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Journal of Agricultural and Resource Economics 32(2):363–382
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Willingness to Pay (WTP) a Premium for Non-GM Foods versus Willingness to Accept (WTA) a Discount for GM Foods

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In a survey of UK consumers, we elicited their willingness to accept (WTA) a discount for GM foods and willingness to pay (WTP) a premium for non-GM foods in order to assess their valuation of the non-GM characteristic in food products. Mean WTA is found to exceed mean WTP, suggesting the valuation of the non-GM characteristic reflects an endowment effect, imperfect substitutability between GM and non-GM foods, or both. Regression results show that perceived risks (benefits) associated with GM foods significantly increase (decrease) WTA and WTP estimates. Additional regression models using the difference between WTA and WTP as the dependent variable indicate that risk (benefit) perceptions increased (decreased) the discrepancy between WTA and WTP estimates. The role of risk perceptions in explaining this discrepancy is congruent with consumers' propensity toward loss aversion as predicted by the endowment effect hypothesis and prospect theory.

Key words: contingent valuation, endowment effect, genetically modified food, prospect theory, WTA-WTP divergence

Introduction

The controversy over genetically modified (GM) food entered a new phase in 2004 when the European Union (EU) replaced its moratorium on GM approvals with new legislation that mandates traceability and labeling of GM foods beyond a 0.9% tolerance level. Originally instituted in 1998, the moratorium responded to the largely negative public reception of GM technology in Europe at that time. The apparent intent of the new traceability/labeling legislation is to transfer the burden of acceptance or rejection of GM technology from a regulatory authority to the dynamics surrounding a free market. Nevertheless, we note the following necessary condition for consumers to either accept or reject GM technology in a "free market" context: Food retailers in the EU should be willing to display labeled GM products on supermarket shelves (Carter and Gruère, 2003; Gaskell et al., 2003; Kalaitzandonakes and Bijman, 2003).

While there is evidence that some labeled GM food products were available in the EU, most European food manufacturers and retailers avoid GM ingredients in line with

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Review coordinated by DeeVon Bailey and George C. Davis; publication decision made by George C. Davis.

the generally negative sentiment there against agrobiotechnology. For example, in 1997, the food industry in the Netherlands introduced a number of products containing GM ingredients, but three years later such products disappeared when it was decided to use only non-GM ingredients (Marks, Kalaitzandonakes, and Vicnker, 2004; Kalaitzandonakes, Marks, and Vickner, 2004). By using non-GM ingredients, the food industry can strategically bypass the implications surrounding the traceability/labeling legislation. As a result, there is no widespread segregation between non-GM and GM foods in Europe, and most European consumers are unable to choose between such foods at this time.

Will the European food industry change its dominant strategy of not using GM ingredients in the foreseeable future? The answer hinges on whether the industry interprets the new legislation as a favorable long-term opportunity to market GM foods. Carter and Gruère (2003) present two reasons why most European consumers cannot access GM foods at this time despite the fact that there has been a mandatory labeling system in place in European countries since the late 1990s: (*a*) the lack of economic incentives to motivate the European food industry to offer labeled GM foods, and (*b*) political pressure from anti-GM activists. Coupled with the moratorium's anti-GM legacy and the generally negative public sentiment toward agrobiotechnology, the mandatory labeling system has acted as a market barrier rather than a facilitator of informed consumer choice. From a normative perspective, however, economic considerations (e.g., the expected market share and profits from labeled GM foods) should ultimately influence the long-term outlook for GM foods within the European food industry.

Previous research on food preferences of European consumers emphasizes willingness to pay (WTP) a premium as a measure of behavioral intention with respect to non-GM foods (e.g., Burton et al., 2001; Moon and Balasubramanian, 2003). While useful in gauging the demand for non-GM foods, this approach offers limited insight in terms of predicting the demand for GM foods. From a forecasting perspective, it appears more appropriate to raise the following questions: Are consumers willing to accept GM foods at some or no discount relative to the price of non-GM foods? To what extent are GM foods considered substitutes for non-GM versions?

The minimum amount of discount (anchored to the price of non-GM foods) that consumers are willing to accept (WTA) to motivate their purchase of GM food products is a useful concept that sheds light on both consumers' preference for GM foods and their perceptions regarding the substitutability between GM and non-GM food versions. For example, Grimsrud et al. (2004) report that consumers in Norway require price discounts ranging from 37% to 63% to motivate their purchase of bread made of GM wheat. McCluskey et al. (2003) demonstrated that Japanese consumers would be willing to accept a discount to purchase GM foods. Additionally, Huffman et al. (2003) found U.S. consumers from the Midwest were willing to pay $0.14 less on average for GM-labeled food products including potatoes, tortilla chips, and vegetable oils. Building on these studies eliciting WTA, our study attempts to offer new insights into consumers' behavior toward GM foods and non-GM foods by comparing WTA and WTP values from UK respondents.

Research Goals

Our study elicited consumers' willingness to accept (WTA) a discount for GM foods and willingness to pay (WTP) a premium for non-GM foods, using a contingent valuation survey administered in the UK. Regression models are employed to analyze and compare

Table 1. Wording of WTP and WTA Questions

Item	Willingness to Pay	Willingness to Accept
A box of breakfast cereals	Suppose the price of breakfast cereals made from GM crops is £2.80 per box. The price of conventional non-GM breakfast cereals will be higher than £2.80, but is not determined yet. What is the most above the current price of £2.80 you would be willing to pay to purchase a box of conventional non-GM breakfast cereals?	Suppose the prices of breakfast cereals of both types are identical at £2.80. The grocery store offers a discount to promote the sales of GM breakfast cereals. What is the minimum amount of discount below the current price of £2.80 that would make you want to purchase a box of GM breakfast cereals?
Weekly food expenditure	Suppose that it generally costs more to purchase non-GM foods due to segregation and labeling requirements. What is the maximum percentage increase in your weekly food bill that you are willing to incur to ensure that you do not eat GM foods?	Suppose that the grocery store offers discounts to promote the sales of GM food products. What is the minimum percentage decrease in your weekly food bill that will make you want to purchase GM food products?

the elicited WTA and WTP data. Specifically, we attempt to segment UK consumers and analyze related WTA and WTP values. Our analyses focus around two issues: (*a*) the relationship between stated WTA or WTP values and individual characteristics, and (*b*) the identification of individual characteristics that account for the difference between WTA and WTP values.

