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Willingness to Pay for Quality in Experimental Auction Markets and Stated Choice Surveys

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Abstract

The principal objective of this thesis is to investigate the willingness to pay for quality. The thesis consists of four papers exploring Norwegian consumer preferences for imported and hormone-treated beef. The first paper presents an analysis of a stated choice survey using a mixed logit model. Target markets for imported and hormone-treated beef are identified, and microsimulations are used to predict market shares and illuminate substitutions patterns. The second paper presents an analysis of an experimental auction market conducted to elicit realistic willingness to pay values for imported and hormone-treated beef. The third paper presents a new method for calibrating hypothetical willingness to pay values estimated from stated choice surveys with willingness to pay values obtained from experimental auctions. The fourth paper presents a new method for incorporating the results of an experimental auction into the joint logit model normally used to combine revealed and stated choice data. The new methods proposed in the third and fourth paper are illustrated with the data analyzed in the first and second papers.

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Frode Alfnes

Ås, March 2003

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Introduction

and

Summary

Introduction and Summary

This thesis consists of four papers on willingness to pay (WTP) for food quality attributes. They are independent papers and can be read separately. However, thematically as well as empirically they are closely related. The first paper presents an analysis of a stated choice survey conducted to investigate consumer preferences for imported and hormone-treated beef. The second paper presents an analysis of an experimental auction market conducted to elicit realistic willingness to pay values for imported and hormone-treated beef. The third and the fourth paper presents two new methods for combining the results from stated choice surveys with the results from experimental auctions. The methods are illustrated using the data analyzed in the first and second paper.

This introduction gives a brief presentation of the political, empirical, and theoretical background and summarizes the results of the four papers.

Background

Beef is an experience good and the safety and quality is impossible to identify prior to purchase. Therefore, consumers use various intrinsic (e.g., color, freshness, and fat) and extrinsic cues (e.g., brand, price, place of purchase, and country of origin) to infer the quality of beef products. The inferred quality depends on the consumer's experience, knowledge, and beliefs, which can vary significantly from one individual to another. In Europe, consumers use country of origin as one of the most important extrinsic quality cues. Beef from developed countries are typically perceived superior to beef from less developed countries. Beef from neighboring countries (with similar culture and beliefs) are typically perceived superior to beef from more distant countries. Norway and the European Union (EU) have imposed

mandatory country-of-origin labeling to allow consumers to differentiate between beef from various countries. The U.S. has decided to impose similar regulations from 2004.

For more than 15 years the U.S. and the EU have disputed the safety of using growth hormones in the production of beef. In 1989 the EU banned imports of beef from cattle treated with growth-promoting hormones, effectively cutting off North American exports of beef to the EU. Considering the ban to be a protectionist measure, the U.S. and Canada made a complaint to the World Trade Organization (WTO) in 1996. After a review of the scientific evidence, the WTO supported the North American position and ruled that there was insufficient scientific evidence to support the ban. The EU was given 15 months to remove the ban unless scientific evidence proving that hormone-treated beef constituted a risk to human health was provided. Although no evidence had been provided by the May 1999 deadline, the ban remained as a provisional measure. The EU argues that there is a lack of knowledge about the long-term effects of consuming hormone-treated beef and, furthermore, that European consumers are unwilling to accept the risk. Because of EU's non-compliance, the U.S. was allowed to impose punitive tariffs on European agricultural products worth $117 million a year. Since July 1999, a 100% duty has been applied to a range of products.

As a result of the hormone ban and the high import tariffs, domestic beef account for 97% of the 90 000 tons of beef sold yearly in Norway. The remaining 3% is hormone-free beef imported mainly under a reduced tariff arrangement with less developed countries. Hence, there is no available market data for hormone-treated beef and only scattered data for imported beef.

Eliciting Preferences for Private Goods: Theory and Applications

Economists have traditionally focused on the actual market behavior of economic agents, hereafter denoted the revealed preferences (RP), both for theoretical inspiration and for testing

of hypotheses. Despite well-developed theories for dealing with RP data, there are a number of compelling reasons why economist should be interested in alternative data sources (Louviere, Hensher, and Swait, 2000):

- Firms need to estimate demand for new products with new attributes or features for which there is no RP history, and for which one cannot safely forecast by analogy to existing products.
- Explanatory variables have little variability in the market palace.
- Explanatory variables are highly correlated in the market place.
- RP might data fail to satisfy model assumptions and/or contain statistical quirks.
- RP data may be expensive and time consuming to collect.
- The product of interest is not traded in the real market; e.g., public goods.

