507
       pest |  -.0192202   .0012787   -15.03   0.000    -.0217265   -.0167139
       orig |   .0093533    .046947     0.20   0.842    -.0826612    .1013678
------------------------------------------------------------------------------
```

In the model in Table 8.1 the estimated coefficients are negative for **price**, **gm** and **pest**, indicating that increases in these attributes decrease the likelihood of an option being selected. The coefficient on **orig** is statistically insignificant.

As with the models developed to analyse the robustness of GM labelling and the threshold at which labels are necessary, the extent to which interviewees distinguished between attribute levels in their choices was investigated. It was found that consumers did not, at the 5% significance level, respond differently to food baskets in which 0% and 1% of goods contained GM ingredients. Similarly, respondents treated options with 25%, 50% and 80% of goods containing GM ingredients in the same way. On this basis, GM attribute levels were represented by 3 variables: 2 dummy variables, **gm01** and **gm2580**, for the composite GM attribute levels 0-1% and 25-80% respectively, and a dummy variable, **gm100**, to denote all food contained GM ingredients.

The distinctions made between different levels of pesticide residues were also investigated. The choices made revealed that respondents treated pesticide levels of 0%, 5% and 10% as equivalent, and also levels of 50% and 100% were found to be treated the same in the choices made. The composite dummy variables **pest010** and **pest50100** were therefore created and used alongside a dummy variable pest30. There are some variations in the precise grouping of

levels, but the overall result regarding responses to pesticides levels is similar to that found in that section of the survey dealing with label thresholds (respondents faced either the label threshold choice sets, or these, not both).

The results of this model, using these composite attribute levels, is shown in Table 8.2. Again to avoid co-linearity, it is necessary to omit one of the level of the attributes from the estimation - the omitted level acts as the baseline against which the effects of the other levels, on the probability of option selection, are evaluated. The baseline levels used here are 30% for pesticide residues (given that 30% is the current level), and 0-1% for the GM content.

Consumers in the sample responded to the variable representing the origin of one's food (**origin**) similarly between these two sections of the questionnaire also. The raw variable with 3 levels (Anywhere, Mainly Europe, Mainly UK) was insignificant but a modified version of it, a (0,1) dummy variable for 'Mainly UK' (**ori2**) was found to be positive and significant, indicating, indicating that people preferred options with their food mainly being UK in origin, but were indifferent to whether their food came mainly from Europe or from 'anywhere'.

Table 8.2

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4056
                                                  LR chi2(6)      =     436.28
                                                  Prob > chi2     =     0.0000
Log likelihood = -1267.1838                       Pseudo R2       =     0.1469

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |  -.0067815   .0019632    -3.45   0.001    -.0106293   -.0029336

      gm2580 |  -.9642369   .0865282   -11.14   0.000    -1.133829   -.7946446
       gm100 |  -1.535469   .1286746   -11.93   0.000    -1.787666   -1.283271

        p010 |   .2132105   .0948635     2.25   0.025     .0272814    .3991396
      p50100 |  -1.006938   .0980664   -10.27   0.000    -1.199144   -.8147311

        ori2 |   .2229408   .0806604     2.76   0.006     .0648493    .3810324
------------------------------------------------------------------------------
```

Differentiated Models

The next stage of the analysis is to investigate whether socio-economic differences in the sample affect the way in which changes in the levels of the attributes influence choices. As was explained in Section 3, these factors can not be simply entered into the choice model, rather they enter as interactions with the attributes, thus altering the impact of the latter. To recapitulate, a preliminary analysis identified the following demographic factors as significant:

- Social Class (AB, C1, C2, D and E)
- Gender
- Presence of children in the household
- Age
- Attitudes (GMTrust and EnvCons)

As in the previous analysis of label robustness, we first consider the role of class, gender and the presence of children in the household. An additional factor to be borne in mind here is that there are, given that the 0-1% GM level is the baseline, two other GM levels to consider: 25-80% and 100%. Hence segments in the sample who treated GM levels equivalently were identified in terms of a move to the 25-80% GM level as well as the 100% GM level. This led to the identification of several groups whose responses to the GM variables were significantly different from each other:

25-80% GM level:

Group A: Class AB, C1, C2 – without children

Group B: Class AB, C1, C2 – with children

Group C: Class D and E

100% GM level:

Group D: Class AB, C1, C2, D: males and females without children

Group E: Class AB, C1, C2, D: females with children

Group F: Class E

In addition while respondents responded in a similar manner to lowering the proportion of food with pesticide residues to the 0-10% level, the disutility from increasing pesticide residue levels to the 50-100% level differed between social class D and the other social groups.

A model estimated in this form is shown in Table 8.3. We found that, in terms of the move to 25-80% of food containing GM ingredients those in social class A to D with children in the household are most unreceptive to such a development, followed by those in the same classes but without children, with those in classes D and E being least concerned. In terms of the move to all food containing GM ingredients, it is female respondents in classes A to D, with children in the home, whose utility is most reduced by this option, followed by males and also females without children from the same social groups, and finally social class E.

Table 8.: Segmented Model

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4056
                                                  LR chi2(11)     =     468.83
                                                  Prob > chi2     =     0.0000
Log likelihood = -1250.9104                       Pseudo R2       =     0.1578

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |  -.0069048   .0019774    -3.49   0.000    -.0107804   -.0030292

  grpAgm2580 |  -.8632964   .1233219    -7.00   0.000    -1.105003   -.6215899
  grpBgm2580 |  -1.305098     .13476    -9.68   0.000    -1.569223   -1.040973
  grpCgm2580 |  -.7039091   .1395407    -5.04   0.000    -.9774039   -.4304143

   grpDgm100 |   -1.39046   .1647549    -8.44   0.000    -1.713373   -1.067546
   grpEgm100 |  -2.287213   .2712833    -8.43   0.000    -2.818918   -1.755508
   grpFgm100 |  -.6712379   .3047818    -2.20   0.028    -1.268599   -.0738766

      p0to10 |   .2249699   .0956118     2.35   0.019     .0375742    .4123657
sc1235p50100 |  -1.092684    .104237   -10.48   0.000    -1.296985   -.8883834
   sc4p50100 |  -.5732415    .176134    -3.25   0.001    -.9184577   -.2280253

        ori2 |   .2195567   .0811551     2.71   0.007     .0604957    .3786178
------------------------------------------------------------------------------
```

As with the analysis of responses relating to the robustness of the labelling regime, age was initially considered through the use of discrete age groups. As with the robustness results, there appears to be evidence of a quadratic relationship between age and the extent to which welfare is reduced by higher GM levels in food.

This issue was therefore explored by adding **age** and **age^2** terms to the choice model. The effects of these terms could then be tested to see if both, either or none of them were significant for the segments identified above. A model introducing these age terms is shown in Table 8.4. There is no age effect for Groups A and B, for a move to 25-80% GM level. For group C, however, there is a quadratic age effect with both age and age^2 significant. There are no significant age interactions concerning the 100% level, but there are age effects concerning

pesticides. For example, on the pesticide 0-10% variable there is an age term which is negative and significant, the age^2 term on this attribute was insignificant. The implication of this is that the benefit of reducing pesticide residues to this level is valued less by older respondents. This linear relationship is such that the model suggests that as someone reaches their mid 70s the value of this reduction in pesticide levels falls to zero. There is another age effect regarding pesticides, this time concerning those in social class D, but on this occasion it is a quadratic, not linear, age relationship.

Table 8.4: Adding Age Effects

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4056
                                                  LR chi2(16)     =     487.06
                                                  Prob > chi2     =     0.0000
Log likelihood = -1241.7927                       Pseudo R2       =     0.1640

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |  -.0070702     .00199    -3.55   0.000    -.0109704     -.00317

  grpAgm2580 |  -.8575376   .1234906    -6.94   0.000    -1.099575   -.6155005

  grpBgm2580 |  -1.313891   .1353245    -9.71   0.000    -1.579122    -1.04866

  grpCgm2580 |   2.104686   .9730047     2.16   0.031     .1976316     4.01174
     grpCage |  -.1119449   .0421459    -2.66   0.008    -.1945494   -.0293405
    grpCage2 |   .0009678   .0004119     2.35   0.019     .0001605    .0017752

   grpDgm100 |  -1.381234   .1649879    -8.37   0.000    -1.704604   -1.057863

   grpEgm100 |  -2.289871   .2720079    -8.42   0.000    -2.822997   -1.756746

   grpFgm100 |  -.6486332   .3064818    -2.12   0.034    -1.249326   -.0479399

      p0to10 |   .6119523   .2101124     2.91   0.004     .2001395    1.023765
   p0to10age |  -.0082973   .0038916    -2.13   0.033    -.0159247   -.0006699

sc1235p50100 |  -1.107027   .1046676   -10.58   0.000    -1.312172   -.9018821

   sc4p50100 |   2.092397   1.214494     1.72   0.085     -.287967    4.472761
sc4p50100age |   -.123085   .0547555    -2.25   0.025    -.2304038   -.0157662
sc4p50100age2 |   .0012397   .0005551     2.23   0.026     .0001517    .0023278

        ori2 |   .2249562   .0814895     2.76   0.006     .0652397    .3846728
------------------------------------------------------------------------------
```

Including Attitudes in the Model

For all three social segments identified the attitude factor score for the composite variable GMTrust (see Section 6.1.3 for an explanation of this composite attitudinal factor) was included to see whether it, alongside age in some cases, affected the way in which changes in the GM content of the household's food affected welfare.

In all three cases the coefficient estimated for the GMTrust variable was positive, meaning that as this attitude score increases (i.e. the respondent has a more positive view of GM food), the negative effect of the increase in the GM content of the household's food is reduced.

In addition, the second composite attitudinal score introduced in Section 6.1.3, EnvCons, was used to interact with the pesticide terms in the model. This second attitudinal score is significant in changing the way in which an increase in residues to the 50-100% level for social classes A, B, C1, C2 and E. More specifically, the negative coefficient on this variable acts to increase the negative effect of an increase to 50-100% of food having detectable pesticide residues for these groups.

Table 8.5: A Model with Attitudes Included

```
Conditional (fixed-effects) logistic regression   Number of obs   =       4056
                                                  LR chi2(22)     =     553.53
                                                  Prob > chi2     =     0.0000
Log likelihood = -1208.5603                       Pseudo R2       =     0.1863

------------------------------------------------------------------------------
        choi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price |  -.0076281   .0020346    -3.75   0.000    -.0116158   -.0036403

  grpAgm2580 |  -.8991967   .1275986    -7.05   0.000    -1.149285    -.649108
    grpApca1 |   .5196658   .1216591     4.27   0.000     .2812184    .7581133

  grpBgm2580 |  -1.285261   .1382436    -9.30   0.000    -1.556213   -1.014308
    grpBpca1 |   .5848288    .124792     4.69   0.000      .340241    .8294166

  grpCgm2580 |    1.73874   .9973992     1.74   0.081    -.2161261    3.693607
    grpCpca1 |   .5306218   .1526634     3.48   0.001     .2314071    .8298365
     grpCage |  -.1109424   .0429577    -2.58   0.010     -.195138   -.0267469
    grpCage2 |   .0010228   .0004193     2.44   0.015     .0002009    .0018446

   grpDgm100 |  -1.452981   .1725554    -8.42   0.000    -1.791184   -1.114779
    grpDpca1 |   .6753697   .1627479     4.15   0.000     .3563897    .9943497

   grpEgm100 |  -2.246072   .2733867    -8.22   0.000      -2.7819   -1.710244
    grpEpca1 |   .6126652   .2943348     2.08   0.037     .0357796    1.189551

    sc5gm100 |  -.5464722   .3073833    -1.78   0.075    -1.148932     .055988

      p0to10 |   .6822369   .2120163     3.22   0.001     .2666925    1.097781
   p0to10age |  -.0097904   .0039285    -2.49   0.013    -.0174902   -.0020907

sc1235p50100 |   -1.13978   .1069627   -10.66   0.000    -1.349423    -.930137
  p50100pca2 |  -.2478574   .0750965    -3.30   0.001    -.3950437    -.100671

   sc4p50100 |   2.081416    1.23919     1.68   0.093    -.3473513    4.510182
sc4p50100age |  -.1224954   .0558317    -2.19   0.028    -.2319235   -.0130674
sc4p50100age2 |   .0012194   .0005656     2.16   0.031     .0001108    .0023279

        ori2 |   .2174471   .0827886     2.63   0.009     .0551844    .3797098
------------------------------------------------------------------------------
```

As a result, this final model indicates a series of segments based on the interviewees' class, gender, age attitudes and whether there are children present in the household.