As shown in table 1, our survey sought two WTP responses: (*a*) the maximum premium consumers are willing to pay for a box of breakfast cereals made of non-GM ingredients, and (*b*) the maximum additional weekly food expenditure consumers are willing to pay to avoid GM foods. The survey also elicited two related WTA measures: (*a*) the minimum discount consumers are willing to accept for a box of breakfast cereals made of GM ingredients, and (*b*) the minimum decrease in weekly food expenditure consumers are willing to accept in order to purchase GM foods.

When properly designed, WTA measures should identify consumers (*a*) willing to buy GM foods at no discount (GM-embracing segment), (*b*) willing to buy GM foods at some discount (price-conscious segment), (*c*) unwilling to buy GM foods, and (*d*) who remain unsure. Similarly, WTP values provide information on those (*a*) willing to pay premiums to avoid GM foods, (*b*) who are protest respondents and feel it is their right to consume non-GM foods (as identified via a followup question asked only to individuals who selected a zero premium), (*c*) willing to embrace GM-technology, and (*d*) who remain unsure. While both WTA and WTP measures help identify consumers who protest against GM, embrace GM, or remain uncertain, only WTA values help characterize consumers who are willing to buy GM foods at a price discount. Information on this price-conscious segment is critical to an understanding of larger issues such as the degree of substitutability between GM and non-GM foods.

Context and Interpretation of WTA and WTP Questions

Interpretively, the survey questions in table 1 seek respondents' willingness to pay a premium for non-GM foods and their willingness to accept a discount to forego such an

opportunity. More specifically, our research goal is to assess the value of the non-GM attribute of food products—i.e., consumers are required to pay a premium in order to obtain it, and offered a discount in order to give it up (to purchase GM foods instead of non-GM foods). To the extent that European consumers currently access only non-GM foods but may access both non-GM and GM foods in the future, non-GM foods provide a useful baseline for comparing the present with the future. In this context, WTP measures may shed light on the intensity of European consumers' desire to preserve what they now have (i.e., the non-GM attribute of foods) into the future; in contrast, WTA values are likely to capture acceptable monetary tradeoffs associated with giving up what they now have (i.e., the non-GM attribute of foods) if European consumers transition to an environment where GM foods are both available and accepted.

Generally, WTP assesses the value that consumers place when they purchase goods, whereas WTA reflects the value that consumers seek when they sell them (Carmon and Ariely, 2000). Linking this buyer-seller perspective to our study, respondents in our contingent valuation survey hypothetically buy or sell the non-GM attribute of food products, thereby yielding measures of WTP or WTA, respectively.

Propositions on WTA and WTP

Divergence Between WTA and WTP

Absent income effects, economic theory predicts that WTA and WTP estimates will converge (Willig, 1976; Randall and Stoll, 1980). Should this theoretical convergence occur, the intensity of demand for non-GM foods (represented by mean WTP—the larger the stronger) should not differ from the intensity of demand for GM foods (captured by mean WTA—the smaller the stronger). For example, consumers who are willing to pay £0.50 more to avoid purchasing breakfast cereal made from GM ingredients should be willing to accept a price discount of £0.50 to forego the opportunity to purchase non-GM breakfast cereal.

In contrast, a number of contingent valuation studies in both field and laboratory settings consistently show significant discrepancies between WTP and WTA measures for public goods (e.g., Knetsch and Sinden, 1984; Kahneman, Knetsch, and Thaler, 1990). Two explanations have been advanced to rationalize this divergence between theory and practice.

First, Kahneman and Tversky (1979) and Thaler (1980) suggested that WTA values may be higher than WTP due to an endowment effect, a phenomenon whereby individuals value goods more highly if they own them (as opposed to when they do not). This effect is a plausible result of loss aversion in prospect theory, whereby individuals weigh losses substantially more than objectively commensurate with gains while evaluating prospects or trades. In laboratory experiments using coffee mugs, Kahneman, Knetsch, and Thaler (1990) show this endowment effect persists even after controlling for transaction costs and learning opportunities.

Second, WTA and WTP values may diverge because of a substitution effect, a phenomenon that actually produces a far greater divergence than the income effect (Hanemann, 1991). In other words, WTA and WTP measures in our study are unlikely to converge if the goods in question are not close substitutes. More specifically, if the implicit comparison between non-GM foods to GM foods in the survey questions discussed earlier (e.g.,

giving up or selling the non-GM food attribute) is such that these two food versions are viewed as fundamentally different, with GM foods perceived as less desirable than non-GM foods, then it is likely WTA will exceed WTP values. Using experiments involving private and public goods, Shogren et al. (1994) offer empirical support for Hanemann's premise on the substitution effect. These authors report that the divergence between WTA and WTP measures disappears for a private good that has a close substitute; in contrast, the divergence was found to be robust and consistent for a private non-market good with no close substitute.

Taken together, the preceding discussion suggests the following:

- PROPOSITION 1. *Divergence between WTA and WTP measures suggests an endowment effect (where consumers' over-weight what they possess or own, such as the non-GM food attribute) and/or a substitution effect (where GM and non-GM foods are not considered good substitutes).*

Presence or Absence of "Cheap Talk" Script

Applications of the contingent valuation (CV) approach are often associated with a hypothetical bias whereby respondents overstate the amount they are willing to pay for public or private goods of research interest. A number of studies present evidence that hypothetical transactions typically addressed in CV questions are not incentive compatible (e.g., Cummings, Harrison, and Elisabet, 1995; Loomis, Gonzalez-Caban, and Gregory, 1994). Under these circumstances, it is useful to incorporate the "cheap talk" script into the survey design to test for this hypothetical bias. Essentially, the script sensitizes respondents about this bias prior to administration of CV questions (for an example, see the appendix). Cummings and Taylor (1999) found that the cheap talk approach eliminated hypothetical bias in laboratory experiments involving public goods. Using a mail survey to measure WTP for Golden rice, Lusk (2003) offers additional evidence in support of the cheap talk script.