I will focus on alternative data sources recently used by economist to study preferences and WTP for private goods. For a discussion on methods used to elicit preferences and WTP for public goods, see Mitchell and Carson (1989).

The primary alternative to RP has been stated preference (SP). In contrast to RP, SP methods are not limited by existing markets and technology structures. Furthermore, in SP studies researchers can determine the degree of variability in the explanatory variables and avoid correlation between them. The main use of SP methods by academic and applied researchers involve modeling likely demand and identifying appropriate target markets for new products.

Academic marketing's interest in SP methods has primarily been concentrated on conjoint analysis (CA) and related work on modeling consumer tradeoffs and preferences. Traditional CA research involves evaluation or decision tasks that bear little resemblance to

choice situations faced by real consumers. For example, traditional CA typically relies on elicitation tasks that involve one-at-a-time ratings of product profiles. Such tasks may indeed elicit preferences, but they have no counterpart in real market consumer behavior. See Gustafsson, Herrmann, and Frank (2000) for an overview of traditional CA methods.

In stated choice (SC) experiments, consumers are presented several choice sets with two or more products described by their attributes, and asked to chose the preferred alternative in each set. The impact of the individual attributes on the choice probability is estimated with discrete choice models based on random utility theory. The estimated model can be used to identify target markets for new products, and can also be used in microsimulations to predict market shares and illuminate substitutions patterns.

In the design of SC experiments four issues are taken into consideration: a) the possible forms of utility functions that can be identified from the data; b) the precision or efficiency of the estimates; c) the realism or to what degree the experiments mirrors real market place choices; and d) the cognitive limitations of the respondents. Typically, one tries to maximize identification, minimize standard errors, and maximize realism subject to management of the complexity at levels that do not compromise the data quality.

SC data has most frequently been analyzed with a multinomial logit model. Due to the strong restrictions on the error structure, the model is very computer friendly. However, the independently and identically distributed error term results in what is known as the Independence of Irrelevant Alternative property: *The relative odds of one alternative being chosen over a second should be independent of the presence or absence of unchosen third alternatives*. This property means that a change in the attributes of one alternative will affect the market share of all other alternatives proportional to their initial market share, leaving the relative market shares of the other alternatives unchanged. The economic interpretation is that all alternatives are equally close substitutes.

Recently increased computer speed, improved simulation algorithms as Halton draws, and readily available computer packages as Limdep with Nlogit (Greene, 2002) have resulted in an increased use of more complex models. Discrete choice models with correlated error terms like the nested logit, multinomial probit, and mixed logit model allow a more flexible substitution pattern than the multinomial logit model. The mixed logit model allows heteroskedastic and freely correlated error terms. Moreover, it has been shown that under mild regularity conditions any discrete choice model derived from random utility maximization has choice probabilities that can be approximated as closely as one pleases by a mixed logit model. See Train (2003) for a thorough discussion of discrete choice models and application.

Recent examples of SC studies in agricultural marketing include a comparison of preferences for hormone-treated and GMO-fed beef across countries; an investigation of the demand for GMO food; two studies of the demand for ecolabeled food; two analyzes of preferences for country of origin for beef; and an investigation of preferences for safety inspection of fresh salmon. See paper 1 for references.

SC methods can capture a wider array of preference-driven behavior than RP methods. However, SC methods have difficulty taking all real market constraints into account. As a result, microsimulations with discrete choice models based solely on SC data may not be able to replicate the market shares in existing markets. In the late 1980's procedures for combining SC and revealed choice data were developed to utilize the complementary strengths of the two data sources. These models are now applied in marketing, transportation, and environmental economics. Revealed choice and SC data are pooled and a joint logit model for the pooled data is estimated. The resulting choice models combine the real market information in the RP data with the flexibility of the SC method. For a further discussion on combining choice data from different sources, see chapter 8 in Louviere, Hensher, and Swait (2000).

