Consumer benefits of labels and bans on genetically modified food – An empirical analysis using Choice Experiments

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JEL classification: Q13, Q16, Q18

Abstract
Applying an experiment on the choice of consumer goods, we show that Swedish consumers do not regard genetically modified (GM) food as being equivalent to conventional food. A central argument by proponents of GM is that the end products are identical to those where GM has not been used. That respondents in our survey disagree with this argument is supported by two observations. First, a positive significant WTP is found for a mandatory labeling policy. This result confirms previous observations that GM food can be a credence good causing a market failure. Second, consumers are also willing to pay a significantly higher product price to ensure a total ban on the use of GM in animal fodder. Even if scientists and politicians argue that most of today's GM food is indistinguishable from GM-free food, consumers disagree.

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Introduction

The use of biotechnology in agriculture increases at a fast pace. While the adoption rate is relatively faster in developing countries, it is mainly used in a few relatively large agricultural exporting countries. Argentina, Canada and the United States, account for ninety-five percent of the global biotechnology acreage in 2002 (Clive, 2002). The European Union (EU), on the other hand, has been relatively cautious about the new technology. A moratorium on the approval of new genetically modified (GM) organisms, required ability to trace GM through the food chain, and mandatory labeling are examples of policies undertaken in the EU in an attempt to at least slow down the advance of the use of GM. Other governments, including the United States (US), view the EU policies as non-tariff trade barriers (Carter and Gruere, 2003; and Sheldon, 2002). Trade barriers, traditionally viewed as welfare reducing measures, impose a cost on consumers in order to protect domestic producers. This conventional wisdom, however, may not apply to labeling of GM food since it has the potential to benefit domestic consumers (Lusk and Fox, 2002; Lusk, 2003; and Lusk, Roosen and Fox, 2003).

Opponents of mandatory labeling claim that such a label implies a food safety risk that is actually nonexistent, raises marketing costs, possibly inhibits further development of GM technology, and is unnecessary since the products are similar to their conventional counterparts (Carter and Gruere, 2003). In response, proponents argue that GM foods are not equivalent to their conventional counterparts, consumers should be allowed to decide themselves what to buy, and biotechnology creates so-called credence goods (Sheldon, 2002).[1] The first-generation GMs, also called process-based GMs, have primarily lowered production costs (Phillips and Isaac, 1998). While consumers eventually benefit from lower product prices, in general there have not been any detectable differences in product quality. If consumers cannot observe whether GM has been used or not, there is a chance this uncertainty eventually drives out what the consumers see as high-quality (GM-free) products so only low-quality (GM) products will prevail (Akerlof, 1970). When labeled, GM food is put to the 'market test', where consumers and producers jointly can decide whether they want the product or not. It is not obvious, however, that labeling should be mandatory. If consumers are willing to pay a price premium for food guaranteed to be free from GM, it is in the interest of GM-free producers to label their food. The welfare maximizing measure, whether to have a voluntary or a mandatory label, depends on the proportion of reluctant versus indifferent consumers, and the cost of labeling, Crespi and Marette (2003). In general, the higher the proportion of reluctant buyers, the more likely is a mandatory policy efficient, while voluntary labels (thus resulting in GM-free labels) are preferred the lower the ratio is.

Even if we disregard product quality, consumers can still have a preference for GM-free products due to what (Antle, 1999) calls extrinsic quality. This is when the consumer cares about the production process, even if it does not affect product quality; for example, this may be due to animal, environmental, ethical, and religious reasons. Some of these values have a public good character, which in turn implies that labeling might not be enough. Consumers may prefer a ban of the use of GM, since with labeling the consumer only can internalize her own perceived disutility caused by GM food. Thus the quantity of GM-free products will be lower than what is socially efficient.

Little quantitative work has been done to measure whether GM food is a credence good or not. Previous studies of GM food investigate the demand for beef from cattle fed genetically modified corn in the US and four European countries (Lusk, Rosen, and Fox, 2003); the demand for the label itself in the US (Lusk and Fox, 2003); how the inclusion of GM ingredients change the willingness to pay (WTP) for chocolate chip cookies in the US, United Kingdom and France (Lusk, 2003); WTP for GM labeled vegetable oil, tortilla chips and potatoes in the US (Huffman, 2003); and a test of whether consumers read GM labels (Noussair, Robin, and Ruffieux, 2002). No study has estimated the benefits to European consumers due to labeling of GM products nor estimated any public good attributes of GM, though Rousu *et al*. (2004) has estimated the public value of conflicting information on GM. Neither has any study covered such a broad range of commodities as we do (chicken, beef, hog, and egg).