8.1.1. Partworths / Willingness to Pay

As with the other sections of the study, the WTPs regarding changes in the GM content of the household's food may vary with class, gender, and whether there are children present, as well as age and attitude.

These WTPs regarding GM food are displayed in Tables 8.6 - 8.8 for 3 illustrative **GMTrust** attitudinal scores: +1, 0, -1. where +1 represents a more positive attitude to GMs, -1 is a more hostile view of GM issues and 0 is the mean composite attitudinal score.

Considering a change in GM content to 25-80% of the food basket, it is found that, for Groups A and B, WTPs are large, and significant, but do not vary by age of respondent. For Group C, WTPs do vary with age of the respondent but are only significant in certain ranges; notably, of those more confident regarding GM food and the regulatory process (GMTrust(1)) only respondents aged between 36 and 69 would pay to avoid this increase in GM content. The WTPs for Group C are depicted also in Figure 8.1

Table 8.6: GM 25-80% Group A: Class AB, C1, C2 – without children

	GMTrust (0)	GMTrust (1)	GMTrust (-1)
	-117.88	-49.75	-186.01

Table 8.7: GM 25-80% Group B: Class AB, C1, C2 – with children

	GMTrust (0)	GMTrust (1)	GMTrust (-1)
	-168.49	-91.82	-245.16

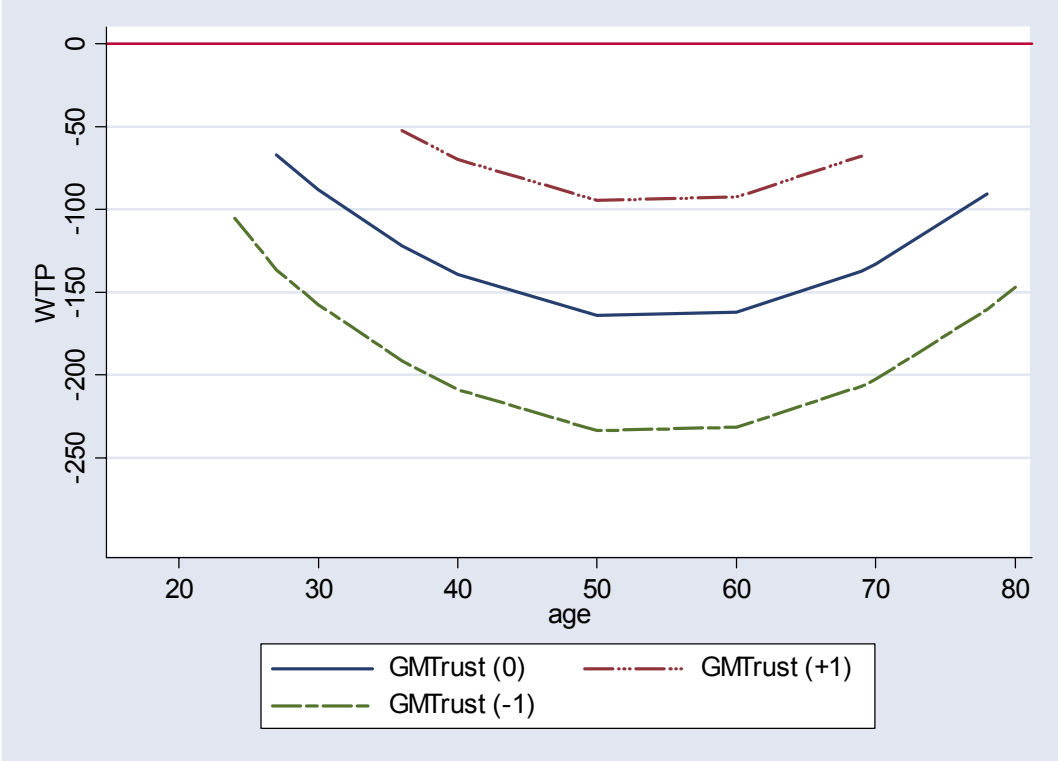
Table 8.8: GM 25-80% Group C: Class D and E*

Age	GMTrust (0)	GMTrust (1)	GMTrust (-1)
20			
24			-105.2
27	-67		-136.56
30	-87.71		-157.27
36	-121.87	-52.31	-191.44
40	-139.29	-69.73	-208.85
50	-164.06	-94.5	-233.62
60	-162.01	-92.45	-231.57
69	-137.24	-67.67	-206.8
70	-133.14		-202.7
78	-90.74		-160.3
80			-147.02

*Insignificant estimates are not tabulated

These age and attitudinal effects for social classes D and E can be seen more clearly when these WTPs are graphed:

Figure 8.1: WTPs (%)GM 25-80% Group C: Class D and E



Turning to the situation where all food contains GM ingredients (Table 8.9), no age effects are found for any of the Groups, but WTPs do vary with attitudes for Groups D and E. In all three groups WTPs are large, although, for Group E, WTP is not statistically significant.

Table 8.9: GM 100% Group D: Class AB, C1, C2, D: males and females without children

	GMTrust (0)	GMTrust (1)	GMTrust (-1)
	-190.48	-101.94	-279.02

Table 8.10: GM 100% Class AB, C1, C2, D: females with children

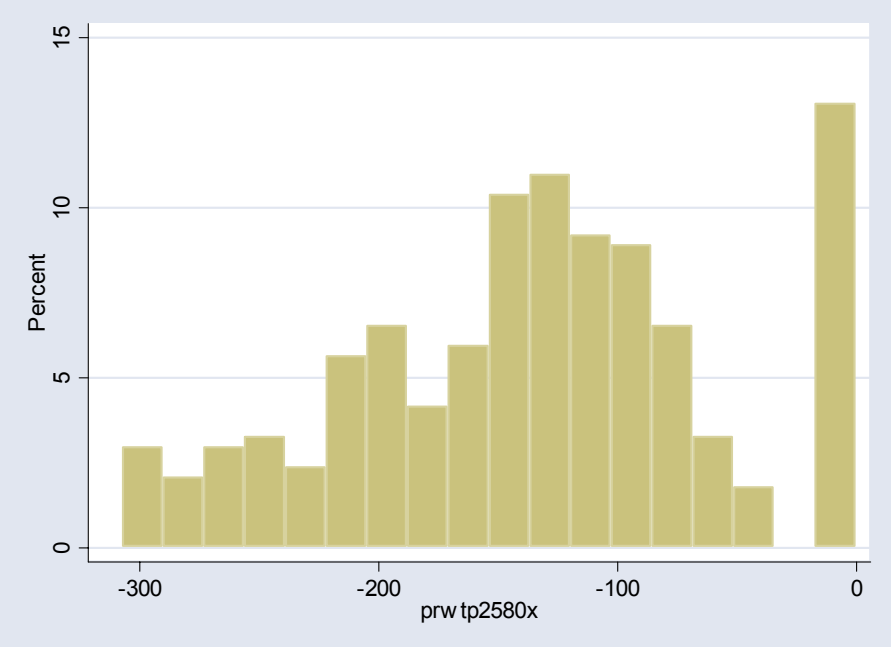
	GMTrust (0)	GMTrust (1)	GMTrust (-1)
	-294.45	-214.13	-374.77

Table 8.11: GM 100%: Class E

	All respondents
	-71.64^{NS}

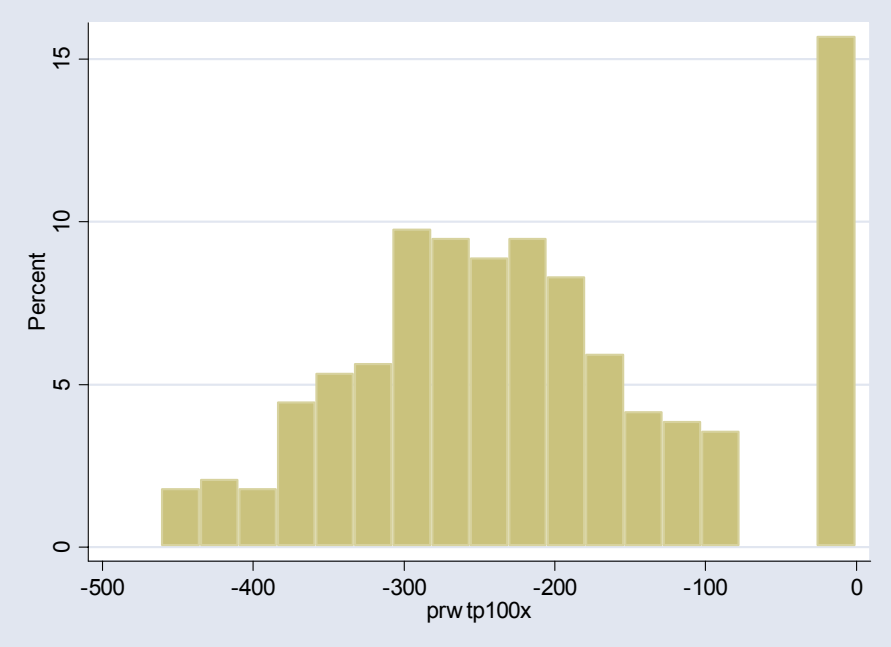
The distributions of these willingness to pay to avoid the two levels of GM content in food, for the whole sample, are shown in Figures 8.2 and 8.3

Figure 8.2: Distribution of WTPs(%) GM 25-80%



The median is -130.6%, with a mean of -136.4%.

Figure 8.3: Distribution of WTPs(%) GM 100%



The median is -226.3%, with a mean of -224.9%.

8.2 Contingent Valuation Results

The value of the information obtained from the previous CV question identifying respondents' WTP to change the level at which GM content would be revealed will vary according to the individual's assessment of the impacts of GM content on their welfare.

For the final dichotomous CV question in the study, the level of GM content in the food basket itself is varied. Specifically, the following question was posed:

> Suppose you were offered the choice of two food baskets as your weekly food shop:
>
> – one which has only non-GM food and one in which *(50%, 5% or 100%)* of the food contains GM ingredients.
> – Would you choose the one containing *(50%, 5% or 100%)* GM ingredients if it were *(50%)* cheaper than your usual weekly food spend?
>
> **IF NO, ASK:**
> Would you choose the basket with *(50%, 5% or 100%)* of the food containing GM ingredients if it were *(67%)* cheaper than your usual weekly food spend?
>
> **IF YES, ASK:**
> Would you still choose the basket with *(50%, 5% or 100%)* of the food containing GM ingredients if it were *(33%)* cheaper than your usual weekly food spend?