Although, SC researchers seek to develop surveys that resemble their real market counterparts in as many essential details as possible, several studies have found that consumers are more willing to use money in hypothetical markets than they are in real markets. This overspending degrades the WTP estimates from stated preference studies and is known as the "hypothetical bias" in the valuation literature. To avoid the hypothetical bias, incentive compatible experimental methods to elicit WTP have been developed.

These experiments are examples of a non-hypothetical data source that can be used as an alternative to RP. By far, institutional experiments dominate the experimental economic literature. In institutional experiments the environment are controlled to explore how alternative market and nonmarket mechanisms affect the allocation of scarce resources. Evolving from informal games and role-playing, these experiments are used to address the question of economic design, i.e., the efficient institutional design given administrative failure, public goods, externalities, asymmetric information, and incomplete markets. In valuation experiments, the researcher wants to control the institution and actual behavior through a design that generates predictable patterns of behavior. If a researcher wants people to sincerely reveal their WTP for a good or service, they can employ an exchange mechanism where it is the participants' dominant strategy to reveal their own reservation price.

The extensive literature on incentive compatible methods for eliciting WTP for private goods goes back to work by Vickrey and by Becker, DeGrooth, and Marschak in the early nineteen-sixties (see the survey on experimental auctions by Kagel, in Kagel and Roth (1995), for references). The family of incentive compatible valuation methods for private goods includes the English clock auction, the second-price sealed-bid auction, the random n-th-price sealed-bid auction, and the Becker-DeGrooth-Marschak mechanism.

The second-price sealed-bid auction, also known as the Vickrey auction, is the most frequently used auction in valuation studies. The participants give sealed bids for the product

on offer, and the highest bidder buys the product to a price equal the second-highest bid. The dominant strategy in the second-price sealed-bid auction is to submit a bid that is equal to your reservation price for the product on offer. Bidding below the reservation price reduces the chance of winning without increasing the profit from wining, and bidding above your reservation price and winning *as a result* of the higher bid results in an economic loss. The intuition of the dominant strategy is more transparent in the strategically equivalent English clock auction. In this auction, the price is increased to only one bidder remains. The dominant strategy for the individual bidders is to stay in the auction as long as the price is below their reservation price, and get out of the auction when the rising price passes their reservation price, and thereby revealing their reservation price. Since the dominant strategy in second-price sealed-bid auctions is not transparent to all participants, the auction is often repeated several times to allow the participants to refine their bids to more accurately reflect their true valuation. At the end of the session the binding auction trial is chosen at random. The second-price sealed-bid auction with repeated trials has been employed to elicit WTP for e.g., pork attributes, food safety, reduction in pesticide use, and GMO food. See paper 2 for references.

Experimental auctions and SP methods have many of the same features, as full control over the included alternatives and the information given to the respondents. However, experiments are limited to available products with existing product characteristics and are usually conducted in a laboratory setting with a relatively small and locally recruited sample. Given the hypothetical bias in surveys and the limitations of experimental auctions, some efforts have been put into to combing the strengths of two methods. One approach estimates a statistical “bias functions” to transfer the hypothetical bias in take-it-or-leave-it offers (accepting the offer in a hypothetical case but rejecting the same offer in a real case) for a particular good in one sample of subjects to a different good in another sample. A second approach use results from experimental auctions to estimate a calibration function for the

responses to open-ended WTP questions. Common for all previous attempts of combining SP and experimental methods, is that they do not combine the most frequently used elicitation methods within the two categories; stated choice surveys and second-price sealed-bid auctions. See paper 3 for references.

The Thesis

The main theoretical objectives of the research presented in this thesis were, firstly, to compare hypothetical and non-hypothetical methods for eliciting preferences and WTP for private goods and, secondly, to find new ways of combining the results of hypothetical and non-hypothetical studies. The main efforts on improving SP methods in recent years have been concentrated on SC methods based on random utility theory. In experimental valuation the second-price sealed-bid auction with repeated trials has been the most frequently used method. Despite that SC and second-price sealed-bid auctions have different response formats - choice and open-ended valuation - we chose to compare the results and develop methods for combining these two frequently used data sources.