The objective of this survey is to measure potential market failures with GM foods. Conducting a series of choice experiments applied to animal fodder, Swedish consumers' preferences about GM foods are explored. We test whether consumers are willing to pay a higher product price to ensure that GM foods are labeled or banned. Our main results are: (i) consumers are willing to pay a substantially higher price premium for farm animal products if they are able to distinguish GM food from GM-free food (labeling); and (ii) consumers are willing to pay even more for a total ban of GM within the EU. This means that we cannot reject the hypothesis of a public good character of GM in food. The results hold for all the farm animal foods surveyed.

Testing for the Credence Good and Public Good Hypotheses

Hypotheses

To determine whether GM food is a credence good and whether or not there are public good qualities, two null hypotheses are tested. If GM is not a credence good, then the WTP for labeled GM food is zero: $H_0 : WTP^{label} = WTP^{nolabel}$. A significantly higher WTP for labeled food is interpreted as a support for the potential of GM food being a credence good. A ban on the use of GM would not only solve the information problem but also the potential market failure due to public good values. The second null hypothesis is then that the WTP for a ban on GM food equals the WTP for labeling: $H_0 : WTP^{label} = WTP^{ban}$. A significantly higher WTP for a ban is interpreted as support for the hypothesis that GM food creates public good values. These null hypotheses are tested using a two-sided test since it is possible to rationalize both a higher and negative WTP price premium for GM food. For example, (Hamilton *et al*., 2003) find that regulation on food safety can lower WTP since it results in a loss of options.

The Choice Experiment

Since one objective is to test whether there are public good qualities associated with GM food, it is difficult to use methods that rely on actual market data; instead we have to use a stated preference method such as the contingent valuation method (CVM), or a choice experiment. Both survey methods ask the respondent to make hypothetical trade-offs between different attributes. The possibility of including non-existing situations makes it possible to empirically test our hypotheses. A CVM survey provides the surveyor with a point value estimate of a good with a certain combination of attributes such as color, shape, free range, etc. It is difficult, however, or expensive, to estimate the value of individual product attributes since each change of an attribute requires a new CVM scenario to value. A choice experiment, on the other hand, allows us to estimate marginal rates of substitutions between different attributes, existing as well as hypothetical. We, therefore, choose to conduct a choice experiment to test our hypotheses. For an overview of choice experiments, see Alpizar, Carlsson, and Martinsson (2003) and Louviere, Hensher, and Swait (2000).

A number of steps were taken to design a questionnaire that was policy relevant, plausible, and meaningful to the respondent. First, industry representatives and academic researchers who specialized in farm animal production were consulted and involved in the process of developing the questionnaire. This was followed up by focus groups, where the participants were asked to fill out a questionnaire and write down eventual questions and comments. The focus group participants later took part in a round-table discussion of the questionnaire. The results from the following pilot survey were returned to the individuals and organizations who participated. This was repeated three times until we had a satisfactory questionnaire. Each pilot study was distributed to a random sample of 200 individuals and was conducted during May-September 2003.

The resulting questionnaire consists of three parts. The first includes questions about the respondent's and the household's habits regarding food consumption. The choice experiment constitutes the second part and the third part contains questions regarding the respondent's socio-economic and demographic status.

In the introduction to the choice experiment, the purpose of the survey was briefly explained. This was followed by a description of the different attributes. The respondents were also provided with a separate fact sheet providing a description of each attribute. The provided information on GM in fodder was:

> The Swedish Meat Producers' Association allows for use of genetically modified fodder if it is shown that it is not harmful to humans or animals, does not reduce the biological or genetic diversity and does not survive or reproduce outside what is intended. Possible alternatives are:

- The fodder fulfils the current policy, that is, genetically modified fodder can be used. There is no responsibility to inform about this on the food product.
- The fodder fulfils the current policy. If genetically modified fodder has been used, this must be labeled on the food product.
- The use of genetically modified products in fodder is banned.

