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

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Abstract

This study compares consumer valuations of beef steaks from cattle produced without growth promotants or genetically modified corn in France, Germany, the United Kingdom, and the United States. In general, European consumers place a higher value on beef from cattle that have not been administered growth hormones and/or fed genetically modified corn than United States consumers. There is a larger divergence between the two cultures with regard to the issue of biotechnology and genetic engineering than with the issue of growth hormones. Results suggest that liberalizing trade policy for hormone-treated beef may be welfare reducing for the European Union.

Introduction

Under the General Agreement on Trade and Tariffs (GATT), non-tariff trade barriers are not allowed, unless there is scientific evidence to suggest that a product is unsafe. Perceived consumer concerns about food safety issues have prompted some countries to halt imports of certain products. These countries claim to have a valid basis for their trade barriers because of public health concerns or because their consumers have strong moral or ecological objection to certain products such as genetically engineered food. Exporting countries contend that these trade barriers provide a means of protecting domestic agricultural prices by limiting international competition. Equality of consumer concerns for these issues across borders would lend support to the exporter's argument. Although the World Trade Organization (WTO) was organized to arbitrate in such cases, few guidelines are available to settle disputes based on differences in consumer attitudes.

The United States (US) and the European Union (EU) are currently in the midst of such a debate over the use of growth hormones in US beef cattle production and the proliferation of genetically modified (GM) crops in the US. The goal of this research is two-fold: to determine if the often cited differences in consumer preferences for hormone-treated/GM fed beef across countries are reflected in willingness-to-pay estimates; and to analyze the implications of various trade policies given the estimated differences in consumer preferences. We estimate consumer willingness-to-pay (WTP) for beef in France, Germany, the United Kingdom (UK), and the US using a variety of quality variables such as the administration of growth hormones and/or feeding of GM corn to cattle. Using these empirical WTP estimates, we draw conclusions about possible impacts of trade policies based on the analytical model proposed by Bureau, Marette, and Schiavina. Survey results indicate that European consumers place a greater monetary value on

beef from cattle that were not administered growth promotants or fed GM corn than US consumers. These results have important implications for international officials attempting to resolve disputes regarding non-tariff trade barriers due to food safety concerns, for US and EU officials attempting to determine optimal trade policies, and for US and EU producers who are interested in determining the value of alternative production practices.

The paper proceeds with a review of the current trade disputes between the US and the EU and a review of the sparse literature on differing consumer attitudes across the two continents. We then introduce a model of trade in credence goods based on Bureau, Marette, and Schiavina, and show how the welfare impacts of trade liberalization depend on the feasibility of low cost labeling and the differences in perceived quality across countries.[1] Implementing a contingent valuation (CV) choice experiment, we estimate WTP for "hormone-free" and non-GM fed beef. The paper concludes with a discussion of our findings and implications for trade.

Cattle Production Methods and Consumer Preferences

Use of Hormones in Livestock Production

Since January 1, 1989, the EU has enforced a ban on beef imports from the US due to the use of growth hormones in US beef production.[2] This issue has been disputed in the courts of the World Trade Organization (WTO) for the past several years. According to the most recent ruling, the EU must make compensation payments to the exporting countries unless the ban is lifted. Prior to the import ban in 1989, the EU was not a major importer of US beef. However, it was the largest importer of beef offals (National Provisioner). In 1987, the EU imported almost 74,000 metric tons of edible offals from the US worth $144 million (USDA FAS, 1998). Although total US beef exports have been increasing in the 1990s, a valuable export market has

been lost due to the ban (Brester, Mintert, and Hayes). Estimates of the costs of the ban to the US beef sector range from 100 to 250 million dollars (Drazek; Elliot; Hayes; and Kelch).

However, totally eliminating the use of hormones in US beef production would be much more costly to US producers than the benefits gained through sales to the EU. Peterson, Paggi, and Henry reported that a ban on domestic use of growth hormones would cost US producers $314 million. Kulcher, McClelland, and Offutt reported that 95% of US cattle are implanted with growth hormones. Growth hormones are reported to improve weight gain by 5 to 20 percent, feed efficiency by 5 to 12 percent, and lean meat growth by 15 to 25 percent (Kenney and Fallert).