Since I started the work on this thesis, a number of papers using experimental auctions in valuation as well as papers comparing methods for eliciting WTP have been publish. However, the experimental auction reported in the second paper and utilized in the third and fourth paper is one of the very first European applications of experimental auctions used to value quality attributes. Some of the results of WTP literature, as the hypothetical bias, have been documented beyond all doubt. Therefore, the research presented in this thesis took the hypothetical bias as given and instead concentrated on finding new ways of exploring the complementary strengths of SC surveys and experimental auction markets. The calibration methods proposed in the third and the fourth paper are, to my knowledge, the first two calibration methods using experimental data to calibrate SC results.

The practical objective of the research presented in this thesis was to investigate consumer preferences for imported and hormone-treated beef. The WTO has ruled the European ban of hormone-treated beef illegal. We wanted to investigate European consumers WTP for hormone-treated beef relative to hormone-free beef to foresee the effect of allowing hormone-treated beef into the European market. This is also important when determining the compensation the U.S. are entitled to for EU's non-compliance to the WTO ruling. Furthermore, we wanted to find the price premiums Norwegian consumers are willing to pay for Norwegian beef compared to imported beef. In view of the pressure from the WTO and the EU to reduce the trade barriers surrounding the Norwegian market, the price premium is an important matter for the Norwegian farmers and the food processing industry, as well as Norwegian policy makers.

Norwegian consumer preferences for country of origin and hormone status of beef were elicited using a survey and an experimental auction in April 2000. The survey included questions about food habits, a series of food related statements, and a SC experiment with beef from five different countries. In addition to domestic beef, beef from the following four countries were included: Sweden (a neighboring Scandinavian country); Ireland (Europe's largest net exporter of beef); the U.S. (the world's largest producer of beef); and Botswana (Africa's largest net exporter of beef). To investigate the importance of hormone status, U.S. hormone-treated as well as hormone-free beef were included. The survey was supplemented by an experimental auction including Norwegian, Irish, U.S. hormone-free, and U.S. hormone-treated beef.

Each of the four papers included in this dissertation employ a different approach for illuminating the Norwegian consumer preferences for country of origin and hormone status of beef. In the first paper, a mixed logit model is used to analyze the responses to the stated choice survey. In the second paper, the bids in the experimental auction are analyzed. In the

third paper, a non-linear calibration function for the hypothetical WTP results from the survey is estimated with the help of the auction results. In fourth paper, the results of the experimental auctions are incorporated into the joint logit framework used to analyze pooled choice data sets. The empirical results concerning preferences and WTP for imported and hormone-treated beef will be summarized after the methodology and contributions of the four papers are presented in more detail.

Paper 1: Stated Preferences for Imported and Hormone-Treated Beef: Application of a Mixed Logit Model

Consumer preferences for country of origin and hormone status of beef were analyzed using a stated choice experiment and a panel version of the mixed logit model. To complement the stated choice analysis, the responses to a series of statements regarding imported food were analyzed using an ordered logit model.

Throughout the paper, the results of the mixed logit model are compared with the results of the corresponding multinomial logit model. The differences in model specification are discussed and the advantages of the mixed logit model emphasized. The mixed logit and the multinomial logit models were used in a series of market simulations, and the results of these simulations are discussed with respect to the model specification and the estimated parameters.

The main contributions of this paper are: (1) identifying the market segments that are most positive to imported beef; (2) identifying how the preferences for imported beef are related to attitudes toward Norwegian agricultural production and toward foreign produced food in general; (3) identifying the preference ordering for the country of origin of beef; (4) identifying tradeoffs between country of origin and hormone status; (5) identifying the

substitution patterns for imported beef; and (6) discussing and illustrating the advantages of the mixed logit model relative to the multinomial logit model.

Paper 2: European Consumers' Willingness to Pay for U.S. Beef in Experimental Auction Markets

We analyzed consumer preferences for country of origin and hormone status of beef using an experimental auction market. The sample was representative for the four counties in the southeastern part of Norway from which it was drawn. The participants faced real tradeoffs between money and Norwegian, Irish, and U.S. beef in a series of simultaneous second-price sealed-bid auctions.

The main contributions of the paper are: (1) the estimation of consumers' valuation of the use of growth promoters by comparing participants' WTP for U.S. beef produced with and without the use of growth-promoting hormones; (2) the investigation of the importance of European versus North American origin by comparing WTP for Irish and U.S. beef; (3) the construction of a simultaneous-auction design that provides an efficient elicitation of the complete distribution of WTP differences when the participants' preference ranking over the alternatives is heterogeneous.