Four farm animal products are valued, and each questionnaire included a combination of two products: (i) chicken and ground beef, or (ii) pork chop and egg. For each product, respondents answered four choice sets, i.e. in total eight. An example of a choice situation is presented in the Appendix. The choice sets were created using a cyclical design principle (Bunch, Louviere, and Andersson, 1996). A cyclical design is a straightforward extension of the orthogonal approach. First, each of the alternatives from a fractional factorial design is allocated to different choice sets. Attributes of the additional alternatives are then constructed by cyclically adding alternatives into the choice set based on the attribute levels. The attribute level in the new alternative is the next higher attribute level to the one applied in the previous alternative. If the highest level is attained, the attribute level is set to its lowest level.

The choice experiment does not include an opt-out alternative.[2] For all attributes, however, the current level is included as one level. Furthermore, we are not primarily interested in estimating the total WTP for certain attribute combinations, or the actual market share for a certain attribute combinations. Instead we are interested in comparing the marginal WTP for certain attributes, in this case for GM. As argued by Lusk and Schroeder (forthcoming) although total WTP is overstated in hypothetical experiments, the marginal WTP may not be. This confirms the results of Carlsson and Martinsson (2001); they reject the hypothesis of hypothetical bias with respect to marginal WTP in a choice experiment. Even if there is a hypothetical bias in marginal WTP, our main interest is in the relative magnitude of the estimated WTP for the two GM attributes.

The attributes used in the choice experiments vary, since the relevant policy questions for different foods are not the same. Information about the attributes and the experiments when they were included is presented in Table 1.

>>>>> Table 1

Econometric Specification

Assuming a linear indirect utility function, the utility of alternative *i* in choice situation *t* for individual *k* is:

(1) $V_{itk} = \beta' a_{it} + \lambda(y_k - \text{cost}_{it}) + \varepsilon_{itk}$

where a_i is the attribute vector, β is the corresponding parameter vector, λ is the marginal utility of money, y_k is income, and ε_{itk} is an error term. From this specification the mean marginal willingness to pay (WTP) for a certain attribute is the ratio of the attribute coefficient and the marginal utility of income (Hanemann, 1984). The probability that individual *k* will chose alternative *i* can be expressed as:

(2) $P_{itk} = P\{\beta' a_{it} + \lambda(y_k - \text{cost}_{it}) + \varepsilon_{itk} > \beta' a_{jt} + \lambda(y_k - \text{cost}_{jt}) + \varepsilon_{jtk} >; \forall j \neq i\}$

In the analysis of the responses, a random parameter logit model is applied. In such a model, taste variation among individuals is explicitly treated, see, e.g. Train (1998, and 2003). With this type of model, some or all, parameters are assumed to have a specific distribution; for example a normal distribution. In the analysis, we pool the two choice experiments for the four goods, since the experiments are similar to each other. However, we still estimate separate valuations of the attributes of the experiments; the coefficient that is assumed to be the same across the experiments is the cost coefficient. This means we assume the marginal utility of money does not vary between the two experiments. All attribute parameters are assumed to be normally distributed, which means we estimate a mean and a standard deviation for each of the normally distributed parameters. The data has a panel structure since we observe the respondents over a sequence of choices. We assume, therefore, that the randomly distributed parameters are constant across the choice situations for each individual. This reflects an underlying assumption of stable preference structure for all individuals over the choice experiment (Train, 1998). Since the choice experiment is relatively small and simple, this seems to be a realistic assumption

Results

The population that the sample was drawn from was defined as those between 18 and 75 years with a permanent address in Sweden. A random sample of 1600 individuals was selected from the Swedish census registry. A mail survey was conducted in November-December 2003; two reminders were sent out within a two-week interval to those who had not replied. In total 747 (47 %) individuals returned the questionnaire, of which 710 were available for analysis due to non-responses to various questions. Not all of these answered all eight choice sets; however, we still chose to include these individuals in the analysis. Table 2 presents the results for the random parameter logit model. For each random parameter, the estimated mean and standard deviation are reported. The model is estimated with simulated maximum likelihood using Halton draws with 250 replications. See Train (2003) for details on simulated maximum likelihood and Halton draws. The model is estimated using Nlogit 3.0.