Although the cheap talk script attempts to correct respondents' predisposition to overstate WTP values, this problem may also arise for WTA questions. Because WTP or WTA questions are largely theoretical and context driven, and do not typically discourage inflated responses, participants may feel just as rewarded for overstating WTA as they do with WTP (Kaez, Smith, and William, 1985). The cheap talk script may therefore be beneficial in both cases.

- PROPOSITION 2. *Respondents unexposed to the "cheap talk" script are likely to provide higher WTP and WTA values than those exposed to this script.*

Ordering of WTA and WTP Questions

If WTA and WTP questions are posed to the same sample of respondents, it is desirable to test for a potential question ordering effect. We propose that respondents exposed to WTA questions prior to WTP questions are more predisposed to the endowment effect than those responding to these same questions in the opposite order. This is because WTA items require respondents to consider scenarios where they sell or "give up" an attribute or property (i.e., non-GM characteristic) they currently possess, a process likely to increase this attribute's salience and reinforce its ownership value.

■ PROPOSITION 3. *Exposure to a WTA item prior to a corresponding WTP item is likely to inflate WTP values.*

Contingent Valuation Survey Design

Our survey instrument was administered using the web-panel of UK households maintained by Harris Interactive, a consulting firm specializing in public polls and opinion surveys. Questionnaires were e-mailed to a subsample of 2,500 participants of this panel that was representative of the UK population. A total of 1,090 consumers completed the online survey within seven days, accounting for an impressive 44% response rate. About 55% of the respondents were female. The average respondent age was 44 years. While average income was £23,500, about 38% of the respondents reported income less than £19,999, 48% between £20,000 and £40,000, and 13.9% greater than £40,000. Finally, survey respondents on average had 14.9 years of formal and informal schooling.

The first part of the survey tapped respondents' attitudes toward genetic engineering applications involving food production and medicine, and self-rated knowledge/perceptions about negative and positive attributes of agrobiotechnology. As shown in table 1, the second part focused on WTA and WTP measures in two contexts: (*a*) a box of breakfast cereals made of non-GM and GM ingredients (base price of £2.80), and (*b*) weekly expenditure on foods with non-GM and GM characteristics (actual expenditure in £). Note that a box of breakfast cereals represents a very small portion of the typical household budget. Therefore, the second question encompasses a much bigger share of this budget because it represents all weekly food purchases. Posing WTA and WTP questions for both of these contexts facilitated a check for consistency in responses.

Format of the WTA and WTP Questions

The contingent-valuation (CV) questions were structured in the payment card response format that has gained popularity in recent years, as a compromise between the open-ended and closed-ended formats (Cameron and Huppert, 1989). CV questions in the form of the payment card contain an ordered set of threshold values. In the payment card approach, consumers are asked simply to go over the range of values and to circle the highest amount of premium they would be willing to pay, or the lowest amount of discount they would be willing to accept.

For a box of breakfast cereals made of non-GM crops (base price £2.80), the WTP payment card included a range of premiums from £0.00 to £2.10. For the question on weekly food expenditures, the payment card ranged from 0% to 75%, with suitable increments consistent with those used for breakfast cereal. The payment cards also included a "don't know" category. Moreover, a followup question was presented to respondents who selected zero as the maximum premium. The goal was to identify true zeros (i.e., no preference between non-GM and GM foods) from zeros that protested against paying a premium for conventional non-GM foods (Boyle, 2003, p. 143).

An identical range of discounts was used for willingness-to-accept (WTA) measures along with a "don't know" category. Yet, the payment card for WTA differed from that of WTP in two respects. First, the followup question is not relevant in the WTA context because zero values here imply that respondents do not consider GM foods inferior to

non-GM versions (i.e., no preference between GM and non-GM foods). Second, a new response category was added to the WTA payment card in order to identify respondents who will not buy GM food at any discount. These differences render the design of WTP and WTA questions somewhat asymmetric. Another reason for this asymmetry is that, for some respondents, GM food may be a "bad" rather than a "good" (i.e., GM foods are worse than simply being inferior to non-GM foods). We further note that this bad involves a product where safety remains the utmost concern for most consumers (unlike public goods such as clean air for which consumers are generally willing to live with lower quality, if adequately compensated).

One-half of our respondents received the "cheap-talk" script prior to the WTA or WTP questions (see the appendix for this script). Additionally, we tested for question ordering effect. One-half of the sample received a survey questionnaire in which WTP questions were presented prior to WTA questions, while WTA questions were presented first to the remaining respondents.

Data Analysis

Segmentation of Consumers

Table 2 reports the distribution of responses to the four contingent valuation questions across the WTP and WTA payment cards. For WTP items, about 21% (21.2% for breakfast cereal, 20.5% for weekly food expenditure) of respondents chose the zero premium response option, indicating their unwillingness to pay any premium to purchase non-GM foods. Table 3 further separates the zero premium responses into true zeros and protest responses. Of the 21% of respondents who selected the zero premium response option, about 8% were protest responses that reject the notion of paying a premium to purchase non-GM foods. The remaining 13% (12.8% for breakfast cereal and 13.7% for weekly food expenditure) preferred GM and non-GM food equally. About 20% of respondents (19.5% for breakfast cereal and 20.4% for weekly food expenditure) selected the "don't know" category, reflecting uncertainty about whether to pay a premium in order to avoid GM foods. After accounting for GM-embracing, protest, and unsure respondents, approximately 58% were willing to pay varying premiums to avoid GM foods.

For WTA items, approximately 45% of respondents (46.6% for breakfast cereal and 43.6% for weekly food expenditure) voiced their rejection of GM foods by selecting the response option "I'll never buy GM food at any discount." After accounting for about 8% of the unsure respondents, approximately 35% of respondents (33.9% for breakfast cereal and 36.7% for weekly food expenditure) were willing to consume GM foods at some discount. About 12% of respondents (12.0% for breakfast cereal and 12.1% for weekly food expenditure) did not require a discount to buy GM foods.