Again, the respondent is being asked to value the change in content, and the content levels vary. Table 8.12 presents the distribution of responses to the initial and follow-up questions. The same modelling approach is taken as that in the label threshold section (Section 7.2).

Table 8.12: Distribution of Responses to the CV GM% Content Question.

	Round 2		
Round 1	no	yes	Total
no	150	26	176
yes	27	135	162
Total	117	153	338

Initially an unrestricted model is estimated that includes only demographic variables. In this case, age, the presence of children and social class variables are significant. Non-linear age effects, as identified in the choice modelling section, are not significant, nor is the impact of total food bill on the WTP (in percentage terms). Again, the effect of social class has to be restricted between the two rounds to achieve convergence. Subject to this prior, the coefficients in round 1 and round 2 can be restricted to be the same (test statistic of 2.9, compared to a critical χ^2 value of 9.49). The results of the restricted model are reported in Table 8.13.

Table 8.13

```
Seemingly unrelated bivariate probit              Number of obs   =        338
                                                  Wald chi2(7)    =      60.88
Log likelihood = -347.75385                       Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
yes11a       |
       value |
         GM% |  -.0089974   .0018145    -4.96   0.000    -.0125537   -.0054411
         age |  -.0222636   .0044061    -5.05   0.000    -.0308994   -.0136278
        kids |  -.3864147   .1481142    -2.61   0.009    -.6767131   -.0961162
        scc1 |   .7822201   .1994735     3.92   0.000     .3912594    1.173181
        scc2 |   .6476088   .2053063     3.15   0.002     .2452159    1.050002
         scd |   .4939603   .2362159     2.09   0.037     .0309857    .9569349
         sce |   .2556223   .2546742     1.00   0.316    -.2435299    .7547746
       _cons |   1.113918   .3101519     3.59   0.000     .5060313    1.721804
-------------+----------------------------------------------------------------
yes11bc      |
       Value |   .0133862   .0018933     7.07   0.000     .0096755    .0170969
         GM% |  -.0089974   .0018145    -4.96   0.000    -.0125537   -.0054411
         age |  -.0222636   .0044061    -5.05   0.000    -.0308994   -.0136278
        kids |  -.3864147   .1481142    -2.61   0.009    -.6767131   -.0961162
        scc1 |   .7822201   .1994735     3.92   0.000     .3912594    1.173181
        scc2 |   .6476088   .2053063     3.15   0.002     .2452159    1.050002
         scd |   .4939603   .2362159     2.09   0.037     .0309857    .9569349
         sce |   .2556223   .2546742     1.00   0.316    -.2435299    .7547746
       _cons |    .444607   .3201012     1.39   0.165    -.1827798    1.071994
-------------+----------------------------------------------------------------
     /athrho |   3.299485    55.3685     0.06   0.952    -105.2208    111.8198
-------------+----------------------------------------------------------------
         rho |   .9972802   .3007769                              -1           1
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0:     chi2(1) =  10.8861    Prob > chi2 = 0.0010
```

Including the attitudinal variables did not lead in this case to a loss in significance of the demographic variables, but caused some extreme instability in the other parameters. In particular, it caused the coefficient on Value to change sign, and significance, but only in the restricted model. It is unclear why this occurred, and for current purposes this model is not pursued further.

Using the estimated model in Table 8.13, the median WTA for the increases in the level of goods containing GM ingredients can be estimated for a range of increments in GM level. Table 8.14 presents the WTPs, by social class, for a 50 year old respondent with children in the household and sample average attitudes. Table 8.15 shows WTP, by age group, for a respondent in social class AB, with children and sample average attitudes.

Table 8.14: Median discounts required for respondents to accept a basket with #% GM content, by social class.

Age	5% GM content	50% GM content	100% GM content
AB	32.2	62.4	96.0
C1	0	3.9[NS]	37.6
C2	0	14.1 [NS]	47.6

[NS] denotes not significant at 5%

Table 8.15: Median discounts required for respondents to accept a basket with #% GM content, by age.

Age	5% GM content	50% GM content	100% GM content
25	0	20.8 [NS]	54.4
50	32.2	62.4	96.0
70	65.4	95.7	129.3

[NS] denotes not significant at 5%

For the first time in this study, some median WTP values are reported as 0. This is because a significant proportion (greater than 50%) of the sample would be prepared to purchase a food basket containing 5% GM products, even if the size of the discount were zero. However, as the GM percentage increases, respondents in these groups (class C1 and C2 in Table 8.14 and age group 25 in Table 8.15) do require a discount to achieve a 50% probability of acceptance.

What is notable about these tables is the very high level of discount that is associated with the 100% GM content: at times in excess of the weekly basket cost. However, these values are for sub-groups within the population, and some may represent very small elements of it. An

alternative is to evaluate the median discount required for each basket, for the average respondent within the sample. These values are reported in Table 8.16

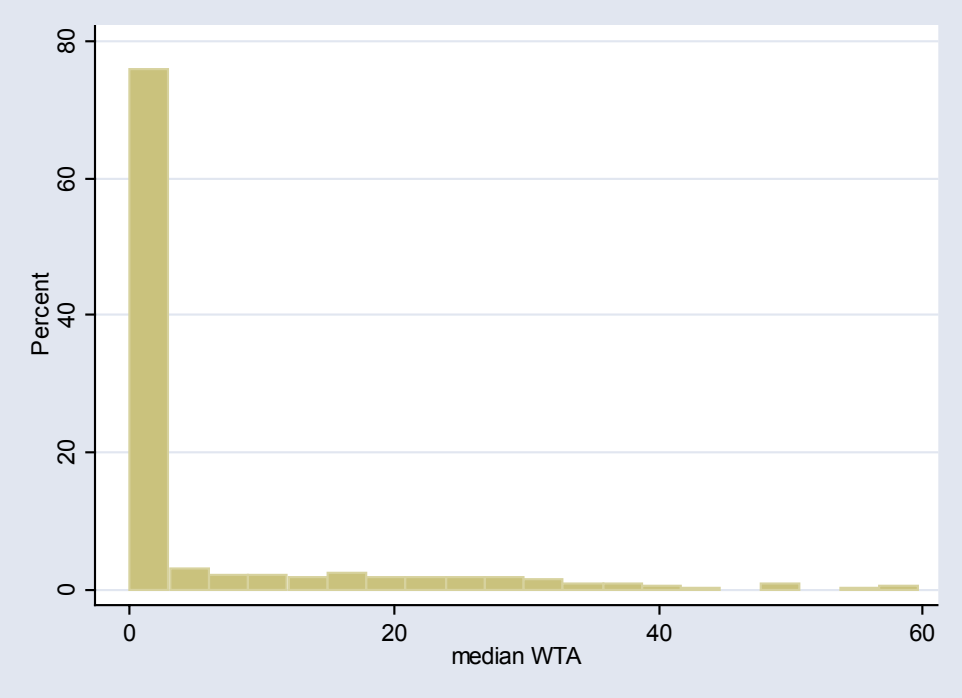
Table 8.16: Sample means and medians to accept a range of GM content.

	5% GM content	50% GM content	100% GM content
Sample Median	0	6.7 [NS]	40.3
Sample Mean	19.5	33.3	54.2

Derived from table G, all variables taken at average values.
[NS] denotes not significant at 5%

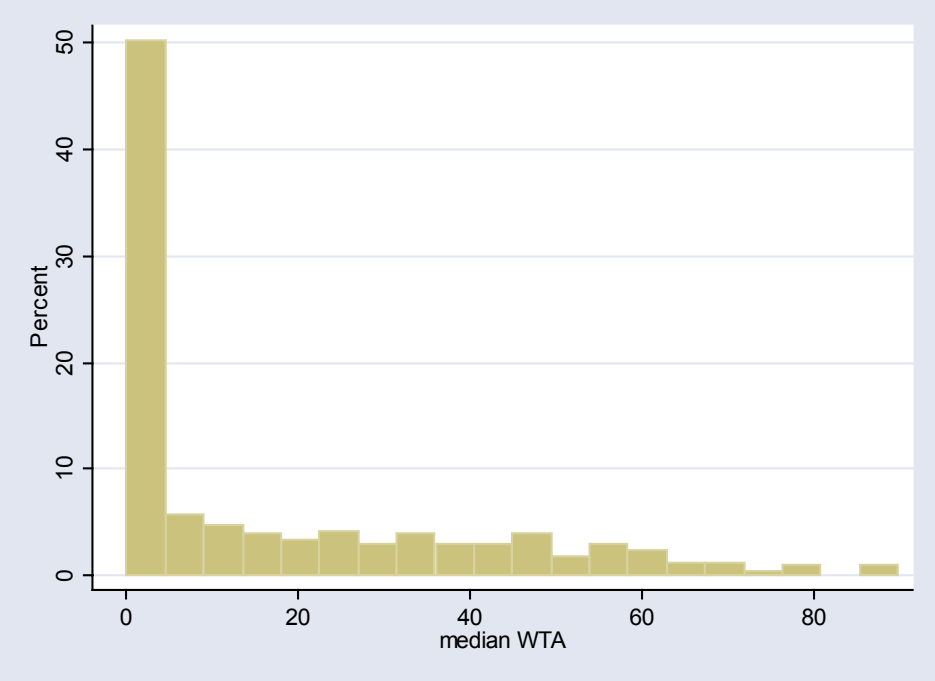
The distributions of WTAs compensation for the presence of the GM ingredients, at the GM content levels of 5%, 50% and 100%, are presented in Figures 8.6 to 8.8.

Figure 8.6: Distribution of median WTA, GM% in the food basket at 5%.



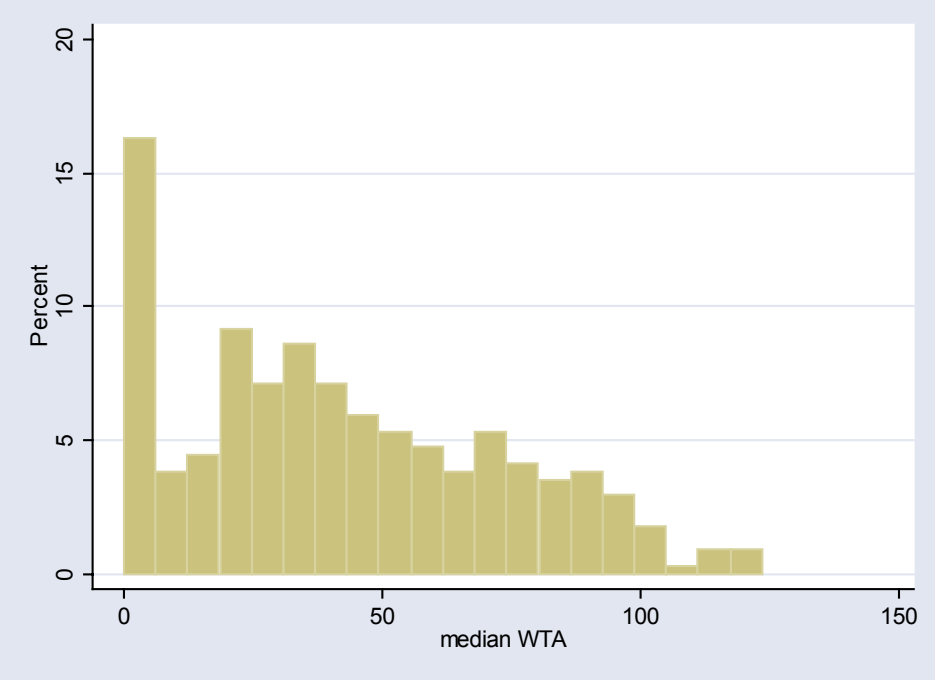
Censored at zero (74%=0).