>>>>> Table 2

Most of the attribute parameters are significant, and many of the estimated standard deviations are significant, indicating heterogeneity in preferences among respondents. Furthermore, the relative magnitude of the standard deviations implies that the probability that people have the reverse preference for a particular attribute is rather low for most attributes in the first experiment (chicken and ground beef). For the other experiment (hog and egg), the standard deviations are relatively high for some of the attributes.

The marginal WTP and the difference in marginal WTP between the two attributes are presented in Table 3 together with the corresponding 95% confidence intervals. The confidence intervals are based on standards errors estimated with the Delta method.

>>>>> Table 3

The WTP estimates are compared to the baseline where GM is allowed and not labeled. The first null hypothesis is rejected since a significant WTP premium for labeling is found for all four food types. This supports the hypothesis that GM is a credence good. Also the second hypothesis of no public good qualities in GM food is rejected. The estimated WTP premium for a total ban on GM in fodder is significantly higher than the premium for labeled food for all four goods.

In the presentations of labels on the fact sheet, it is not specified whether the commodity they choose is GM-free; it only indicates they will be able to distinguish such food from food containing GM. This design is due to the plausible assumption that some respondents may be willing to pay more for a GM product. The previous discussion of credence goods still applies, with the GM food now being the high quality good. Our rejection of the second hypothesis also indicates the respondents regard food containing GM as a good of lower quality.

The estimated WTP for the two GM-related attributes is high compared with the current market prices. Although our main focus is on the relative marginal WTPs, one still needs to be cautious in interpreting the actual levels. In particular, an attribute such as GM can, compared with the other attributes, be relatively prone to warm glow.

Conclusions

Europeans in general are relatively reluctant to accept the combination of biotechnology and food. It is debatable whether this is due to recent food scares such as BSE, successful campaigns by 'green' lobbyists, or the central parts of food and cooking in the European culture. No matter what the reasons for this reluctance, we show Swedish consumers do not regard GM food as being equivalent to conventional food. Swedes have been shown to be relatively more averse towards GM than many other Europeans (Hoban, 1997). However, if citizens of other member states in the EU share the same type of values, there are important policy implications to be drawn from this study. A central argument by proponents of GM is that the end products are identical to those where GM has not been used. The fact respondents in our survey disagree with this argument is supported by two observations. First, a positive significant WTP is found for a mandatory labeling policy; that is, consumers want to be able to identify where GM has been used. This result confirms previous observations that GM food can be a credence good. A second striking result, with potentially large welfare consequences, is also found. A label enables the consumer to distinguish GM food from GM-free food. If her associated costs with the former food are higher than the price difference, she will naturally choose GM-free food, if any. As a consumer, however, she cannot affect externalities that arise due to environmental, religious, ethical, farm animal welfare, and other concerns. Our results show that the consumer is willing to pay a significantly higher product price to ensure a total ban on the use of GM in animal fodder, indicating there might be a market failure even if GM food is labeled.

Our results can also shed some light on the differences in policies adopted by the US and the EU with respect to GM. In the US, relatively few consumers are concerned about GM, and hence a voluntary labeling approach is in use, while, in the EU, consumers are more concerned with GM; thus the EU requires labeling for food that contains more than 0.9 percent of GM.

Further empirical and theoretical work to investigate the robustness of our results is warranted. For example, where do the market failures arise, in consumption or production? How does information affect the acceptance of GM food? We leave these and other questions to future work.

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Footnotes

1. A credence good is a good whose quality cannot be determined by the buyer even after consumption (Darby and Karni, 1973).

2. A respondent would, however, only answer the choice experiment if he or she actually consumes the good. So, for example, a vegetarian would not answer the choice experiments on chicken, beef or hog.

Table 1. Attributes and levels

Attribute	Levels	Chicken	Beef	Hog	Egg
		Food type			
1. Label	1.1 Minimum required by law				
	1.2 Farm of origin and choice of husbandry		x	x	
2. Fodder	2.1 No information if GM fodder has been used				
	2.2 Label if GM fodder has been used				
	2.3 Use of GM fodder is banned	x	x	x	x
3. Outdoor Production	3.1 Herd kept outdoors summer time/Herd always kept indoors				
	3.2 Herd kept outdoors all year/Herd kept outdoors summer time	x	x	x	
4. Transport	4.1 Transport of live animals to slaughter house				
	4.2 Mobile slaughter house	x	x	x	
5. Growth	5.1 Fast growth chicken (35-39 days)				
	5.2 Slower growth chicken (at least 81 days)	x			
6. Cages	6.1 Only battery cages				
	6.2 Battery cages and free range systems co-exist				
	6.3 Battery cages are banned				x
7. Omega 3	7.1 Not Omega 3 enriched				
	7.2 Omega 3 enriched				x