Paper 3: SC-X: Calibrating Stated Choice Surveys with Experimental Auction Markets

We developed and implemented a method to calibrate the hypothetical WTP estimates from SC surveys with the WTP found in experimental auctions. The core of the calibration method is the estimation of a non-linear function relating the individual WTP values observed in the auction to the WTP predicted by the survey model. The method allowed us to extend the WTP results from auctions to socioeconomic groups not included in the auction and to hypothetical products with unavailable characteristics such as for example European hormone-treated beef.

The method is illustrated using Norwegian consumer preferences for country of origin and hormone status for beef.

The main contributions of this paper are: (1) the development of a new method for calibrating WTP values obtained from SC data with WTP observed in experimental auctions; (2) the comparison of the results of the SC survey with the results of the experimental auction; (3) the prediction of auction WTP values for the socioeconomic groups not participating in the auction; (4) the prediction of auction WTP values for hypothetical products.

The main advantage of the method proposed in this paper as compared with the method proposed in the fourth paper is that the SC data can be estimated separately without including source-specific scaling factors. This is an advantage since none of the readily available computer packages allow estimation of mixed logit models with source-specific scaling factors. A second advantage is the flexibility in the calibration function allowing non-linear calibration.

Paper 4: Combining Stated Choice and Experimental Auction Data.

I show how experimental auctions data can be incorporated into the general joint logit framework used to combine SC and revealed choice data. Norwegian consumer preferences for imported and hormone-treated beef were used in an empirical illustration. The data from the experimental auction was transformed to choice data by simulating a choice experiment. The simulated choice data was pooled together with the SC data and a joint logit model with source-specific price parameters and scaling factors was estimated. The estimated parameters from the simulated data and from the pooled data are compared with the estimation results from the original data sets. The price parameter obtained from the experimental auction data was used to predict WTP values corresponding to the survey parameters.

The main contributions of this paper are: (1) proposing a practical method for incorporating experimental auctions data into the joint logit framework used for combining choice data from different sources; (2) investigating the effects on the WTP results from transforming the auction data into choice data; (3) showing how the joint model can be used to enriching the auctions model with hypothetical products with unavailable characteristics and with new socioeconomic groups.

Compared with the third paper, the method proposed in this paper is based on a more general framework. In addition to predicting auction WTP values for products and socioeconomic groups included in a survey, this method can also be used to incorporate experimental features such as tasting or information shocks into the joint logit framework. Furthermore, the method can be used to combine revealed choice data and experimental auction data to, for example, find price sensitivity parameters in markets were the prices of close substitutes are very correlated.

Empirical Results

Domestic beef was preferred to imported beef, beef from Sweden was preferred to beef from more distant countries, and beef from developed countries was preferred to beef from less developed countries. However, Botswanan beef was preferred to U.S. hormone-treated beef. In the SC survey, Irish beef was not significantly preferred to U.S. hormone-free beef, while in the auction participants bid more for the Irish beef than for the U.S. hormone-free beef.

Women, elderly people, people rarely traveling abroad, people living in rural areas, and people raised on farms were most reluctant to choose imported beef. The same segment were also most likely to agree with statements such as “the quality of Norwegian agricultural products is better than the quality of comparable foreign products” and “the Norwegian agricultural subsidies should at least be maintained at the current level.”

The participants that were most positive towards Irish beef were also most positive toward U.S. and Botswanan beef. Moreover, these participants were likely to be positive toward Swedish beef, but the correlation in preferences between Swedish and the other imported alternatives were not as strong as strong as between the non-Scandinavian alternatives.

There are large regional differences in the preferences toward imported beef. Survey respondents in the region where the experimental auction was conducted, the southeastern part of Norway, were significantly more positive towards imported beef than participants in other regions.

The place of purchase also affects the preferences for imported beef. On average, Norwegian consumers agreed that the country of origin was important for beef bought in grocery stores, but did not agree that it was important for beef bought in restaurants.