Figure 8.7: Distribution of median WTA, GM% in the food basket at 50%.



Censored at zero (43%=0)

Figure 8.8: Distribution of median WTA, GM% in the food basket at 100%.



Censored at zero (11%=0).

8.3 Summary and Key Conclusions

Respondents were found to be sensitive to the varying levels of products in their shopping containing GM ingredients. Their valuations differed between these levels. Thus there is not a blanket response to an increase in GM levels in food. However the degree of sensitivity to these varying levels of GM content differed between the two approaches. In the choice modelling results respondents were fount to be insensitive over the following GM ranges: 0-1%, 25, 50, 80%, whereas for the CVM model only the 0-1% levels were found to be equivalent.

The fact that consumers generally treat the 0% and 1% levels of GM content as equivalent might suggest that they are indifferent when there is only a very small presence of GM material in their food (e.g. in derived products such as modified starch, emulsifiers, and soy products).

As with the robustness issue, and unlike the GM label threshold results, there was found to be considerable variation in the valuations across socio-economic groups and attitudes..

Regarding the scale of the valuations implied by the CM and CV models, it should be noted that the derived values are unfeasibly large in the CM analysis, whereas the average valuations are much lower for the CV model and for some segments of the sample, over certain ranges of GM content, the valuation is found to be zero.

A fuller discussion of the these results and the implications of the similarities and differences between the CM and CV results is found in Section 9 where there is a full discussion of the study's results.

Section 9 Discussion of Results and Conclusions

While there have been a number of quantitative, economic studies of consumer responses to GMOs in food conducted in a number of countries since 2000, this is the first such study based on a nationally representative dataset.

In this concluding section of the report the results from both methodologies are discussed in terms of the two core research questions that were initially set out in the context of the forthcoming changes in the EU GM food labelling regime:

- Estimating the benefits of increasing the robustness of the labelling regime
- Estimating the benefits of a reduction in GM labelling threshold levels

In addition it has sought to compare the results from two alternative methods for producing and analysing stated choice survey data: contingent valuation and the more recently developed choice modelling.

In addition, the results regarding a third more general research question, namely how consumers respond to changes in the proportion of their food items containing GM ingredients are discussed.

A related question which the research set out to investigate was what was the best methodological approach to estimating the benefits of these changes to the labelling regime? Specifically, are these benefits more amenable to estimation through contingent valuation than choice modelling?

In this Section of the report the results from both the choice modelling (CM) and contingent valuation (CV) models are discussed first regarding the two core research questions, and then regarding how consumer responses to changes in the proportion of their food items containing GM ingredients. Some methodological issues regarding choice modelling, contingent valuation and studies of this type are then discussed. Before addressing all these issues, we begin by briefly discussing some of the survey's more general results regarding GMOs in food, labelling, testing and the commercial growing of GM crops.

9.1 Results regarding GMOs in food and trust, labelling, testing and the commercial growing of GM crops

We find considerable consistency between the views and attitudes expressed in this study and those which have been found elsewhere in reports from the Consumers Association, work by Marris *et al*., (2001*)* and the GM Nation? consultation process. While there are some differences by social class and gender, there are some broad assertions that can be made about the views expressed.

Those surveyed were sceptical of the long term effects of GM crops and also, crucially, of why they should be introduced. The question of "who gains?" is significant. There also appears to be considerable scepticism regarding the information received on GM issues from most sources,-with the only sources of GM information which more than 10% of respondents say they would 'definitely trust' being universities/educational organisations. The government appears to be widely distrusted on both the specifics of GM technology as well as on broader food safety issues.

An interesting pattern of answers was given regarding some of the key GM policy issues of the moment. Only 23% of those questioned thought that commercial GM crop growing should be allowed in the UK at present, with 85% indicating that they thought that more testing was required if commercial growing was ever going to take place in the UK. Despite this broadly cautious or anti-GM pattern of views, only 25% of interviewees thought that all GM testing should be stopped and 43% thought that GM food should be available to buy in the UK, if clearly labelled, with 28% undecided on this issue.

There are parallels with the results here and some other research, including that by Marris *et al*, (2001) and the GM Nation? consultation. The findings here support the view that people are not simply 'for' or 'against' GMOs or that they think GM work should simply stop. There is scepticism regarding the nature of the benefits and of the costs and risks, and in terms of who will be the main beneficiaries of the use of the technology. The responses given indicate that people are wary of the information given from most sources regarding GM technology and are not simply malleable 'victims' of the media.

These attitudes are reflected in the majority view that commercial growing of GM crops should not proceed in the UK at present, but that further GM testing and should continue and indeed is required before any commercial growing takes place.

9.2 Estimating the benefits of increasing the robustness of the labelling regime

9.2.1 Background

As outlined in Section 1 of this report, the food labelling regime regarding GMOs has been based on the notion of substantial equivalence. That is to say, labelling of food products has been necessary where certain differences in composition have been determined. Hence food containing grains from GM crops, which can be tested and the novel genetic material detected, has required labelling. Other foods, produced from derivatives of GM crops such as highly refined oil from GM maize or soya beans have not required a label because they were regarded as chemically indistinguishable in composition from products derived from non-GM crops.

This scientific soundness of using substantial equivalence as the basis of regulation regarding GMOs in food has been discussed at length and it is not the purpose of this report to revisit or add to that debate. However, the new EU Directive on GM food and feed which comes into effect from April 2004 represents a significant shift away from this form of regulation. Ingredients derived from GMOs are now to be traced through the food chain with such ingredients needing to be labelled despite the absence of detectable modified DNA or protein.

This extension of the labelling regime imposes costs on industry and regulators since a traceability system is required so that products which are substantially chemically equivalent can be distinguished on the basis of the crops they are derived from and hence the process by which they were produced.

This study has investigated whether consumers in mainland Britain regard this imminent change to the labelling and traceability system as beneficial, and if so, to what extent. As was explained in Sections 3 and 4 of the report, the analysis of greater robustness in labelling is based on a specific simple good, bread, in order to explain better the issues and terminology involved and assess consumer responses. The analysis was

conducted using both a choice modelling approach and the double-bounded dichotomous choice contingent valuation method.

9.2.2 Results

Following convention, the choice sets included a 'status quo' option which in this context was a non-GM option. 45% of the sample opted for this usual, non-GM, bread in all of their choices. Of the remaining 334 respondents, 47% never chose a GM option, 10% chose one or more GM-derived options only, 19% chose one or more GM options and 24% chose some GM and GM-derived options. On the basis of these results, with 71% of the sample never choosing a bread containing GM or GM-derived ingredients, the results confirm the view of many attitudinal survey findings regarding the use of GMOs in food: there exists widespread distrust, scepticism and hostility towards GM foods.

However it should be noted that the motivations of those always choosing their usual bread are important – some may do so because they know that it contains no GM ingredients, others may do so because they like the taste or other qualities of the bread and may, if these qualities are unchanged, be prepared to purchase the same bread if GM or GM-derived ingredients were used.

The choice modelling results allowed testing of whether, implicitly through their selection of bread options, the interviewees treated the bread containing GM-derived ingredients as equivalent to non-GM bread, or to bread with GM ingredients, or as a distinctly different product. For the vast majority of those sampled, their choices indicated that they treated GM-derived ingredients as no different from GM ingredients. This would imply that regulation on the basis of process, rather than product, was valued by respondents. The critical issue appears to have been not whether the product contained detectable modified material, but the nature of the crop from which it was derived.

It was found that preferences regarding the GM nature of the bread differed by a number of socio-economic and demographic characteristics such as class, gender, age, attitudes, and the presence of children in the household. Preliminary analysis identified only one group of respondents in the sample, those aged between 16 and 24, who treated bread with GM-derived ingredients in the same way as non-GM bread. For all

other groups, the choices revealed that GM and GM-derived ingredients were regarded as the same.

The financial value that people placed on the avoidance of food containing GM and GM-derived ingredients was investigated using both the choice modelling and contingent valuation approaches. In each case the discounts and premia are generated in percentage terms with reference to the price of the household's usual loaf of bread. As such they are percentage changes in the value of a good which represents a very small proportion of the household's weekly expenditure and a proportion that declines as household income increases.

As discussed in Section 3, the statistical models used to analyse the responses from the contingent valuation questions and the choice sets are different and, as a result, the way in which demographic variables are incorporated into the analysis and how social segments are identified within the population differ between the two approaches.

While there were large variations across the social groups identified on the basis of class, gender and the presence of children and within them on the basis of age and attitudes, some average measures of the valuations and their distributions can be identified from both the choice modelling and contingent valuation results.

Figure 9.1 – Distribution of WTPs to secure non-GM bread: CM model[33]

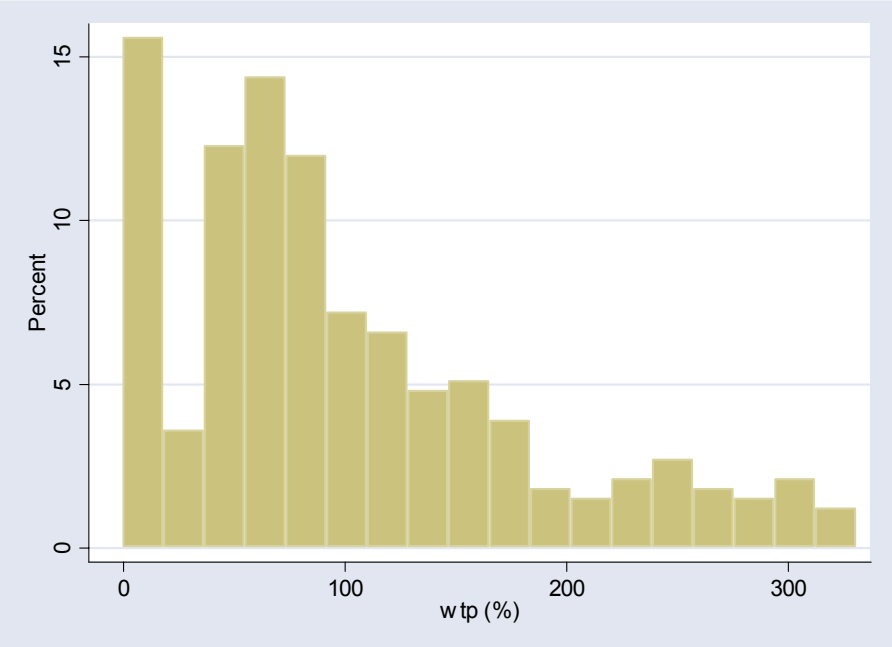
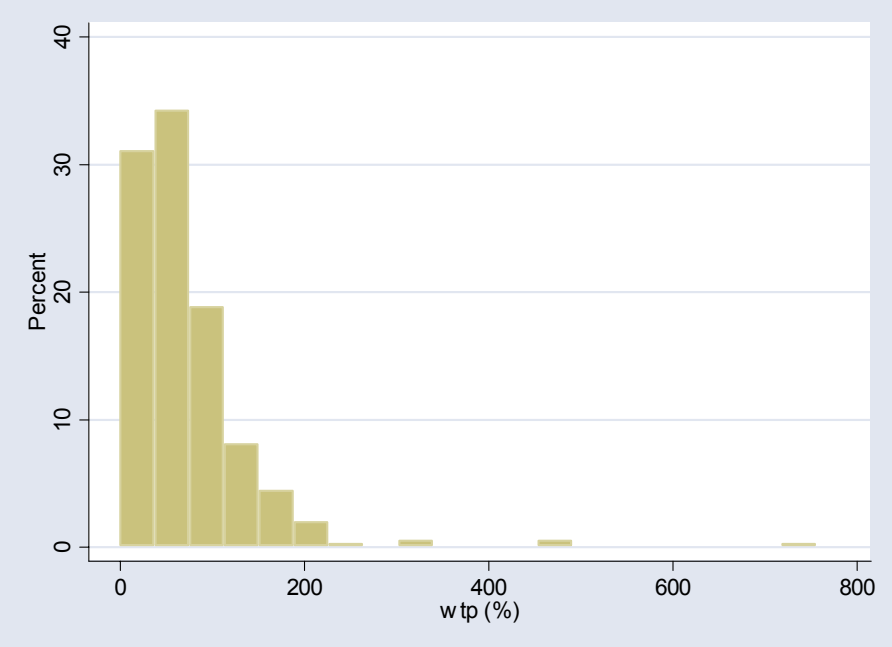