The US Food and Drug Administration (FDA), USDA, WTO, the Lamming Group (a group of European scientists), and other researchers have concluded that growth hormones are safe if used properly. But, because of negative prior experiences with toxic pesticides and other hazards such as contaminated meat from Chernobyl, European consumers may be reluctant to accept this scientific evidence. The European Bureau of Consumer Unions (BUEC) in Brussels claims that consumers want "risk-free" foods (Kelch). Political groups, such as the Greens, have been formed with environmental and consumer safety issues as their platform. These groups, although small, have been forceful and have gained political support for these issues (Kelch). A 1998 opinion poll found that 54 percent of EU consumers felt that the absence of any hormones in food is necessary for the food to be considered safe (INRA – Europe).

Several studies have examined US consumers' concern for hormone use in animal production. Kramer and Penner found that US consumers, when asked to rank a list of food hazards in order of their perceived severity, ranked concern for hormone residues, on average, below concern for environmental contaminants, bacterial contamination, and pesticides. A study

conducted by the Food Marketing Institute found that only one percent of consumers volunteered that they were concerned with hormone residues. However, when specifically asked, 50 percent of consumers said hormones were a serious hazard. Lusk, Fox, and McIlvain found that US consumers indicated a level of concern for animal growth enhancers that was higher than additives and preservative and antibiotic use, but lower than concern for bacteria, spoilage, and chemicals. In an experimental auction, Buhr et al. found that participants placed greater value on the attribute of leanness in pork (contributed from the hormone porcine somatotrophin (pST)) than on concerns they had with the use of the hormone itself. Fox et al. (1995), using a similar methodology, found that consumers make trade-offs between hormone use and quality in pork.

Genetically Modified Foods

USDA estimates suggest that 25 percent of US corn acres will be planted with GM varieties in 2000 (USDA NASS, 2000). The level of consumer acceptance of GM foods is mixed in both the US and EU. Several large European supermarket chains have refused to place any products on their shelves that have been produced with GM ingredients. Further, many violent protests have occurred in the EU over the issue of GM foods (e.g., the destruction of a US based fast food restaurant in France (Kluger)). The EU currently requires labeling of GM foods and some groups, such as Greenpeace, have proposed mandatory labeling of meat from animals that have been fed GM grains. In the US, sales of non-GM products are generally limited to relatively small niche markets. However, concern over GM products is rising in the US as evidenced by public reaction to the recent recall of taco shells produced with GM corn.

A number of studies have polled consumers regarding their attitudes and knowledge of GM foods. Hoban reported that 65 percent of US consumers were aware of biotechnology, 73 percent were willing to buy GM foods, and only 21 percent viewed biotechnology as a health

risk in 1996. In one of the few studies estimating consumer willingness-to-pay for non-GM foods, Lusk et al. found that 70 percent of student participants were unwilling to pay a premium to exchange a bag of GM corn chips for a bag non-GM corn chips, but that 20 percent were willing-to-pay at least $0.20/oz for the exchange.

Hoban reported that consumer awareness of biotechnology ranged from 55 to 57 percent in France and the UK to 91 percent in Germany. Only 30 percent of German consumers were willing to buy GM foods while 57 percent viewed biotechnology as a health risk. In France and the UK, 60 and 63 percent were willing to buy GM foods with 38 and 39 percent viewing them as a health risk (Hoban). Zechendorf theorizes that national, religious, and cultural differences among nations in Europe may explain the differing degrees of acceptance between US and EU consumers, while Gaskell et al. found that differing levels of consumer confidence in GM foods between countries were driven by differing degrees of confidence in government regulations.

Trade Liberalization in Markets of Credence Goods

Trade disputes over beef from hormone treated and GM fed cattle fall into the context of an analysis of credence goods. For credence goods, the consumer cannot judge quality prior to purchase, as is the case with search goods, nor can the producer establish a quality reputation, as they can for experience goods. To determine the impacts of various EU trade liberalization policies in credence goods, Bureau, Marette, and Schiavina propose a simple model with a domestic and a foreign industry, both having linear cost functions and both exhibiting perfectly competitive behavior. Following Mussa and Rosen, consumer preferences for quality are parameterized by a uniform unit distribution, given by $\theta \in [0,1]$. A consumer with preference θ derives the following utility from the purchase of a single good