The preceding description of WTA and WTP responses reflects remarkably similar percentage values for breakfast cereal and weekly food expenditures. This pattern suggests WTA and WTP values may actually be stable across a variety of food consumption contexts.

Table 3 depicts WTA and WTP for two response categories: "do not differentiate between GM and non-GM" and "don't know." The responses to the former are comparable for WTA (approximately 12%) and WTP (approximately 13%), suggesting that the size of the GM-embracing group is consistent across WTA and WTP questions. However, the

Table 2. Distribution of Responses to WTP and WTA Questions

Box of Breakfast Cereals			Weekly Food Expenditure		
Premium/Discount (£)	WTP (%)	WTA (%)	Increase/Decrease in Weekly Food Bill (%)	WTP (%)	WTA (%)
0.00	21.2	12.0	0.00	20.5	12.0
0.01 ~ 0.07	4.0	1.7	0.01 ~ 2.5	5.7	2.1
0.08 ~ 0.14	5.1	1.7	2.6 ~ 5.0	10.0	3.4
0.15 ~ 0.21	8.7	2.2	6.0 ~ 7.55	2.1	2.0
0.22 ~ 0.28	4.8	1.7	7.6 ~ 10.0	7.7	3.6
0.29 ~ 0.35	4.3	2.0	11.0 ~ 12.5	8.1	3.9
0.36 ~ 0.53	7.2	4.1	12.6 ~ 18.9	2.8	2.4
0.54 ~ 0.70	6.0	4.9	19.0 ~ 25.0	7.6	5.3
0.71 ~ 0.88	0.9	1.7	26.0 ~ 31.0	2.0	2.4
0.89 ~ 1.05	4.6	4.7	32.0 ~ 37.0	0.5	1.4
1.06 ~ 1.23	2.1	2.4	38.0 ~ 44.0	0.6	0.6
1.24 ~ 1.40	1.5	2.5	45.0 ~ 50.0	2.9	4.5
1.41 ~ 1.75	0.9	1.0	51.0 ~ 62.0	1.2	1.8
1.76 ~ 2.10	0.6	0.8	63.0 ~ 75.0	0.6	0.7
2.11 or higher	9.0	3.9	76.0 or higher	6.6	3.7
Don't know	19.5	7.5	Don't know	20.4	8.3
I'll never buy GM food at any discount	N/A	46.6	I'll never buy GM food at any discount	N/A	43.6
SUM	100%	100%	SUM	100%	100%

Table 3. Summary Information from WTP and WTA Responses

	Willingness to Pay (WTP)		Willingness to Accept (WTA)	
Segment/Response Category	Box of Breakfast Cereals (£)	Weekly Food Expenditure (%)	Box of Breakfast Cereals (£)	Weekly Food Expenditure (%)
	<– – – – – – – – – – – – – (%) – – – – – – – – – – – – –>			
Never consume GM foods	N/A	N/A	46.6	43.6
Don't know	19.5	20.4	7.5	8.3
WTP premium	57.0	59.0	N/A	N/A
WTA discount	N/A	N/A	33.9	36.7
Do not differentiate between GM and non-GM [a]	12.8	13.7	12.0	12.1
Protest responses [a]	8.0	8.0	N/A	N/A
SUM	100%	100%	100%	100%

[a] These two categories arise from a followup question directed toward respondents who selected £0 as their premium for WTP. The followup was intended to decompose these responses into true zeros and protest zeros.

percentage of unsure respondents differs between WTP (approximately 20%) and WTA (approximately 8%). A plausible reason is that asking the willingness-to-pay-a-premium question is likely to offend these respondents more than asking a willingness-to-accept-a-discount question. Although our survey presented a followup question that allows respondents (who chose zero premium) to protest against paying a premium for conventional non-GM foods, it is likely they did not anticipate or expect this protest option, thereby inflating responses to the "don't know" category in the WTP question.

In sum, table 3 segments UK consumers into four distinct groups: those who (*a*) are unsure, (*b*) fully accept GM foods, (*c*) never accept GM foods (some of them may be willing to pay a premium for non-GM foods and others may protest the notion of paying a premium to purchase non-GM foods), and (*d*) consume GM foods only at a price discount.

Mean WTA and WTP

Table 4 presents mean WTA and WTP for both breakfast cereal and weekly food expenditures (mean WTA and WTP are calculated after dropping "don't know" and protest respondents). Respondents who are willing to pay a premium (58% in table 3) represent two groups in the UK population: (*a*) those who will not consider GM foods at any price discount, and (*b*) those who are likely to consider GM foods if the premium for non-GM foods is unreasonably high. On average, respondents were willing to pay £0.57 more to purchase a box of breakfast cereal made of non-GM ingredients (base price £2.80). They were also willing to spend 16.5% more in weekly food expenditure to avoid GM foods.

The strength (or weakness) of demand for GM breakfast cereal stems from 33.9% of respondents (see table 3) who reaffirmed their willingness to accept a price discount in order to buy a box of GM breakfast cereal. Similarly, 36.7% of respondents indicated their willingness to accept GM foods in return for a decrease in their weekly food expenditure. On average, a discount of £0.65 (table 4) was needed to motivate this group to purchase a box of breakfast cereal made of GM ingredients (or a 23% decrease from the base price of £2.80). Similarly, a 21.8% reduction in weekly food expenditure was needed to induce these consumers to purchase GM foods.

Table 4 also presents the results of Tukey tests for mean differences between WTP and WTA. Mean WTA was significantly greater than mean WTP for both breakfast cereal ($p < 0.01$) and weekly food expenditure ($p < 0.00$). Consistent with proposition 1, this result indicates that the valuation of non-GM foods is associated with the endowment effect, imperfect substitutability, or both. The non-equivalence between WTA and WTP values also suggests that demand estimates for non-GM foods may be upwardly biased if they are derived from stated WTA estimates.