Figure 9.2 – Distribution of Median WTPs to secure non-GM bread: CV model

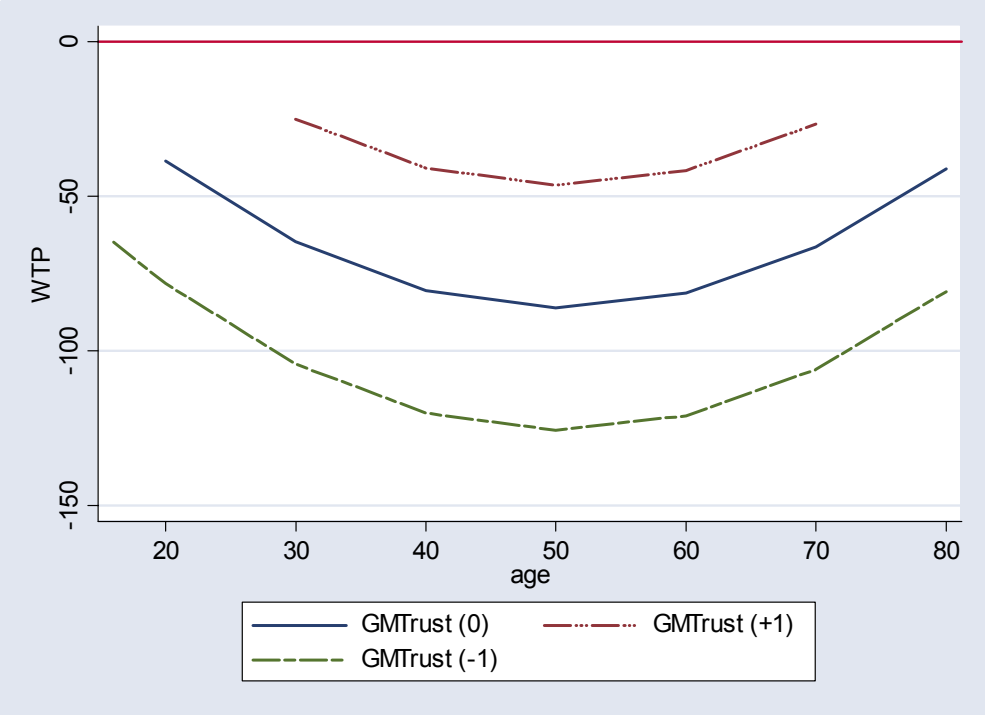


[33] Note that in this Figure the WTPs have been converted from negative to positive values to aid comparison with the CV graph. The interpretation is unchanged: they are WTPs to avoid the GM bread.

The distribution of the willingness to pay (WTPs) from both approaches, in percentage terms, to secure the non-GM bread is shown in Figures 9.1 and 9.2. The median WTP to avoid the GM bread is 57% from the contingent valuation results and 79% from the choice modelling results, while the mean figures are 62% and 99% respectively. It is unsurprising that those with attitudes which we characterise as more distrustful of GM food, who think that the benefits of GM food will primarily be captured by international companies and who trust the government less on food safety issues have, *ceteris paribus*, high WTPs to avoid GM ingredients in bread. Similarly we find that those in social classes AB and females in C1 also would pay more in both absolute, and indeed percentage, terms to avoid bread containing these GM ingredients. The choice modelling results indicate that approximately 15% are indifferent to the presence of GM ingredients in their bread, that is, their WTPs are effectively zero.

In addition to the finding from the choice modelling analysis that 16-24 year olds were the only group to regard GM-derived ingredients as equivalent to non-GM ingredients, there was a more general finding that age affected the extent to which people considered the GM ingredients to reduce their welfare. This is illustrated for a specific social segment in Figure 9.3, where the WTPs to avoid the GM bread are shown in percentage terms for 3 example values of the composite attitudinal score **GMTrust**. This figure shows that for a **GMTrust** value of +1, the WTP is insignificant until the mid 30s, it then increases to its maximum value at about age 50 before declining once more becoming insignificant again at age 70.

Figure 9.3 Class C1 males, Classes C2, D and E - with children



The results generated indicate a section of the population with extremely high WTPs. The choice modelling results imply 39% of the sample (excluding those who always chose their usual, non-GM bread) have a WTP to avoid GM bread of over 100%. It should be noted that these percentage figures are in terms of the cost of their bread which is a only small element of household food costs. The contingent valuation results also identified high WTPs for certain sections of the population, particularly those in class A and B who are prepared to pay extremely large amounts to avoid the GM bread. However the standard errors of these estimates are large. This means that these respondents' welfare would be strongly (negatively) affected by the consumption of such GM bread, but that the estimates regarding the size of these effects are imprecise.

9.2.3 Conclusions

The fundamental result from this first piece of analysis is that the vast majority of consumers regard the forthcoming extension of the labelling and traceability regime to include both GM ingredients and ingredients derived from GM products as highly desirable. With the possible exception of some of the youngest in the sample, the bread made with GM-derived ingredients was treated in the same manner as that made with

ingredients containing detectable altered genetic material or protein. While the introduction of the new labelling regime will no doubt generate additional costs for both industry, retailers and regulatory authorities, the evidence here is that the more robust and comprehensive labelling regime will deliver significant benefits for consumers.

Some in the sample are estimated to have extremely high WTPs, and some of the methodological issues related to this are discussed in Section 9.5. It is likely that these consumer will never knowingly consume bread containing GM or GM-derived ingredients. The fact that for these people large but statistically insignificant values were determined is at one level unimportant, the implication is that these people will, if they have a choice, avoid this type of food. However, it does make the estimation of an aggregate value of the label, even in terms of bread alone, problematic.

This complication is exacerbated by the fact a single good is being used here whereas the labelling issue is much broader. As was discussed in Section 6 and is returned to in Section 9.5, the complexity of the issues investigated here required the use of a specific single good, that is, bread. The values inferred from the models relate to percentage changes in the value of the household's bread. It would be inappropriate to assume that one can extend this result by aggregating it across all food types within the basket: there would be impacts on residual family income which are substantially greater than those implied for bread alone. Aggregating up to all goods from a single commodity study is therefore complicated by this budgetary impact. This aggregation problem is exacerbated by the fact that the prevalence of ingredients derived from GM crops will vary across the range of household food goods and because consumers are likely to react differently to the presence of GM (derived) ingredients in different foods (e.g. baby food as opposed to food for adults).

9.3 The benefits of a reduction in GM labelling threshold levels

9.3.1. Background

The second element of the EU regulation regarding GM food and feed is a lowering of the threshold level at which food with low levels of GM content that can be shown to be adventitious or technically unavoidable requires a label. This level was previously set at the 1% level, but this has been lowered to 0.9%, i.e. the accidental presence of GM material below the 0.9% level in food or feed does not require labelling. Labelling is still not required for food made using genetic modification technology, such as hard cheese produced with the help of chymosin from GM micro-organisms, and products such as meat and milk from animals fed on GM feed.

The extent to which consumers valued, if at all, this lowering of the threshold value for adventitious presence of GM was investigated using both the choice modelling (CM) and contingent valuation (CV) methods. Two hundred and seventy people in the sample were presented with choice sets and contingent valuation questions on this issue.

9.3.2. Results

The finding from both the CM and CV analysis was that consumer did not value the lowering of the threshold for inadvertent GM presence from the 1% to 0.9% level. Findings are consistent across both methods in this respect. However, respondents would value the lowering of this labelling threshold to the 0.5% and 0% levels. Indeed, the results from both methods of analysis indicate that consumers treated threshold levels of 0% and 0.5% as equivalent.

While these label threshold levels are strictly cardinal, it would appear that the respondents are not responding to level changes in that way. This suggests that those questioned are reacting positively to ‘substantial’ changes in the threshold level, but are doing so at a fairly coarse level. A larger sample might allow this issue of discrimination to be investigated further, but this is not possible here.

In contrast to the analysis dealing with the increase in the robustness of the labelling, which found significant variation in the way in which consumers with different demographic profiles responded to the GM issue, very little variation was identified regarding the label threshold issue. Social class, age and the presence of children were all found to play no significant role in terms of people's responses to changes in threshold levels. In the CV model there was a gender effect identified, and in both the CM and CV models the composite attitudinal variable GMTrust was found to have a significant effect with, unsurprisingly, those more trusting on GM issues generally placing lower values on a reduction in the label threshold to 0-0.5%.

While there is considerable similarity between these characteristics of the results from the parallel CM and CV investigations of the label threshold issue, there are substantial differences regarding the estimates of what people would be prepared to pay to secure a lowering of the label threshold to, for example, 0-0.5%.

Leaving to one side the effect of differential attitudes across the sample, and their effect on the willingness to pay, the median WTPs for a lowering of the threshold to the 0-0.5% level are, for men and women, shown in Table 9.1.

Table 9.1: Median WTPs (%) to Lower GM Label Threshold to 0-0.5%

	WTP
CM Model	26.4%
CV Model	5.9 - 8.1%

When attitudes are introduced into the models, the divergence of the WTP estimates becomes considerably greater. This is shown in Table 9.2 which indicates the differing estimates of WTP for three example scores of the GMTrust composite attitudinal score.

Table 9.2: WTPs (%) to Lower GM Label Threshold to 0-0.5% for those with differing Attitudes

	GMTrust (0)	GMTrust (1)	GMTrust (-1)
CM	26.4	4.4^{NS}	48.4
CVM	7.2	6.1	8.3

Whilst the estimate of WTP from the choice modelling model is insignificant for a GMTrust value of +1, the value for attitude scores of 0 (the mean attitude in the sample) and -1 are significant and large, especially when compared to those from the CV model, all of which are significant.

As with the robustness issue, sample mean and median WTPs to secure the lower threshold can be calculated, for both models. For the CV models the estimated median WTP is in the range 7.16% - 7.27% while the mean WTP is in the range of 7.6% - 7.65%. The values from the CM model are considerably higher, in the range 24.3% - 26.2%. These WTPs are displayed in Figures 9.4 and 9.5.

Despite these relatively high WTP estimates from the CM model it should be noted that there is a considerable section of the sample who are indifferent to a lowering of the label threshold to the 0-0.5%. Of the 246 people whose responses were used in the CM analysis, 30% of them were found to place no value on such a tightening of the labelling regime, which is shown in Figure 9.4.