$$U(k, I(\theta) - p, \theta) = \theta k + I(\theta) - p(k) \quad (1)$$

where k represents a quality index, p is the price of the good, and $I(\theta) - p(k)$ represents consumption of the numeraire good. Thus, willingness to pay for one unit of the product of quality k is θk. The WTP premium for beef of superior quality, k_2, versus beef of lower quality, k_1, depends on the *perceived* quality difference between the two goods. Consumers' perception of quality is parameterized by $\beta \in [0,1]$. From the vantage point of the EU consumer, it is assumed that the US produces beef of quality, k_1, and the EU produces beef of quality, k_2. If β represents EU consumers' perception of the differences in beef raised with/without hormones or GM feed, then the perceived quality differences are

$$k_2 - k_1 = (1 - \beta)\Delta_{12} \quad (2)$$

where Δ_{12} is a number defining the maximum perceived quality difference between qualities k_2 and k_1. Thus, perceived difference in quality is small (large) if β is close to one (zero). It is assumed that β is common to all EU consumers, but that consumers differ in their WTP for a given perceived quality due to the distribution of θ.

Given perceived differences in quality between products produced in the EU, k_2, and the US, k_1, where $k_2 > k_1$, linear marginal costs function, c_1 and c_2, where $c_2 > c_1$, and a WTP for product of quality k resulting in θk, Bureau, Marette, and Schiavina derive the following analytical results regarding trade liberalization:

a) If the cost of labeling born by the EU is zero:

$$W^L - W^A > 0 \ \forall b \in [0,1]$$

b) If the cost of labeling born by the EU is positive:

i) $W^L - W^A < 0 \ \forall b < b'$ and $W^L - W^A \geq 0 \ \forall b \geq b'$ where $b' \in [0,1]$

ii) $W^{FT} - W^{A} < 0 \ \forall b < b''$ and $W^{FT} - W^{A} \geq 0 \ \forall b \geq b''$ where $b'' \in [0,1]$

iii) $W^{L} - W^{FT} > 0 \ \forall b < b'''$ and $W^{L} - W^{FT} \leq 0 \ \forall b \geq b'''$ where $b''' \in [0,1]$

where W^{A} is aggregate consumer and producer surplus (welfare) under autarky, W^{FT} is aggregate welfare under free trade without labeling, and W^{L} is aggregate welfare under free trade with labeling.

Opening trade with labeling is always welfare improving if labeling is costless because consumers have a larger choice of products than under autarky. If labeling is costly, the welfare impacts of trade liberalization depend on the perceived differences in product quality and the cost of labeling. Generally, opening trade is beneficial to the EU if the perceived quality difference is small, i.e., b is close to one. Trade with labeling is welfare improving to the EU, versus trade without labeling, as perceived quality differences become more pronounced, i.e., b is close to zero. In other words, if EU consumers perceive little difference in quality between hormone treated/GM fed beef and non-hormone treated/non-GM fed beef, then the cost of labeling the meat outweighs the benefit of informing EU consumers of the beef characteristics.

These results highlight the fact that welfare implications of trade liberalization will, among other things, strongly depend on the perceived differences in product quality. Bureau, Marette, and Schiavina conclude by indicating (pg. 456), "A quantitative estimation of the different parameters involved would be necessary for a conclusive opinion . . . At present, the only figures available are very questionable, and precise quantification of welfare losses for EU consumers would require, for example, experimental economics or contingent valuation techniques." They go on to say that (pg. 456), "In international negotiations involving food quality, measuring the willingness to pay may be a way to give proper weight to cultural or ethical characteristics to which consumers are genuinely attached." In this context, one of the

primary aims of this research is to test for differences in perceived qualities using a WTP approach. According to equations 1 and 2, WTP to exchange a unit of product k_1 for a unit of product k_2 can be calculated as:

$$WTP_{12} = (k_2 - k_1)\theta = [(1 - \beta)\Delta_{12}]\theta \quad (3)$$

Empirically, we can estimate differences in quality perceptions across countries by testing for differences in WTP to exchange products of different qualities. As the results in Bureau, Marette, and Schiavina show, the evidence of such differences might be a powerful explanation of countries attitudes toward trade liberalization and the need for effective labeling policies.

Methods

Because market-level data on sales of "hormone-free" versus hormone-treated and/or "GM-free" versus "non-GM free" beef is unavailable, collection of primary data was necessary. A mail survey was developed and sent to consumers in France, Germany, the UK, and the US. The survey contained a choice experiment (CE) in which consumers made choices between ribeye steaks with varying levels of price, marbling (intramuscular fat), tenderness, and use/non-use of growth hormones and GM corn in livestock production.