Regression Models for WTA and WTP

Descriptive analyses of WTA and WTP data offer information useful to segment UK consumers with regard to GM foods. We now develop regression models to analyze relationships between stated WTA or WTP values and individual characteristics. Note that WTA and WTP were measured with respect to breakfast cereals and weekly food expenditures. Regression models were run for both items and the estimated results were very similar between the two products. Therefore, only the estimation results for breakfast cereals are presented here. These regression models are based on respondents who

Table 4. Mean Difference Between WTP and WTA

	Box of Breakfast Cereals		Weekly Food Expenditure	
Description	WTP	WTA	WTP	WTA
Mean	£0.57	£0.65	16.5%	21.8%
Mean Difference (WTA – WTP)	£0.65 – £0.57 = £0.08 ($p < 0.01$)		21.8% – 16.5% = 5.3% ($p < 0.00$)	

were either willing to pay (accept) a premium (discount) or indifferent between GM and non-GM breakfast cereal. In other words, the following respondents were excluded from the analyses: those who protested, were unsure, or categorically indicated an unwillingness to buy GM breakfast cereal.

Two aspects of the regression models are addressed. First, we examine the role of individual characteristics in explaining variations in stated WTA or WTP. Contingent valuation studies typically employ regression models as tools to check internal validity. Second, we examine whether individual characteristics account for differences between WTA and WTP. Considering that the mean WTA was significantly greater than mean WTP, regression analyses may offer insights useful in identifying variables driving such discrepancies.

Model specification in this study is based on the following premises: (*a*) WTP or WTA is determined by consumers' attitude (acceptance) toward agrobiotechnology, and (*b*) this attitude is in turn shaped by consumers' perceptions of various attributes associated with agrobiotechnology or GM foods (Ajzen and Fishbein, 1980). We hypothesize that consumers' perceived risks and benefits, their trust in government, and their knowledge about GM issues are major determinants of WTA or WTP. Equations (1a) and (1b) depict the regression models to be estimated:

$$WTA = f(RISK, BENEFIT, TRUST, KNOWLEDGE, CHEAP_TALK, QUEST_ORDER) \quad (1a)$$

and

$$WTP = f(RISK, BENEFIT, TRUST, KNOWLEDGE, CHEAP_TALK, QUEST_ORDER). \quad (1b)$$

Benefit and Risk Measures

The development of benefit and risk measures was guided by substantive and theoretical insights from previous research in both risk and agrobiotechnology domains. The risk literature provided insights on problems and pitfalls associated with measuring risks related to GM foods, while the literature on GM foods helped orient our measurement items around specific benefits and risks.

Risk Literature

Relative to other established technologies, agrobiotechnology is a recent enterprise. Therefore, many unknowns linger within this emergent area. Kunreuther and Bendixen (1986) suggest that individuals find it more difficult to evaluate benefits associated with a new technology when compared to a more familiar technology (e.g., automobiles) for

which extensive, accurate, and accessible information already exists. Similarly, the assessment of risks related to agrobiotechnology appears a formidable task. Slovic, Fischhoff, and Lichtenstein (1983) assert consumers are likely to consider home appliances (which represent a familiar or mature technology) to be less risky than objective data on these products may suggest. In contrast, GM foods (a newer technology) may produce an opposite effect, in that consumers may exaggerate the risks involved simply because objective data on future effects do not exist. Moreover, behavioral decision theory indicates that individuals can be misinformed about risks (Fischhoff, Slovic, and Lichtenstein, 1982) or easily influenced by the manner in which the risk information is framed (Tversky and Kahneman, 1981).

Overall, the preceding discussion indicates that the scale items we develop to measure the benefits or risks of GM foods should be unambiguous, informative, and avoid framing effects. Moreover, since individuals may be misinformed about GM foods, such items should comprehensively address all their potential risks/benefits, as highlighted next.

Prior Literature on GM Foods

With respect to benefits, GM proponents argue that the application of biotechnology to crop production will substantially benefit society by reducing the use of pesticides and herbicides in crop production, improving crop yield, and enhancing nutritional value of foods (see Vogt and Parish, 1999; Pidgeon et al., 2005; Nielsen, Theirfelder, and Robinson, 2003).

On the other hand, opponents of agrobiotechnology contend that GM foods bring significant negative consequences such as harmful outcomes to human health (Vogt and Parish, 1999; Hansen, 2001; Lusk and Coble, 2005). If the altered genetic formulation of GM crops stimulates production of more toxins than are present naturally, long-term negative health consequences could follow. Moreover, the risk of ecotoxicology exists (Linacre et al., 2006). For example, genes in GM plants may spread into the environment through cross-fertilization, posing unknown risks to the ecosystem (Caplan, 2001).

Some researchers acknowledge ethical (e.g., Scholderer, 2005) or moral issues, because GM crops may irrevocably alter nature/God's creations. Others assert the fruits of agrobiotechnology are not distributed equitably, whereby multinational corporations that develop/promote this technology are its prime beneficiaries (Moon and Balasubramanian, 2003; Fukuda-Parr, 2006). More specifically, this development undermines the interests of small-scale farmers (because multinational corporations entirely control the agrobiotechnology agenda) and consumers (because they assume all the risks associated with consumption). Related concerns addressed in prior research (e.g., Pidgeon et al., 2005) include the notion that agrobiotechnology is driven more by profit than by the public interest, and that it benefits the producers rather than ordinary people.

In line with the preceding discussion, table 5 presents a brief description of the risk/benefit measures used in our study [along with other variables shown in equations (1a) and (1b)]. In brief, perceived risks were measured with five items: (*a*) health risks, (*b*) environmental risks, (*c*) moral and ethical considerations, (*d*) image of multinational corporations as primary beneficiaries of biotechnology, and (*e*) the growing control of multinational corporations over farming. Perceived benefits were measured with three items: (*a*) potential increase in crop yield, (*b*) reduced use of chemicals in crop production,

Table 5. Definitions and Descriptive Statistics of Variables Used in the Empirical Model