Figure 9.4: WTP(%) to secure lowering of threshold to 0-0.5%: CM Model

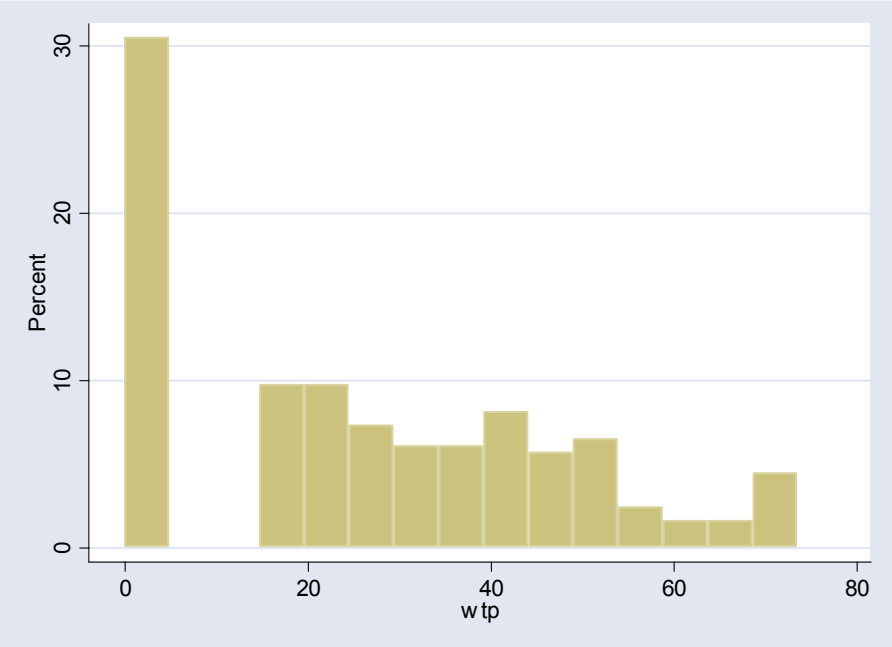
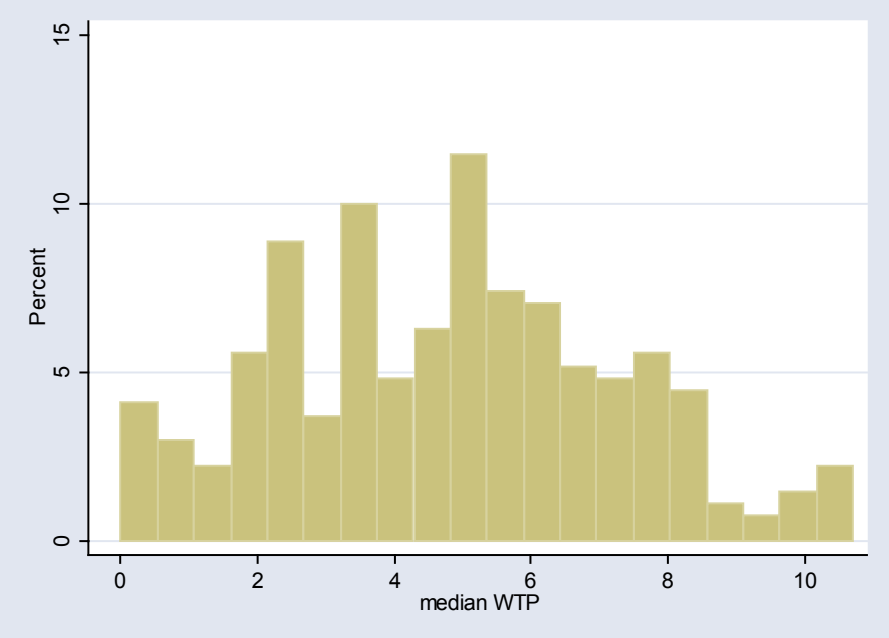


Figure 9.5: Median WTP(%) to secure lowering of threshold to 0-0.5%; CV Model



In terms of a comparison with the results regarding bread and the robustness of the labelling regime, the percentage values obtained here are smaller but there is a crucial difference. The bread WTPs are expressed as percentage changes in the price of bread, hence a value of 100% represents less than £2/week per household on average. The WTPs to secure a lower label threshold are expressed in terms of percentage changes in the household's weekly food cost.

It is significant to note that the levels of the WTP, and particularly those from the CVM model, are substantially smaller than those for GM bread which is appropriate given that bread is such a small element of the overall food basket and so there would seem to be evidence of an appropriate scale effect. It is also noteworthy that the inclusion of the household's food bill in the label threshold model was not statistically significant, in contrast to the finding from bread CV results. So there was, as theory would suggest, no evidence that those with higher food bills are prepared to pay higher *percentage* increases in food bill to achieve tighter labelling standards, whereas such an effect was present for the relatively low value bread.

9.3.3. Conclusions

The core result from this second piece of analysis is that the majority of consumers do not regard the new labelling threshold of 0.9% for inadvertent GM presence as significantly different from the current 1%. Hence they place no value on this change. However, there is, in general, a distinction made between a label threshold of 0.9/1.0% and a lower level of 0-0.5%.

The value placed on lowering the label threshold does not vary across the sample as markedly as the valuations identified regarding label robustness. There were some differences in terms of gender and more substantial differences in terms of attitudes, but social class, age and the presence of children in the household were not found to be significant in determining WTPs.

Estimates of the magnitude of these WTPs differed between the two methodologies employed, with the CV model producing typically lower WTPs. The scale of both sets of valuation estimates were of a lower order than those which were obtained regarding GM-

derived ingredients in bread, this is as one would expect given that the baseline cost for the former is the weekly food cost while that for the latter is the cost of a loaf of bread.

It is interesting to note that in both the CM and CV models respondents did not distinguish between threshold levels of 0% and 0.5%. One might have expected people to view the 0% level as qualitatively different from low positive levels since it could be interpreted as meaning “GM-Free” as opposed to merely “non-GM”. This was found not to be the case for the sample as a whole nor for specific groups within the sample. It should also be noted that in the semi-structured interviews and the pilot interviews there was little awareness of the existence of a positive threshold level, with many people assuming that if the food was not labelled it did not contain GM ingredients.

Given an average household expenditure of £42/week on food and alcoholic drinks, a WTP of 7% to lower the threshold at which food is labelled as containing GM ingredients to the 0-0.5% level represents less than £3/week. Given the annual aggregate expenditure on such goods is approximately £54bn the aggregate annual value of such a lowering of the GM labelling threshold might be thought of as £2 - 4 billion. This range of values is wide and has a lower bound below that from strict aggregation. This reflects the note of caution we would sound given the emotive nature of the GM issue to many and the difficulty in deriving aggregate values when sections of the population are not prepared to trade off the GM attribute against financial gains or losses. This is something evident from past valuation studies in the area of food and health risk (see for example Donaldson *et al.* 1996; Latouche *et. al.,* 1999) where stated preference techniques have performed relatively poorly.

9.4 Variations in food levels containing GM ingredients

As discussed in Section 3 of the Report, a third issue was investigated in this study, not directly related to evaluating the EU Regulation regarding the GM labelling regime. The issue was the consumer response to variations in the proportion of their food containing GM ingredients (with no distinction made between GM and GM-derived ingredients).

This issue was also investigated using CM and CVM models, with 338 people presented with choice sets and CV questions on these issues.

In both the CV and CM analysis there was, as with the label robustness section but unlike the label threshold results, considerable variation in preferences in terms of class, age, gender, attitudes and the presence of children. Females and those who bought food for children in the household disliked the presence of GM ingredients more. There was, as with the GM labelling robustness results, some evidence in the choice modelling results of a quadratic interaction with age, that is, younger people were less concerned about GM but concern increased over a certain age range before declining again in later years.

Despite the similarities in this respect between the CV and CM model results, it was in this section of the evaluation that the most marked differences between the WTPs from the two methodologies were evident. These are discussed next, while possible causes of these differences and the implications are considered in Section 9.5.

The CM analysis indicated that respondents regarded the 0% and 1% of food containing GM ingredients as equivalent, and also the 25%, 50% and 80% levels of food with GM ingredients were treated the same; the category of 100% of food containing GM ingredients was distinct in terms of consumers' responses. This was not the case with the contingent valuation results – respondents' valuations were different between these varying levels of GM content.

In addition, the differences between the CM and CV WTP estimates to avoid GM ingredients were extremely large. Table 9.3 displays overall sample averages from the CV model for the percentage willingness to pay, in terms of the weekly food bill, to avoid GM ingredients. The median WTPs to avoid a diet in which 5% and 50% of goods contained GM ingredients were effectively zero. The median WTP to avoid a diet in which all foods contained GM ingredients was 40%. The mean WTP figures for these three levels of food containing GM ingredients were 20%, 33% and 54% respectively.

Table 9.3: Median and Mean WTPs (%) to avoid GM Food: CV Model

	5% GM content	50% GM content	100% GM content
Sample Median	0	6.7 [NS]	40.3
Sample Mean	19.5	33.3	54.2

In addition there are considerable variations in these valuations of a diet free from varying levels of GM ingredients which are shown in Table 9.4. Consistent with previous findings in this study, the young and those from classes other than A or B are prepared to pay the least, and in some cases the estimates are effectively zero.

Table 9.4: Variations in WTPs (%) to avoid GM Food by Class & Age: CV Model

Social class	5% GM content	50% GM content	100% GM content
AB	32.2	62.4	96.0
C1	0	3.9 [NS]	37.6
C2	0	14.1 [NS]	47.6

Age	5% GM content	50% GM content	100% GM content
25	0	20.8 [NS]	54.4
50	32.2	62.4	96.0
70	65.4	95.7	129.3

As was discussed in Section 8, the estimates derived from the choice modelling study in this aspect of the study were largely infeasible. For social classes A, B, C1 and C2 only those with a positive view on GM issues (GMTrust[1]) would purchase a GM food basket and then only a substantial discount (50% and 92% for those without and with children respectively). All other WTPs are unfeasibly large implying that such a change would be unacceptable. In social classes D and E, those who are neutral on GM issues and are aged below 35 or over late 70s, and those aged 36-70 with positive attitudes would buy the GM basket of goods, but again would require a large discount between 52% and 94%. Hence the CM results indicate exceptionally, and unfeasibly, large WTPs to avoid a food basket with 100% of its items containing GM ingredients.

One issue worthy of attention here is whether there is a contradiction between the relatively large proportion of the sample who appear in the CV model to be indifferent when considering the percentage of ingredients containing GM ingredients and the relatively high CV WTPs to avoid GM bread (high in terms of percentage increases in prices that would be paid).

There are two, non-competing, rationalisations of this effect. The first is a statistical argument. The model assumes that the response function to percentage GM and indifference are driven by the same function: indifference is derived by censoring of the distribution below a zero discount. However, evaluation of the distribution at zero implies a degree of extrapolation, given that the smallest discount offered in the survey is 33%. It is possible to estimate a model which imposes the condition that the probability of accepting the GM food basket is zero at zero discount i.e. that GM is seen as a 'bad' by all respondents, and the possibility of indifference is ruled out. Although the former approach may be an oversimplification of the response function, it is preferable to one which simply rules out the possibility of indifference, even if it leads to an overstatement of that effect.

The second explanation is one of context. The CV bread analysis indicates high levels of WTP to avoid GM ingredients in bread, and relatively low levels of indifference. However, in that section of the questionnaire bread was presented as the only foodstuff containing GM ingredients. In this context, it is perhaps not surprising that respondents are prepared to pay a relatively small value to avoid it (even if it is a high percentage value of the price of bread). One could even interpret this bread analysis as equivalent to the current analysis of prevalence of GM ingredients, but at very low levels of GM content and also low levels of payment needed to avoid GM. However, to explore this effect one would have to conduct an experiment using a single product, but place it within the context of background GM levels, that is, run two experiments where one states explicitly that all other food is GM free, and an alternative structure where respondents are asked to value GM bread with a background GM content (e.g. 20%) stated.