The CE is a type of conjoint analysis and is frequently used in environmental, marketing, and transportation literature to predict consumer choice by determining the relative importance of various attributes in consumers' purchasing decisions (Adamowicz et al. 1998; Adamowicz et al. 1997; Jayne et al.; Louviere; MacNair and Palm; Unterschultz et al.; Wardman). With this methodology, quality parameters used to describe choices faced by respondents can be varied with relative ease. Underlying this approach is the assumption that consumers derive utility from

consumption of the attributes embodied in a good, rather than deriving utility from the good itself (Lancaster).

CEs have been found to accurately predict the likely success of new products in the marketplace. For example, Jayne et al. used a CE to examine consumer choices for maize meal in Africa and found that the analysis provided useful information in estimating the response to structural changes in food markets. It has also been shown that results from a CE are comparable to consumers' revealed preferences (Adamowicz, Louviere, and Williams; Adamowicz et al., 1997). Adamowicz et al. (1998), examining passive use values for a wildlife improvement program, found that the CE had several advantages over typical CV methods. Two factors motivated the use of a CE in this analysis. First, the CE is appealing because it is based on random utility theory (Ben-Akiva and Lerman). Second, CEs are more general than typical CV methods because they allows for multi-attribute valuation and permit the measurement of trade-offs between numerous attributes.

In our survey, consumers were asked to make a choice between two ribeye steaks, each described by four quality variables and one price variable, in a set of 18 questions.[3] An information sheet, included with the survey, described each of the four quality variables: marbling, tenderness, produced with/without growth hormones, and animal was fed/not fed GM corn.[4] The price variable was included to provide a monetary valuation of the variations in the other attributes. Respondents were also allowed to indicate that they would buy neither of the two steaks. The attributes of price, tenderness, and marbling were included in the analysis because of their perceived importance in the consumer steak purchasing decision. Marbling, or intra-muscular fat content, is the primary determinant of quality in the USDA quality grading system, and tenderness has been identified as the most important palatability attribute in beef

(Huffman et al.; Miller et al.). The attributes of growth hormones and GM corn were also added to the CE because they were the primary variables of interest in this study. A sample CE question is shown in figure 1 and table 1 shows the different levels of each attribute.

Given the set of five attributes and their varying levels, 108 unique steaks could be constructed. An orthogonal fraction factorial design was used to generate 18 choice sets (Addelman; Louviere and Woodworth). The design assures that the survey is constructed such that the minimum amount of choice sets is used, while statistical performance of coefficient estimates is optimized. The language, currency, and weight measurements in the surveys were translated and converted for each of the European countries.

Choice Experiment Model

In the survey, consumers i = 1, 2, …, N are faced with 18 discrete choices between two steaks described by a set of steak attributes. As shown by Adamowicz et al. (1998), a random utility function may be defined by a deterministic (V_{ij}) and a stochastic (ε_{ij}) component.

$$U_{ij} = V_{ij} + e_{ij} \tag{4}$$

where U_{ij} is the i^{th} consumer's utility of choosing option j, V_{ij} is the systematic portion of the utility function determined by the steak attribute values (table 1) for alternative j, and ε_{ij} is a stochastic element. In this case there are three alternatives (A, B, or C) as shown in figure 1. The probability that a consumer will choose alternative j is given by (5).

$$\text{Prob}\{\text{j is chosen}\} = \text{prob}\{V_{ij} + e_{ij} \geq V_{ik} + e_{ik};\ \text{for all } k \in C_i\} \tag{5}$$

where C_i is the choice set for respondent i, i.e., C_i = {A, B, C}

If the random errors in equation 4 are independently and identically distributed across the j alternatives and N individuals with a type I extreme value distribution and scale parameter equal to 1, then the probability of consumer i choosing alternative j results as

$$\text{prob}\{\text{j is chosen}\} = \frac{e^{V_{ij}}}{\sum_{k \in C} e^{V_{ik}}} \quad (6)$$