Variable	Description	Mean (Std. Dev.)
RISK:		***19.70 (8.90)***
▸ Health risks	Biotech foods pose health hazards.	3.61 (1.50)
▸ Environmental risks	Agrobiotechnology poses hazards on ecosystem.	4.06 (1.44)
▸ Morality	It is morally and ethically wrong to use biotechnology.	3.39 (1.55)
▸ Multinational corporations	Multinational corporations are primary beneficiaries of agrobiotechnology, while consumers assume most of the risks.	4.54 (1.49)
▸ Control on farming	Multinational corporations are increasingly controlling farming.	4.22 (1.29)
BENEFIT:		***10.20 (3.75)***
▸ Increase in yields	Agrobiotechnology reduces world food shortages by increasing yields.	3.92 (1.35)
▸ Reduced chemical use	Agrobiotechnology reduces the use of chemicals in crop production.	3.52 (1.38)
▸ Improved nutrition	Agrobiotechnology enhances nutritional composition.	3.17 (1.23)
TRUST	I feel that the UK government has adequate rules and regulations with regard to genetically modified (GM) foods.	***2.51 (1.54)***
KNOWLEDGE	How much do you know about agricultural biotechnology? [1 = nothing; 6 = a great deal]	***3.68 (1.27)***

Notes: Items for *RISK*, *BENEFIT*, and *TRUST* are measured on a seven-point scale ranging from "disagree completely" to "agree completely" to "don't know." Calculation of mean and standard deviation excludes "don't know" responses. Cronbach's alpha for *RISK* and *BENEFIT* are 0.820 and 0.822, respectively.

and (*c*) potential improvement in nutritional contents of crops. We constructed composite indices for risk (*RISK*) and benefit (*BENEFIT*) by aggregating the preceding five and three items, respectively. Cronbach's reliability coefficients for these two composite indices were acceptably high (0.820 and 0.822, respectively).

Finally, the regression models included *TRUST* and *KNOWLEDGE* variables, and two binary variables representing cheap talk script (*CHEAP_TALK*) and question ordering (*QUEST_ORDER*), respectively.

Because the CV questions on WTA or WTP generate value responses in the form of intervals rather than point estimates, the mid-points of the intervals may be used as approximations of the true unobserved values in order to derive a univariate distribution. The mid-points can also be used as values of the dependent variable in ordinary least squares (OLS) regression. Given that expected values within the intervals are not necessarily equal to the interval mid-points, we used the maximum-likelihood (ML) estimator proposed by Cameron and Huppert (1989) for estimating WTA and WTP regression models.

Table 6. WTA and WTP Regression Results for GM and Non-GM Breakfast Cereals

	Box of Breakfast Cereals			
	Willingness to Accept (WTA)		Willingness to Pay (WTP)	
Variable	Estimated Parameter	*t*-Statistic	Estimated Parameter	*t*-Statistic
Constant	0.7073	2.805	0.5019	2.466
RISK	0.2452***	6.205	0.1783***	5.990
BENEFIT	−0.0796*	−1.893	−0.0760**	−2.414
TRUST	−0.0883***	−3.170	−0.0286	−1.336
KNOWLEDGE	−0.0056	−0.316	0.0224	1.624
CHEAP_TALK	−0.1949***	−2.929	−0.0545	−0.938
QUEST_ORDER	−0.0812	−0.224	−0.5045***	−8.704
No. of Observations	500		856	
R^2	0.25		0.24	

Note: Single, double, and triple asterisks (*) denote $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively.

Table 6 presents estimation results for WTP and WTA models. The cheap talk script has a negative sign in both WTA and WTP regressions. In other words, as per proposition 2, both WTA and WTP values tend to be higher when respondents are unexposed to the cheap talk script. However, the difference was statistically significant only in the WTA model—i.e., respondents who were exposed to the cheap talk script tended to require a smaller discount to buy GM breakfast cereals compared to those who were not exposed to the script. This result is of considerable interest given that hypothetical bias was debated largely in terms of WTP rather than WTA. Moreover, tests involving the cheap talk script have been restricted to WTP questions thus far. Nevertheless, our result demonstrates that respondents tend to inflate WTA, and explaining the nature of hypothetical contingent valuation reduces the size of WTA. The script may motivate respondents to contemplate the true minimum amount of discount they would be willing to accept.

Question ordering of WTP and WTA items yielded a statistically significant and negative impact on stated WTP values, but not on stated WTA values (this finding is partially consistent with proposition 3). That is, presenting WTA questions prior to WTP questions significantly increases WTP values when compared to the situation where respondents were exposed to WTP questions first. A plausible reason is that, in the former case, respondents use their WTA responses to frame answers to the subsequent WTP questions, thereby inflating the premiums to an extent inconsistent with their true preferences.

Results show that the composite indices of risk and benefit perceptions have a strong impact both in the WTA and WTP regression models. Those who perceive risks in connection with agrobiotechnology/GM food are likely to require a large premium (discount) to avoid (purchase) GM foods. In contrast, when consumers perceive benefits from agrobiotechnology/GM food, they are predisposed to accept a small discount (premium) to purchase (avoid) GM foods.

As respondents' trust in regulatory agencies increases, they are predisposed to require a smaller discount to purchase GM breakfast cereals. Self-rated knowledge

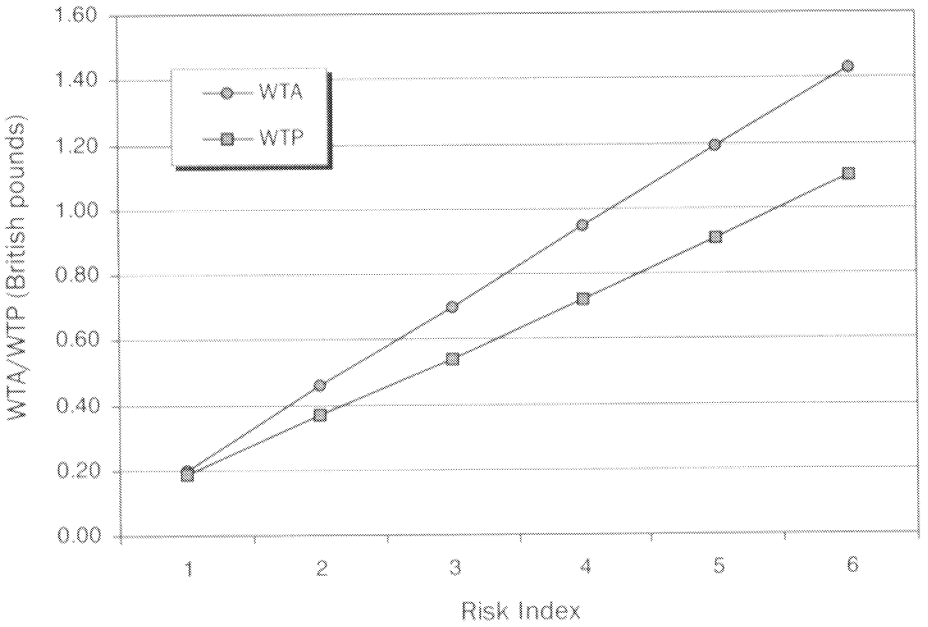


Figure 1. Simulated relationship between risk perception, and willingness to pay premium for non-GM cereal and willingness to accept discount for GM cereal