9.5 Some Lessons & Questions Regarding Methodology & Results

The study set out to identify the benefits associated with the EU increasing the robustness of the GM labelling regime and lowering the GM labelling threshold levels. Considerable benefits have been identified regarding in both these respects, although there are considerable variations in the population regarding the valuation of the labelling of GM-derived ingredients.

The core results have been that:

- the vast majority of the population regard GM ingredients and those derived from GM crops as effectively the same
- people place no value on the lowering of the GM food labelling threshold for adventitious presence to 0.9%, but do value a further lowering of the threshold to the 0.5% or 0% level.

There are a number of issues that have been raised in the course of this research regarding methodology and the associated results. Some of these are now discussed, with some potential lessons identified and some further questions posed.

9.5.1. Using a specific good or the overall food basket?

It is good practice in any valuation study to use a good with which the respondents are familiar. Thinking about a specific food good seems therefore desirable since the notion of the 'weekly food basket' is a somewhat abstract concept. However two problems arise with the use of the single good.

The first is that of brand loyalty, familiarity etc which means that many or most consumers do not buy "bread" or "baked beans" or other similar simple goods, they buy specific brands. These are powerful issues in food shopping psychology and economists should try to integrate understanding of such phenomena in their work. In this study this issue was evident in the high numbers of people choosing their "usual bread" despite the attempt to convince them that all three options in the choice sets were variants of their "usual bread".

In this study the use of a single food product to assess the implications of labelling goods which contain ingredients derived from GM crops was necessary. The concepts involved in distinguishing between GM and GM derived ingredients were so complex that they had to be explained and explored in as simple a framework as possible. In addition, since it is unlikely that all the elements in the household's "food basket" contain such ingredients, using this collection of goods as the basis for analysis would have been a flawed approach.

One wishes to obtain aggregate values for policy purposes, but the approaches require the valuation to come from consumers regarding a consumption decision. This is not an easy combination to achieve.

9.5.2. Information provision and the level of technical detail

It was noted above that it is good practice to use a good with which respondents are familiar. It is also desirable that the baseline situation, from which you are asking interviewees to value changes, is also familiar to them. There were complications here regarding both the level of technical detail and the baseline position. The semi-structured interviews, the pilots and indeed general discussion of the project indicated that very few people were familiar with the concept of ingredients being derived from GM crops but free of altered genetic material. In addition, regarding the GM label threshold issue, most people were unaware that there was a permitted level of inadvertent GM presence in food and in fact were usually surprised that this was the case.

9.5.3. What are the implications of the results for the choice of method from CM and CVM?

In the limited but growing number of studies which have sought to compare CV and CM estimates of WTP there have typically been divergences between the values delivered by the two methods. In this study we regard the results from the CVM approach to be more feasible than those from the CM models, particularly on the issue of the proportion of goods containing GM ingredients.

As noted in Section 2, CM has the advantage that the attribute of specific interest can be embedded within the choice sets, which serves to highlight the trade-offs made in real life and avoid focus on only a specific issue. This has been seen as an advantage over CVM.

There are a number of noteworthy points in this regard. First, given the amount of technical information that it was necessary to provide to respondents regarding technical aspects of GM food, embedding the GM issue within the other attributes with no undue prominence was difficult. Indeed, it is questionable whether it is possible to do this with the GM issue in the UK at the moment because of the contentious nature of the issue and the awareness that a number of key policy decisions on GM issues are imminent.

One of the strengths of choice modelling is that it allows one to embed an attribute among the choice set attributes. It is possible however that as well as avoiding a single issue focus, the choice sets can obscure the price attribute with the result that price is not taken sufficiently taken into account. While the criticism of CVM that it focuses on a single issue at the expense of substitutes has been long established, it is also true that is does also focus on the other attribute involved in the CV question – the cost.

As a corollary, in CM the full implications of the respondent's choices (in terms of the implied WTP/WTA) are not clear when they make their selection and study design does not involve revealing to the interviewee what their choices have implied they would pay. One way round this would be to build in a theory consistent constraint that ensures that people cannot bid more than is feasible, in terms of their income or current expenditure levels. To do this would raise a number of challenging econometric problems which would take us far beyond the scope of the present project.

9.5.4. Possible Extensions

The timescale of the project inevitably precluded investigation of a number of potentially significant aspects of the analysis of WTP for GM food. The first of these is our treatment of those respondents who always chose the status quo option as a homogeneous group which could be excluded from the subsequent empirical analysis. There may be some merit in exploring whether, given their stated reasons for their choices, some of this group should be included in the model estimation. Secondly, there

is the question of whether there are latent classes of consumers in the dataset who have systematically divergent preferences regarding the consumption of GM and GM-derived foods. .

This issue of heterogeneity could also be investigated further using mixed logit models as discussed in Section 2. Our analysis has permitted WTPs to vary by demographic factors, such as social group and age; in effect, these factors modify the values of the parameters of the utility function for individuals in each socio-economic segment identified. An alternative approach is to allow the utility function parameters to vary across individual consumers. In this way, preferences regarding GM food are allowed to vary widely across the sample – GM food may be viewed as a 'bad' by some and a 'good' by others, with still others viewing it with complete indifference. Recently developed econometric techniques would permit this heterogeneity to be explored in a systematic way.

REFERENCES

Adamowicz,W., Boxall,P., Williams,M. and Louviere,J.J. (1998). "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation". *American Journal of Agricultural Economics*, 80:64-75

Adamowicz,W. and Boxall, P. (2001). "Future Directions of Stated Choice Methods for Environmental Valuation". Paper presented at the AES One-Day Conference on 'Choice Experiments: A New Approach to Environmental Valuation', Imperial College, London, 9th April 2001

Baker G, and Burnham T. (2001)."Consumer Response to Genetically Modified Foods: Market Segment Analysis and Implications for Producers and Policy Makers". *Journal of Agricultural And Resource Economics* 26(2): 387-403.

Ben-Akiva, M. and Bierlaire, M. (1999). "Discrete Choice Methods and their Applications to Short-term Travel Decisions". In R. Hall (ed.). *Handbook of Transportation Science*. International Series in Operations Research and Management Science, Vol.23 Kluwer.

Bennett, J. (1999). *Some Fundamentals of Environmental Choice Modelling.* Choice Modelling Research Report no.11, University College, The University of New South Wales, Canberra

Bennett, J and Blamey, R. (2001). "The Strengths and Weaknesses of Environmental Choice Modelling". In J.Bennett and R. Blamey *The Choice Modelling Approach to Environmental Valuation.* Edward Elgar, 228-241

Blamey, R.K. Bennett, J.W., Morrison, M.D., Louviere,J.J. and Rolfe,J.C. (1998*). Attribute Selection in Environmental Choice Modelling Studies: the Effect of Causally Prior Attributes.* Choice Modelling Research Report no.7, University College, The University of New South Wales, Canberra.

Blamey, R., J. Bennett and J.J. Louviere (2001) "Green Product Choice", in J. Bennett and R. Blamey (ed.) *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, 115-130.

Boccaletti, S and Moro, D (2000) Consumer Willingness to Pay for GM Food Products in Italy. *Agbioforum* 3(4):259-267.

Breffle, W.S., and R.D. Rowe (2002) "Comparing Choice Question Formats for evaluating Natural Resource Tradeoffs" *Land Economics* 78(2): 298-314.

Burgess, J., J. Clark and C. Harrison (2000) "Culture, Communication, and the Information Problem in Contingent Valuation Surveys: A Case Study of a Wildlife Enhancement Scheme" *Environment and Planning C: Government and Policy* 18(5): 505-524.

Burton, M. and D. Pearse (2002) "Consumer Attitudes towards Genetic Modification, Functional Foods, and Microorganisms: A Choice Modeling Experiment for Beer" *AgBioForum*, 5(2): 51-58

Burton, M., D. Rigby T.Young and S. James (2001) Choice Modelling Consumer Attitudes to GMOs in Food. European Review of Agricultural Economics, 28(4): 479-498.

Cameron,T. and Quiggin,J. (1994) 'Estimation using a Contingent Valuation Data from a "Dichotomous Choice with Follow-up" Questionnaire' *Journal of Environmental economics and Management*, 27:3, 218-34

Campbell, S., Townsend E. (2003). Flaws undermine results of UK biotech debate. *Nature* 425: 559.

Carson, R.T., N.E. Flores, and N.F. Meade (2001) "Contingent valuation: controversies and evidence" *Environmental and Resource Economics* 19**:** 173–210.

Carson, R.T. (2000) "Contingent Valuation: A User's Guide" *Environmental Science & Technology,* 34 (8), 1413 –1418.

Carson, R. T. (1997) "Contingent Valuation and Tests of Insensitivity to Scope". In Kopp, R., Pommerhene, W., Schwartz, N. (Eds.) *Determining the Value of Non-Marketed Goods: Economic, Psychological, and Policy Relevant Aspects of Contingent Valuation Methods*. Kluwer: Amsterdam.

Carter, C (2002) "International Approaches to the Labeling of Genetically Modified Foods". *Update. Agricultural and Resource Economics* University of California Giannini Foundation Vol. 6 No. 1 Sept/Oct.

Caswell, J (2000). "An Evaluation of Risk Analysis as Applied to Agricultural Biotechnology (With A Case Study of GMO Labeling)." *Agribusiness* 16(1), 115-123.

Caswell, JA and EM Mojduszda (1996) "Using Information Labeling to influence the Market for Quality in Food Products" *American Journal of Agricultural Economics* 78(5): 1248-1253.

Caswell, JA and DI Padberg (1992) Towards a more comprehensive treatment of food labels" *American Journal of Agricultural Economics* 73(3): 945-946.
Consumer Association (2002) GM Dilemmas – Consumers and Genetically Modified Foods. Policy Report.

Consumers Association (2002) *GM Dilemmas – Consumers and Genetically Modified Foods*. Policy Report
http://www.which.net/campaigns/food/gm/misc/gm_report.pdf

Cooper, J, Hanemann, M and G.Signorello (2002) One-And-One-Half-Bound Dichotomous Choice Contingent Valuation. *The Review of Economics and Statistics* (84) 4: 742-750.

Crespi J.M. and S. Marette (2003). "Some economic implications of public labeling". Paper presented at the workshop Emerging Roles for Food Labels: Inform Protect, Persuade in Washington D.C., March 20-21, 2003

Crespi J.M. and S. Marette (2003a). "'Does Contain' vs. 'Does Not Contain': Does it matter which GMO Label is Used?", *European Journal of Law and Economics* , 16 (3).

Currie, M. and I. Steedman (2000) “Consumer Perceptions of Commodity Characteristics: Implications for Choice and Welfare” *The Manchester School* 68 (5) September.

Donaghy, P., J. Rolfe and J. Bennett (2003) “Consumer demands for organic and genetically modified foods”. Paper presented at the 47th Annual Conference of the Australian Agricultural and Resource Economics Society, February 2003. Freemantle, Western Australia.

Donaldson C., Mapp T., Ryan M., Curtin K., (1996), Estimating the economic benefits of avoiding food borne risk: is ‘willingness to pay’ feasible. Epidemiology and. Infection 116, 285-294.