Assuming V_{ij} is linear in parameters, the functional form may be expressed as:

$$V_{ij} = b_1 x_{ij1} + b_2 x_{ij2} + ... + b_n x_{ijn} \quad (7)$$

where x_{ijn} is the n^{th} attribute value for alternative j for consumer i, and β_n represents the coefficients to be estimated. Equations 6 and 7 describe a conditional logit model, which may be formulated using the attribute levels given in table 1 and the responses to the CE survey questions. In the conditional logit model, consumer demographics do not vary across choice sets and the probability of choice is only affected by steak attributes and not by consumer-specific characteristics. However, it is possible to determine the impact of certain demographic variables, such as nationality, by including separate coefficients for each steak attribute segregated for each nationality. Thus, we multiply country-specific dummy variables and each of the five steak attributes as shown in equation 8

$$V_{ij} = USb'_{US}\mathbf{X}_{ij} + FRb'_{FR}\mathbf{X}_{ij} + GRb'_{GR}\mathbf{X}_{ij} + UKb'_{UK}\mathbf{X}_{ij} \quad (8)$$

where *US*, *FR*, *GR*, and *UK* take the value of 1 if the respondent was from the US, France, Germany, or the UK, respectively and 0 otherwise, β_k is a vector of country-specific coefficients and $\mathbf{X}_{ij}$ is a vector of steak attributes, as identified in table 1 and equation 7. For estimation, attribute levels in equation 8 were effects coded. Adamowicz, Louviere, and Williams describe effects coding and provide motivation and justification of the use of effects coding in a CE with an orthogonal design.[5]

Results

In the spring of 2000, 2,500 surveys were mailed in the US, and 3,000 surveys were mailed in France, Germany, and the UK (1,000 in each country). Mailing lists were obtained from reputable private companies to ensure the representativeness of the sample. After adjusting for undeliverable surveys, response rates were 29%, 12%, 7%, and 15% in the US, France, Germany, and the UK, respectively.[6] Summary statistics are reported in table 2. In general, more women responded than men, primarily because we requested that the individual who did most of the food shopping for the household complete the survey. Average participant age was 51 years in France and the US, 46 in Germany, and 41 in the UK. Consumers in the US had, on average, more years of education and higher incomes than the European consumers. In general, US consumers ate beef and poultry more often and pork, lamb, and fish less often than European consumers.

Statistics reported in table 2 indicate that the European consumers were more concerned about the use of genetic engineering and biotechnology than consumers in the US. On a scale of 1 (not at all concerned) to 5 (very concerned), consumers in France, Germany, and the UK reported average levels of concern of 4.57, 4.42, and 4.22, respectively; whereas, the average US level of concern was 3.89. European consumers were also more concerned about use of growth hormones in livestock production than US consumers, reporting average levels of concern of 4.77, 4.55, and 4.25 in France, Germany, and the UK compared to an average US level of 4.07.

Table 3 reports the estimates of equation 6 segmented by country. For every country, the coefficient for the price attribute was, as expected, negative. German consumers are more sensitive to changes in price than French, UK, and US consumers. For all four countries, abundantly marbled (high intramuscular fat content) steaks were less preferred to steaks with

slight or modest marbling. In the UK, slight marbling (lowest marbling level) was most preferred; whereas modest marbling was most preferred in France and Germany. Interestingly, US consumers are far more sensitive to steak tenderness than are European consumers. In fact, for French consumers, tenderness had virtually no impact on steak choice. In general, the European consumers are much more averse to steaks from animals administered growth hormones and fed GM corn than are US consumers. The coefficients for hormone use and GM feed use for France, Germany, and the UK are all statistically greater ($p = 0.0001$) than US coefficients, i.e., $\beta_{FR} > \beta_{US}$. The coefficients also indicate that US consumers are more averse to hormone use than use of GM feed. For European consumers the coefficients for hormone use and GM feed are similar but with German consumers being somewhat more concerned about GM feed use than hormones.

To quantify the value that consumers place on the attributes of hormone use and GM feed, we estimate the price increase necessary to offset the positive utility associated with a "hormone-free" or "GM-free" steak for each nationality segment. First, for each country we simulated two steaks, one from an animal administered growth hormones and one from an animal not administered growth hormones. Then the level of utility derived for each steak option was calculated (by substituting coefficient estimates in table 3 into equation 7). To estimate the value of the "hormone-free" steak, we reduce the price of the hormone-treated steak until the level of utility for each steak choice is identical. In other words, we chose the price level, $P_{Hormone}$, such that $\hat{V}_{ij}(Hormone) = \hat{V}_{ij}(NOHormone)$. The difference in prices ($P_{Hormone} - P_{NOhormone)}$ between the two simulated steaks can be viewed as the value of the "hormone-free" steak to the average or representative consumer. The same procedure was followed to estimate the value for "GM free" steaks.