Attribute						
8. Cost[a]	Chicken	0 (80);	+4 (84);	+8 (88);	+12 (92);	+24 (104)
	Beef	0 (40);	+4 (44);	+8 (48);	+12 (52);	+24 (64)
	Hog	0 (40);	+4 (44);	+8 (48);	+12 (52);	+24 (64)
	Egg	0 (8);	+2 (10);	+3 (11);	+4 (12);	+6 (14)

a. At the time the survey was carried out, $SEK1 \approx USD0.13$

Table 2. Estimated random parameter logit model.

Attribute		Chicken		Ground Beef		Hog		Egg	
		Coeff (p-value)	Coeff stdv (p-value)	Coeff (p-value)	Coeff stdv (p-value)	Coeff (p-value)	Coeff stdv (p-value)	Coeff (p-value)	Coeff stdv (p-value)
1. Label	Labeling of farm of origin and choice of husbandry			0.30678 (0.000)	0.00014 (0.439)	0.28771 (0.172)	0.47408 (0.212)		
2. Fodder	Label if genetically modified fodder is used	0.19752 (0.078)	0.00031 (0.211)	0.30279 (0.004)	0.00007 (0.785)	0.39662 (0.110)	1.45851 (0.000)	0.43819 (0.001)	0.40634 (0.068)
	Use of genetically modified fodder is banned	0.75037 (0.000)	0.00005 (0.848)	0.73765 (0.000)	0.00003 (0.888)	1.88358 (0.000)	0.13506 (0.826)	1.11265 (0.000)	0.39597 (0.080)
3. Outdoor	Herd kept outdoors all year/summer time	0.28766 (0.001)	0.00023 (0.237)	0.01650 (0.817)	0.00045 (0.024)	2.06869 (0.000)	1.27113 (0.000)		
4. Transport	Mobile slaughter house	-0.22341 (0.004)	0.00017 (0.296)	0.15310 (0.043)	0.00007 (0.639)	0.33424 (0.074)	1.42517 (0.000)		
5. Growth	Slower growth chicken	0.53764 (0.000)	0.00021 (0.271)						
6. Cages	Battery cages and free range system co-exist							1.40950 (0.000)	0.41933 (0.064)
	Battery cages are banned							2.15056 (0.000)	1.59398 (0.000)
7. Omega 3	Omega 3 enriched							0.22072 (0.026)	0.28814 (0.129)
		Chicken/Beef				**Hog/Egg**			
		Coeff (p-value)	Coeff stdv (p-value)			Coeff (p-value)	Coeff stdv (p-value)		
Cost		-0.03802 (0.000)	0.00004 (0.012)			-0.13558 (0.000)	0.36801 (0.000)		

Table 3. Mean marginal WTP in SEK/kg and SEK/half dozen (for egg) and 95% confidence intervals.

	Chicken	Ground Beef	Hog	Egg
Use of genetically modified	19.74	19.40	13.89	8.21
fodder is banned	(12.0; 27.5)	(14.5, 24.3)	(7.9; 19.9)	(4.6; 11.8)
Label if genetically modified	5.19	7.96	2.93	3.23
fodder is used	(-.04; 10.8)	(2.8; 13.1)	(-0.7; 6.5)	(0.9; 5.5)
Difference in WTP	14.54	11.44	10.97	4.97
	(6.9; 22.15)	(5.7; 17.2)	(5.1; 16.8)	(2.5; 7.4)

Appendix

Choice 1, ground beef

Attributes ground beef	Ground beef 1	Ground beef 2
Label	Minimum required by law	Farm of origin and choice of animal husbandry
Fodder	Genetically modified products in fodder are forbidden	No information if genetically modified fodder has been used
Outdoor production	Outdoor summertime	Outdoor all-year around
Transport to slaughter	Mobile slaughter house	Transport of live animals
Price increase SEK/kg	+ SEK 4	+ SEK 8
(total cost)	(SEK 44)	(SEK 48)
Your choice (mark one alternative)		