Einsiedel, E. (2000) “Consumers and GM food labels: providing information or sowing confusion?” *AgBioForum* 3(4): 231-235.

Field, B. (1997) *Environmental Economics. An Introduction*. McGraw-Hill Second Edition.

Finke, M.S. (2000) “Did The Nutrition Labeling and Education Act Affect Food Choice in The United States?” Selected conference paper, *The American Consumer and the Changing Structure of the Food System* , Economic Research Service, USDA, May 4-5, 2000, Arlington, Virginia.

Freeman III, A.M. (1979) *The Benefits of Environmental Improvement. Theory and Practice.* John Hopkins University Press.

Gaskell, G., N. Allum and S. Stares (2003) *Europeans and Biotechnology* In 2002 Eurobarometer 58.0 (2nd Edition: March 21st 2003) A report to the EC Directorate General for Research from the project 'Life Sciences in European Society' QLG7-CT-1999-00286.

Genewatch (2003) Food Standards Agency Hides Unanimous Findings Of Citizens’ Jury That GM Crops Should Not Be Grown In The UK Now – GeneWatch UK Challenges The FSA To Come Clean. Genewatch Press Release, 9/5/03.

Giannakas, K. and M. Fulton (2003). “Consumption Effects of Genetic Modification: What if Consumers are Right?” *Agricultural Economics* 27: 97-109.

Greene, W. H. (1997). *Econometric Analysis*. Prentice Hall; Englewood Cliffs, N.J.

Grimsrud, K.M., J. J. McCluskey, M. L. Loureiro, and T.I. Wahl (2002) “Consumer Attitudes toward Genetically Modified Food in Norway” Paper to 6th International Conference on Agricultural Biotechnologies: New Avenues for Production, Consumption, and Technology Transfer. ICABR. Ravello, Italy, July 2002.

Hall, C., D. Moran, and D. Allcroft (2004) “The economic value of GM risk perceptions: A meta-analysis of WTP studies using multi-level modelling” Paper to the 78th Annual Conference of the Agricultural Economics Society, London 2-4 April 2004.

Hanemann, W.M., J. Loomis and B.J. Kanninen (1991) "Statistical Efficiency of Double-bounded Dichotomous Choice Contingent Valuation" *American Journal of Agricultural Economics* 73(4)): 1255-1263.

Hanemann, M. and Kanninen, B. (1999) "Statistical Analysis of Discrete-Response CV Data". In Bateman, I and Willis, K (eds) *Valuing environmental preferences* Oxford University Press.

Hanley, N., S. Mourato and R. Wright (2001) "Choice Modelling Approaches: A Superior Alternative for Environmental Valuation?" *Journal of Economic Surveys* 15(3).

Hansen,L and Schmidt, M. (1999). "Revisiting Conjoint: How Danish Pig Producers found the Future Road to Environmentally Concerned Danish Consumers". (mimeo)

Hanley, N., D. MacMillan, R. Wright, C. Bullock, I. Simpson, D. Parsisson and R. Crabtree (1998), "Contingent Valuation versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland". *Journal of Agricultural Economics* 49(1): 1-15.

Harrison, G.W., and Rutström, E.E. 2002. "Experimental Evidence on the Existence of Hypothetical Bias in Value Elicitation Methods." In C. Plott and V.L. Smith (eds.) *Handbook of Results in Experimental Economics*. New York: Elsevier Science.

Hausman,J. and McFadden,D. (1984). "Specification Tests for the Multinomial Logit Model". *Econometrica*, 52(5) 1219:1239.

Horlick-Jones, N, Walls, J, Rowe, G, Pidgeon, N, Poortinga, W, O'Riordan, T (2004) A Deliberative Future? An Independent Evaluation of the *GM Nation?* Public Debate about the Possible Commercialisation of Transgenic Crops in Britain, 2003 Understanding Risk Working Paper 04-02, UEA, Norwich.

HortResearch (2002). The New Zealand Public's Attitudes regarding GM Food. HortResearch, Palmerston North, New Zealand.

Huffman, W, Shogren, J and Rousu, M and Tegene, A (2001) "The Value to Consumers of Genetically Modified Food Labels in a Market with Diverse Information: Evidence from Experimental Auctions". Iowa State University, Dept. of Econ. Staff Paper #345, Dec. 2001.

Huffman, E., J. F. Shogren, M. Rousu, and A. Tegene (2003) "Consumer Willingness to Pay for Genetically Modified Food Labels in a Market with Diverse Information: Evidence from Experimental Auctions." Forthcoming in the *Journal of Agricultural and Resource Economics*. pdf file posted 09/30/03. http://www.biotech.iastate.edu/publications/IFAFS/GMJARE093003a.pdf

Huffman, W. and A. Tegene, (2002) "Public Acceptance of and Benefits from Agricultural Biotechnology: A Key Role for Verifiable Information". In V. Santaniello, R. E. Evenson and D. Zilberman, eds., *Market Development for Genetically Modified Food*, CAB International.

Hunt, S. and L.J. Frewer (2001) “Trust in sources of information about genetically modified food risks in the UK” *British Food Journal* 103 (1)

Institute of International Economic Law (IIEL) (2003) “Proposed Regulation on genetically modified food and feed”. November 8th 2003
http://www.law.georgetown.edu/iiel/current/gmos/gmos_ec_gmoreg.html#publication

Kaneko, N. and Wen S. Chern (2003) “Consumer Acceptance of Genetically Modified Foods: A Telephone Survey” paper to the AAEA Annual Meeting, Montreal, Canada July 2003.

Kinsey, J. (1993) “GATT and the Economics of Food Safety” *Food Policy* Special Issue, April: 163-176.

Kontoleon, A., R. Macrory and T. Swanson (2002) “Individual Preference-based Values and Environmental Decision making: Should valuation have its day in court?” *Law and Economics*, 20: 179–216.

Latouche K. Rainelli P., Vermersch (1999), Food safety issues and the BSE scare: some lessons from the French case, Food Policy 23 (5), 347-356

List, John A., and Gallet, Craig A. (2001). “What Experimental Protocol Influence Disparities between Actual and Hypothetical Stated Values?” *Environmental and Resource Economics*. 20:241-254.

Loureiro, M.L. and S. Hine (2002). “ Discovering Niche Markets: A Comparison of Consumer Willingness to Pay for Local (Colorado Grown), Organic and GMO-free Products,” *Journal of Agricultural and Applied Economics* 34(3): 477-487.

Louviere, J.J. (2001). « Choice Experiments: an Overview of Concepts and Issues”. In J.Bennett and R. Blamey *The Choice Modelling Approach to Environmental Valuation.* Edward Elgar, 13-36.

Louviere, J. J., D. A. Hensher and J. Swait (2000). Stated Choice Methods: Analysis and Application, Cambridge University Press

Lusk, J.L., M S. Daniel, D. Mark and C.L. Lusk (2001) “Alternative Calibration and Auction Institutions for predicting Consumer Willingness to PAy of Nongenetically Modified Corn Chips” *Journal of Agricultural and Resource Economics* 26: 40-57.

Lusk, J.L., J. Roosen, and J.A. Fox. (2003)“Demand for Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn: A Comparison of Consumers in France, Germany, the United Kingdom, and the United States.” *American Journal of Agricultural Economics.* 85(2003):16-29.

McCluskey, J.J., H. Ouchi, K.M. Grimsud and T.I. Wahl (2001) “Consumer Response to Genetically Modified Food Products in Japan”. IMPACT Technical Working Paper TWP-2001-101 Washington State University.

McFadden, D. (1974). “Conditional Logit Analysis of Qualitative Choice Behavior”. In P. Zarembka (ed.), *Frontiers in Econometrics*. Academic Press, 105-142.

Marris, C, Wynne, B, Simmons, P and S.Weldon (2001) Public Perceptions of Agricultural Biotechnologies in Europe. Final Report of the PABE research project. http://www.pabe.net

Moon, W. and S.K. Balasubramanian (2001) "Public Perceptions and Willingness to Pay for non-GM Foods in the US and UK". *AgBioForum* 4(3&4): 221-231.

MORI (2003) "GM Food Opposition Continues" 3 July 2003
http://www.mori.com/polls/2003/gmfood.shtml

Morrison, M. D., Blamey, R. K., Bennett, J.W., Louviere, J. J. (1996). "A comparison of stated preference techniques for estimating environmental values". *Choice Modelling Research Reports*. The University of New South Wales.

Munro, A., & Hanley, N. D. (2000). Information, Uncertainty, and contingent valuation. In: I. Bateman & K. Willis (Eds), *Valuing the Environment Preferences*. Oxford University Press.

Murphy, J.J., T. Stevens and D. Weatherhead (2003) "An Empirical Study of Hypothetical Bias in Voluntary Contribution Contingent Valuation: Does Cheap Talk Matter?" Working Paper 2003-2 University of Massachusetts, Amherst March 2003

Murphy, J.J., P.G. Allen, T.H. Stevens, and D. Weatherhead (2003a), "A Meta-Analysis of Hypothetical Bias in Stated Preference Valuation. Department of Resource Economics, University of Massachusetts, Amherst.
http://www.umass.edu/resec/faculty/murphy/meta/meta.html

Nelson, P. (1970) "Information and Consumer Behavior" *Journal of Political Economy* 78: 311-329.

Norton, J., Lawrence, G. and Wood, G. (1998). "The Australian public's perception of Genetically-Engineered Foods". *Australasian Biotechnology*, 8(3): 172-181, June.

Noussair, C., S. Robin and B. Ruffieux (2004) "Do Consumers really refuse to buy Genetically Modified Food?" *Economic Journal* 114 No. 492: 102- 120.

Rigby, D and Burton, M (2003) "Capturing Preference Heterogeneity in Stated Choice Models: A Random Parameter Logit Model of the Demand for GM Food". School of Economics Discussion Paper 0319, University of Manchester.

Rolfe, J. Bennett, J. and Louviere, J.J. (1999). "What Information do the Error Terms hide in Choice Modelling Environmental Valuation Studies?" Contributed paper, 43rd AARES Conference, Christchurch, New Zealand.

Rousu, M., W. Huffman, J.F. Shogren and A. Tegene (2002) "Are US Consumers tolerant of GM Foods?" Iowa State University Dept. of Economics Working Paper #02014

Rousu, M, Huffman, W, Shogren, J and Tegene, A (2002a) The Value of Verifiable Information in a Controversial Market: Evidence from Lab Auctions of Genetically Modified Food. Iowa State University, Dept. of Econ. Staff Working Paper Series, Paper #3.

Sheldon, I. (2002), “Regulation of Biotechnology: Will We Ever ‘Freely’ Trade GMOs?” *European Review of Agricultural Economics* , 29, 155-176.

Smith, D. and Riethmuller, P. (1999). Consumer concerns about food safety in Australia and Japan. *International Journal of Social Economics*, 26(6): 724-741.

Swinbank, A. (1993) “The Economics of Food Safety” *Food Policy* Special Issue, April: 83- 94.

Teisl M.F. and J.A. Caswell (2003) “Information Policy and Genetically Modified Food: Weighing the Befits and Costs” University of Massachusetts Amherst Dept. of Resource Economics Working Paper No. 2003-1

TNS (2004), Consumer Attitudes to Food Standards. Wave 4. UK Report. Prepared for the Food Standards Agency and COI Communications. COI Ref: 257960.

Wirthlin Group, (2000). U.S. Consumer Attitudes Toward Food Biotechnology. Report on Wirthlin Group Quorum Surveys available from http://ificinfo.health.org/foodbiotech/survey.htm