Table 4 reports the estimated value for "hormone-free" steaks in France, Germany, the UK, and the US. Three WTP values are reported for each country: the point estimate and the upper and lower values of the 95 percent confidence interval. The standard error and the 95 percent confidence intervals for each WTP value were calculated using parametric bootstrapping. We assumed that the relevant coefficient estimates were normally distributed with mean and standard deviation given by the estimates in table 3. For each parameter, 2000 values were randomly drawn from the appropriate distribution. These parameter values were then used to calculate 2000 WTP values for "hormone-free" and GM free beef.

The estimated premiums are large in magnitude; however, this is consistent with previous research, which indicates that consumers overstate their willingness-to-pay in hypothetical settings (i.e., hypothetical bias) (Cummings, Harrison, and Rutström; Fox et al., 1998; List and Shogren). It is unknown to what extent consumers might have overstated their true willingness-to-pay, but "hormone-free" steaks often command large premiums over hormone-treated steaks in high-end retail grocery stores in the US.[7] Even if the WTP estimates reflect some amount of hypothetical bias, we can be more confident about the *relative* magnitude of the WTP values, assuming hypothetical-bias is similar across countries.

The point estimates in table 4 indicate that French and UK consumers are willing-to-pay $2.36/lb. and $1.74/lb. more for a "hormone-free" steak than US consumers. Although the hormone use coefficient estimate for Germany was statistically larger in absolute value than that of the US, the estimated value of the "hormone-free" steak was virtually identical, using the point estimate. This is because the German consumers are much more price-sensitive than US consumers. It takes a much larger price decrease to offset the disutility of a hormone-treated

steak for a US consumer than a German consumer. Stated differently, German consumers are willing to trade price for hormones at a faster rate than US consumers.

The confidence intervals also indicate the statistically significant differences between the "hormone-free" steak valuations. The upper bound of the confidence interval for the US premium falls below the lower bound of the percent confidence interval for the French and UK premiums, indicating that one can be fairly confident that French and UK consumers perceive a large quality/safety difference between hormone and non-hormone treated beef than do US consumers.

The values for steaks from cattle not fed GM corn suggest that French, German, and UK consumers are willing-to-pay a great deal more for a "GM free" steak than are US consumers. Further, despite the price sensitivity of the German consumers, they are still willing-to-pay $4.40/lb. more for a "GM free" steak than US consumers. The upper 95 percent confidence interval for US "GM free" steak valuation is over $3.00/lb. less than the lower 95 percent confidence interval for the three EU countries. Results also suggest that French consumers place a statically greater value on "GM free" ribeye steak than German or UK consumers. In monetary terms, there is a greater difference between European and US consumers with respect to the issue of GM feed than for hormone use in beef.

Conclusions and Implications

Despite World Trade Organization rulings, the EU continues to ban imports of US agricultural products because of concerns about US production practices. The EU is currently paying compensation to the US and other beef exporting countries for preventing imports of beef from cattle administered growth hormones. Critics of the EU trade policy contend that the EU is

enforcing a non-tariff trade barrier to protect domestic agricultural prices. The EU contends that its policy reflects consumer concerns about the safety of food production and that it has an obligation to protect public health.

Using a choice experiment, we estimated demand for several beef attributes and compared valuations across countries. Our results show that consumers in France and the UK were willing-to-pay significantly more than US consumers for beef from cattle not administered growth hormones. Although German consumers are more concerned about hormone use than US consumers, they are also more price sensitive and actually place a lower value on "hormone-free" steaks. Consumers in France, Germany, and the UK were willing-to-pay significantly more than US consumers for beef from animals not fed GM corn.

This study indicates that, in general, consumers in France, Germany, and the UK place higher values on animal production practices and on the safety of their food than US consumers. Results imply that US producers are not likely to enter EU markets with hormone-treated beef. Further, it is evident that resistance to GM foods entering the EU is likely to be strong in the future. Because the estimated differences in value between "hormone free" versus hormone-treated and "GM free" versus "non-GM free" beef are quite large in the EU, EU trade officials are likely to be averse to liberalizing trade in these products because it would likely be welfare reducing for the EU. European consumers place a higher value on "hormone-free" and non-GM products, and our results indicate that they are willing to pay higher prices for these products, directly through increased beef prices, or perhaps indirectly through compensation paid to the US.