about agrobiotech issues, however, did not make a significant difference in regression models with either WTA or WTP as the dependent variable.

A comparison of regression results between WTA and WTP highlights an important difference: perceptions about negative attributes and the degree of perceived trust in the regulatory agency influence WTA and WTP differently. From table 6, it is clear that both *RISK* (WTA: $\beta = 0.2452$, $t = 6.205$; WTP: $\beta = 0.1783$, $t = 5.990$) and *TRUST* (WTA: $\beta = -0.0883$, $t = -3.170$; WTP: $\beta = -0.0286$, $t = -1.336$) generate measurably stronger impact on WTA than WTP. This comparison suggests that UK consumers' perceptions about negative GM attributes play a greater role in shaping WTA, when compared to WTP. This comparison is illustrated by figure 1, which simulates the effect of perceived risk (*RISK*) on WTA and WTP. It displays divergent effects between WTA and WTP. For consumers with low risk perception (Risk Index = 1), the amount of WTA and WTP is nearly identical (around £0.20). When risk perception is in the middle of the range (Risk Index = 3), respondents are willing to pay a premium of £0.55, but would require a discount of £0.70 to purchase GM breakfast cereals. The difference between these two values becomes more pronounced as risk perceptions increase further.

Regression Model on Difference Between WTA and WTP

Our survey elicited both WTA and WTP from each respondent, enabling us to analyze the difference between these values as a function of respondents' characteristics (Adamowicz, Bhardwaj, and Macnab, 1993). In our study, the dependent variable WTA – WTP is regressed against respondents' risk and benefit perceptions. This regression model is based on 377 observations after deleting several categories including "don't know," "I'll

Table 7. WTA-WTP Difference Regression Results

	WTA-WTP Difference	
Variable	Estimated Parameter	*t*-Statistic
Constant	0.4438*	1.708
RISK	0.3515***	4.273
BENEFIT	−0.0356**	−2.442
$R^2 = 0.116$		

Note: Single, double, and triple asterisks (*) denote $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively.

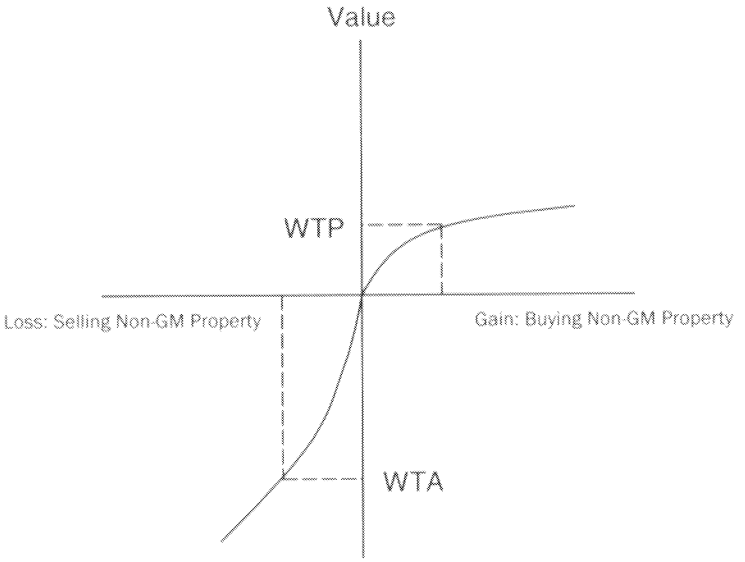
never buy GM food at any discount," and zero. Further, 47 respondents who contributed to a negative difference (higher stated WTP than WTA) were deleted from our analyses.

Table 7 reports regression results for the difference model between WTA and WTP. *RISK* has a positive sign, indicating respondents with higher risk perceptions are predisposed to exhibit greater discrepancy between WTA and WTP. *BENEFIT* has a negative sign and demonstrates that, when respondents see potential benefits from GM food, their discrepancies between WTA and WTP are likely to diminish; i.e., perceived risks increase the divergence, while perceived benefits reduce it. Consistent with the stronger impact of *RISK* and *TRUST* on WTA (when compared to WTP) in earlier regression models, these results highlight two points: (*a*) the magnitude of the WTA-WTP difference may stem from consumer perceptions about negative attributes of the GM food, and as a result, (*b*) loss aversion implied by the prospect theory may underlie the greater WTA in our study.

Figure 2 illustrates the observed asymmetry between perceived risk (loss) and benefit (gain) and between WTA and WTP. The vertical axis represents the value function with the WTP and WTA divided by the reference line, while the horizontal axis shows gains and losses associated with buying and selling the non-GM property of a box of breakfast cereals. Two characteristics of figure 2 are noteworthy. First, the graph is concave in the domain of gains and convex in the domain of losses. Second, the graph is steeper for losses than for gains (Kahneman and Tversky, 2000, p. 3). This figure shows that buying one box of breakfast cereals of non-GM property costs substantially less than compensating the consumer for the loss of the right to buy a box of non-GM breakfast cereals.