Regarding trade liberalization, the ultimate question remains: does consumer concern give sufficient reason to impose non-tariff barriers? So far, the WTO only allows trade barriers

if scientific evidence demonstrates a product is unsafe. Once a product is considered safe, it no longer falls under the Sanitary and Phytosanitary (SPS) Agreement of the WTO, but under the Technical Barriers to Trade (TBT) Agreement. And under the TBT Agreement, policies are judged on the level and pattern of their trade impacts relative to their effectiveness in achieving the regulator's objective (Caswell). Overall, these results tend to support the argument that EU trade barriers have a basis, if not a justification, in consumer preferences that are significantly more conservative than those of US consumers. The interesting question then, is why these differences exist.

Footnotes

[1]Credence, as opposed to experience, goods are those in which consumers cannot detect quality after consumption. For example, a consumer cannot tell whether a steak was produced from an animal administered growth hormones or fed GM corn by simply consuming the product. Because of the nature of credence goods, it is assumed that individual firms cannot establish a reputation for a particular quality. Even if firms attempt to "signal" quality, it is assumed that consumers do not trust the signal, as there is no verification. Quality signals can only be imposed by government entities or independent organizations.

[2]Under the current EU ban, the US is allowed to export approximately 20,000 tons of certified "hormone-free" beef to the EU. Use of growth promotants in EU livestock production is prohibited.

[3]We used ribeye steak because it is a high-value cut that is recognizable to most consumers. It is also the beef cut that the USDA uses to grade the quality of beef carcasses, and thus pictures of ribeye cuts with various marbling scores were readily available.

[4]Photographs of slight, modest, and abundantly marbled steaks were included in the information sheet. The tenderness attribute was described as follows: "New technologies are allowing scientists to more accurately identify steak tenderness - steaks with a tenderness rating of 1 are the least tender with steaks with a tenderness rating of 10 are the most tender." Lastly, information about the production benefits of growth hormones and GM crops was included. It was mentioned that use of GM crops might allow producers reduce pesticide usage, potentially introducing a positive bias about this attribute.

Footnotes continued

[5]Instead of the typical 0,1 dummy variable coding, one category is set as the base with effects coding. Effects coding forces the parameter value for the base category equal to the negative sum of the parameter values for the other estimated categories. Thus, the "left out" category is not incorporated into the intercept as with traditional dummy variable estimation.

[6]The larger response rate in the US is due to both chance and design. We included $1 in each of the US surveys, but monetary and logistical constraints prohibited including the same inducement in the EU surveys.

[7]To offer a basis of comparison and a quasi-external validity check, we recorded observed beef prices in the US. We noted that prices for "organic" or "hormone-free" beef ribeye steaks were $24.95/lb., $11.99/lb, and $9.99/lb at three different retail grocery stores on April 1, 2000 in the Kansas City area. Prices for "typical" hormone-treated steaks were recorded on the same date in the same metro area. Prices ranged from $6.88/lb for an ungraded ribeye steak to $7.49/lb and $8.49/lb for a Select or Choice ribeye steak, respectively. Although the actual premiums are large, it is rare find both "hormone-free" and hormone-treated steak in the same retail shelf. Further, the observed premiums paid for "hormone-free" steak in the US may only represent a small and unrepresentative group of consumers. Since the hormone-treated beef is not allowed in the EU, actual retail prices are not available in France, Germany, or the UK.

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Figure 1 – Sample Choice Experiment Question

Options A and B represent two different descriptions for a beef ribeye steak.
Please check (✓) the option (A, B, or C) that you would be most likely to purchase.

Product attribute	**Option A**	**Option B**	**Option C**
Steak price / lb.	$12.00	$8.50	
Marbling	Abundant	Modest	
Tenderness Rating	5	8	Neither A nor B is preferred
Animal Produced with Growth Hormones	No	Yes	
Animal Fed Genetically Modified Corn	No	No	
I would choose . . .	☐	☐	☐

Table 1 – Steak Attributes and Attribute Levels in the Choice Experiment Survey

Steak Attribute	**Attribute Levels**
Price	$5.00
	$8.50
	$12.00
Marbling	Slight
	Modest
	Abundant
Tenderness	2
	5
	8
Animal Administered Growth Hormones	Yes
	No
Animal fed Genetically Modified Corn	Yes
	No

Table 2 – Summary Statistics and Variable Definitions

Variable	Definition	Mean			
		France	**Germany**	**UK**	**US**
Gender	1 = female; 0 = male	0.575	0.508	0.614	0.534
		(0.497)[a]	(0.504)	(0.489)	(0.499)
Age	age in years	51.315	45.984	41.250	51.602
		(14.408)	(15.013)	(12.342)	(15.166)
Child	1 = children in household; 0 otherwise	0.262	0.317	0.357	0.229
		(0.442)	(0.469)	(0.481)	(0.420)
Education	number of years of education	14.113	13.186	13.376	15.206
		(3.029)	(3.319)	(2.420)	(3.27)
Income	household income level	4.235	4.741	5.081	6.390
	1 = less than $10,000; 2 = $10,000 to 19,999 . . .	(2.693)	(4.102)	(3.217)	(3.829)
	19 = $180,000 to $189,999; 20 = more than $190,000				
Beef	Number of times per month respondent consumes beef	7.400	4.538	5.212	9.337
		(5.396)	(3.230)	(4.088)	(6.278)
Poultry	number of times per month respondent consumes poultry	5.556	3.557	6.851	7.668
		(3.770)	(2.758)	(4.646)	(5.726)
Pork	number of times per month respondent consumes pork	4.847	4.139	2.836	3.344
		(4.289)	(3.728)	(2.682)	(3.657)
Lamb	number of times per month respondent consumes lamb	2.523	0.575	1.979	0.338
		(3.246)	(0.943)	(1.947)	(1.251)
Fish	number of times per month respondent consumes fish	7.070	3.090	4.351	3.358
		(5.399)	(2.152)	(2.933)	(3.476)
HMConcern	concern for use of growth hormones in animal production;1 = not at all concerned, 5 = very concerned	4.769	4.550	4.254	4.073
		(0.731)	(0.982)	(0.971)	(1.162)
GMConcern	concern for use of genetic engineering/biotechnology; 1 = not at all concerned, 5 = very concerned	4.574	4.424	4.224	3.888
		(0.929)	(1.086)	(1.016)	(1.276)
Number of Observations		106	60	134	660

[a]numbers in parentheses are standard deviations

Table 3 – Estimates of Conditional Logit Model Segmented by Country

Attribute	Variable	France	Germany	UK	US
Price	Ribeye price/lb.	-0.256*[b]	-0.313*	-0.173*	-0.164*
		(0.016)[c]	(0.025)	(0.010)	(0.004)
Marbling[a]	Slight	0.005	0.071	0.494*	0.298*
		(0.090)	(0.128)	(0.062)	(0.026)
	Modest	0.338*	0.647*	0.229*	0.245*
		(0.088)	(0.127)	(0.062)	(0.025)
Tenderness	Tenderness scale	0.011	0.071*	0.090*	0.180*
		(0.020)	(0.030)	(0.014)	(0.006)
Animal Produced with Growth Hormones[a]	Yes	-1.192*	-1.094*	-0.753*	-0.571*
		(0.073)	(0.103)	(0.048)	(0.019)
Animal Fed Genetically Modified Corn[a]	Yes	-1.174*	-1.194*	-0.645*	-0.264*
		(0.065)	(0.096)	(0.045)	(0.018)

[a]Attributes are effects coded.

[b]One asterisk indicates statistical significance at the 0.01 level.

[c]Numbers in parentheses are standard errors.

Only respondents who completed all 18 CE questions were included in the analysis.
Number of respondents from: France = 96, Germany = 49, UK = 114, US = 570
Number of observations = 44,766 (829 respondents x 18 questions each x 3 choices)
Model Chi-Square = 8031.4 (significant at the 0.01 level)
Log Likelihood = -12,377
Pseudo R^2 = 0.24

Table 4 – Predicted Willingness-to-Pay Premiums for Beef from Cattle Not Administered Growth Hormones and Not Fed Genetically Modified Corn.

Attribute	Willingness-to-Pay Estimate	France[a]	Germany[a]	UK[a]	US[a]
Growth Hormones	Upper 95% Confidence Interval	$9.36	$7.19	$8.82	$7.03
	Point Estimate	$9.34 (0.012)[b]	$6.99 (0.100)	$8.72 (0.052)	$6.98 (0.025)
	Lower 95% Confidence Interval	$9.32	$6.79	$8.62	$6.93
GM Feed	Upper 95% Confidence Interval	$9.31	$7.64	$7.65	$3.51
	Point Estimate	$9.18 (0.066)	$7.63 (0.004)	$7.47 (0.090)	$3.23 (0.140)
	Lower 95% Confidence Interval	$9.05	$7.62	$7.29	$2.95

[a]Willingness-to-pay estimates in US dollars per pound.
[b]Numbers in parentheses are standard errors of willingness-to-pay point estimates.