Conclusions

Recognizing that WTP alone does not provide sufficient information in gauging the demand for GM food and determining its substitutability with non-GM food, our study elicited UK consumers' willingness to accept (WTA) a discount in exchange for giving up non-GM food and willingness to pay (WTP) a premium for non-GM food. WTA and WTP data were analyzed in four major ways: (*a*) segmenting UK consumers into several distinct groups with reference to behavioral intentions about GM food, (*b*) statistically testing the difference between WTA and WTP, (*c*) regressing the WTA and WTP values against individual characteristics, and (*d*) regressing the WTA-WTP difference against risk and benefit perceptions.



Source: Adapted from Kahneman and Tversky (2000).

Figure 2. Asymmetry between WTA and WTP

Tukey tests show that willingness to accept a discount for GM foods is statistically greater than willingness to pay a premium for non-GM foods. The valuation of the non-GM property in foods does not differ from previous studies that theoretically or empirically display larger WTA. This result suggests consumers consider non-GM foods not perfectly substitutable with their GM counterparts, or consumers have an emotional attachment to the non-GM attribute of food products (endowment effect). We further examine these two hypotheses below in view of our data and regression analyses.

Descriptive data analysis shed some light on the substitutability between GM and non-GM food. Specifically, it revealed that 46% of respondents answered the WTA question by stating they would never buy GM food at any discount. Hence, to these individuals, non-GM food is not substitutable at all with GM food. Given the Tukey test results (WTA is larger than WTP), non-GM food is imperfectly substitutable with GM food to the 36% who needed a discount to buy GM food, and consequently, the GM-free property cannot be perfectly exchanged for money (Shogren et al., 1994). Yet, GM food was perfectly substitutable to about 12% of respondents who did not differentiate between GM and non-GM food.

The last group could be the primary force driving the emergence of the markets for GM-labeled food in the UK. Members of the second group, who need a discount to buy GM-labeled food, represent an additional target market for food manufacturers and retailers contemplating the use of GM ingredients. Our data show that UK consumers require on average a £0.57 discount to purchase GM-labeled breakfast cereals. While there are no market data available in the UK with which to compare our stated WTA data, supermarket scanner data in the Netherlands reveal that the effect of the GM label in aggregate is minimal, indicating GM food products were close substitutes to non-GM versions (Kalaitzandonakes, Marks, and Vickner, 2005). However, the scanner data were aggregated across supermarkets in the Netherlands, and the analysis did not offer more specific information such as who and what percentage of consumers were

purchasing the GM foods. Furthermore, the shares of GM-labeled food products in the Netherlands scanner data were too small to accurately gauge average consumers' preferences. In contrast, our data suggest there would be two particular groups of consumers (GM-embracing and price-conscious) who would be willing to substitute GM with non-GM food products and motivate the food industry to use GM ingredients.

To assess whether the endowment-effect hypothesis can explain our result, we used the results of the two sets of regression models and identified factors influencing the differences between WTA and WTP. The first set shows that risk perceptions were more strongly associated with WTA than WTP, driving WTA to be greater than WTP. The second regression model showed that risk and benefit perceptions had significant and contrasting effects on explaining the differences between WTA and WTP; i.e., consumers with higher risk perceptions required a greater amount of discount in return for accepting GM food than the amount of premium they would be willing to pay for the non-GM counterpart, while benefit perceptions reduced such a discrepancy.

These regression results illustrate that the differences between WTA and WTP in the particular case of valuing the non-GM property of food products are systematically linked to respondents' perceptions about negative attributes of GM food. In line with the earlier finding by Moon and Balasubramanian (2004) that risk perceptions had a significantly greater impact on public acceptance of agrobiotechnology than benefit perceptions, this important role of risk perceptions in explaining such differences is congruent with consumers' propensity toward loss aversion predicted by the prospect theory or the endowment-effect hypothesis. In consideration of the generally negative sentiment against GM food in Europe, UK consumers are likely to give more weight to potential risks (loss) than potential benefits (gain). More importantly, when asked to buy (gain) and sell (loss) the non-GM property of food products, UK consumers treat the buying and selling as asymmetric transactions because of the greater weights on risks and their loss-averting behavior.

In conclusion, our study points to two key implications. First, GM foods are not an immediate substitute for non-GM foods for a considerable segment of UK consumers, explaining why the European food industry has decided not to use GM ingredients thus far. Yet, if the food industry decides to offer GM food, there is a potential demand from two non-negligible groups of consumers—GM-embracing and price-conscious groups. Second, the estimated divergence between WTA and WTP and the significant role of risk perceptions in explaining such divergence imply that consumers' emotional attachment to conventional non-GM food is an important element for the food industry to consider when designing marketing strategies for GM food products.

[*Received March 2006; final revision received February 2007.*]

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Appendix: "Cheap Talk" Script

In a recent study, several different groups of people were asked whether they are willing to purchase a new food product. This purchase was hypothetical for these people, as it will be for you. No one actually had to pay money when they were willing to purchase the new food product. Over 80% of people said they would buy the new food product. However, when a grocery store actually put the same new food on its shelf, and people really did have to pay money if they decided to purchase the new food product, the result was different: only 43% of people actually bought the new food. That's quite a difference, isn't it?

We call this "hypothetical bias." Hypothetical bias is the difference that we continually see in the way people respond to hypothetical purchase questions as compared to real situations.

I think that when we say we will purchase a new food at a particular price in a hypothetical survey we respond according to our best guess of what the food is really worth in the grocery store. But when we

are really in the grocery store, and we actually have to spend our money if we decide to purchase the food, we think a different way: If I spend money on this, that's money I can't spend on other things. We shop in a way that takes into account the limited amount of money we have. This is just my opinion, of course, but it's what I think may be going on in hypothetical survey questions.

So if I were in your shoes, I would ask myself: If I were really shopping in the grocery store and I had to pay a premium of £X if I decide to buy non-GM breakfast cereals, do I really want to spend my money this way? If I really did, I would indicate YES, I would pay a premium of £X to purchase non-GM breakfast cereals; if I didn't want to spend my money this way, I would indicate NO, I would purchase GM breakfast cereals at a lower price.

In any case, I ask you to respond to each of the following willingness-to-pay questions just exactly as you would if you were really in a grocery store and were going to face the consequences of your decision: which is to pay a premium of £X if you decide to buy non-GM foods. Please keep this in mind when answering the following questions.