In the experimental auction the WTP for one kilogram of Irish ribeye steak was found to be NOK 14 less than the WTP for one kilogram of Norwegian ribeye steak. The corresponding numbers for the U.S. hormone-free and the U.S. hormone-treated beef was NOK 19 and NOK 38, respectively. However, the survey showed that the consumers in the region were the auction was conducted were not representative for the Norwegian population. In paper 3 and paper 4, the survey and the auction data were combined to predict the national mean WTP for all alternatives included in the survey. The predicted national mean WTP for Swedish, Irish, U.S., and Botswanan hormone-free beef, and for U.S. hormone-treated beef, estimated in paper 3, were NOK 10, NOK 20, NOK 20, NOK 29, and NOK 38, respectively, less than the WTP for the domestic beef. The corresponding numbers for Norwegian, Swedish, Irish, and Botswana hormone-treated beef, assuming no cross-effects between hormone-status and country of origin, were found to be NOK 34, NOK 35, and NOK 38, NOK 47.

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Paper 1

Stated Preferences for Imported and Hormone-Treated Beef:

Application of a Mixed Logit Model

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Abstract: Norwegian consumers' preferences for country of origin and hormone status of beef are analyzed using a stated choice experiment and a mixed logit model. On average, the participants preferred beef from neighboring Sweden to beef from more distant countries and beef from developed countries to beef from less developed countries. U.S. hormone-free beef was perceived as being equally good as Irish beef, while U.S. hormone-treated beef was perceived as being inferior to Irish and Botswanan beef. Gender, age, education, urbanization, region, raised on a farm, and frequency of traveling abroad are identified as significant segmentation variables. In a series of mixed logit market simulations, it is shown that the non-Scandinavian alternatives are close substitutes competing over the import-friendly market segment.

Key words: beef, country of origin, growth hormones, market simulations, mixed logit, stated choice experiment

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Stated Preferences for Imported and Hormone-Treated Beef: Application of a Mixed Logit Model

Beef is an experience good and its safety and quality are impossible to identify prior to purchase. Therefore, consumers use various intrinsic (e.g., color, freshness, and fat) and extrinsic cues (e.g., brand, price, place of purchase, and country of origin) to infer the quality of beef products. The inferred quality depends on the consumers' experience, knowledge, and beliefs, which can vary significantly from one individual to another.

Norway and the European Union (EU) have imposed mandatory country-of-origin labeling of beef and the U.S. has decided to impose similar regulations from 2004. The labeling allows consumers to differentiate between beef from various countries. European consumers rank country of origin as one of the most important safety and quality cues for beef (Becker, 1999). Food products from developed countries are typically perceived as being superior to food from less developed countries. Foods from neighboring countries (with similar culture and beliefs) are perceived as being superior to food from more distant countries (Juric and Worsley, 1998).

As a result of trade barriers, domestic beef (not treated with growth promoting hormones) accounts for 97% of beef sales in Norway. The remaining sales are hormone-free beef imported mainly under a reduced tariff arrangement with less developed countries. As in the EU, it is prohibited to import, process, and offer beef treated with growth-promoting hormones. Hence, there is no available market data for hormone-treated beef and only scattered data for imported beef. The World Trade Organization (WTO) has ruled the hormone prohibition illegal. Furthermore, tariff reduction for agricultural products will be an important topic in future trade negotiations with the EU and within the WTO, and the Norwegian import of beef is likely to increase.

Alfnes and Rickertsen (2003) reported results from an experimental auction indicating that there is a Norwegian market potential for hormone-free Irish and U.S. beef as well as a market potential for U.S. hormone- treated beef. A survey was conducted to further investigate consumer preferences for country of origin and hormone status of beef. The survey included questions about food habits, a series of food related statements, and a stated choice (SC) experiment. In the SC experiment consumers were asked to choose between rib-eye steaks with various combinations of country of origin, hormone status, and price.

Recent examples of SC studies in agricultural marketing include Lusk, Roosen, and Fox (2003) who compared preferences for hormone-treated and GMO fed beef across countries; Burton *et al*. (2001) who investigated the demand for GMO food; Blend and van Ravenswaay (1999), and Wessells, Johnston, and Donath (1999) who studied the demand for ecolabeled food; Unterschultz *et al*. (1998), and Quagrainie, Unterschultz, and Veeman (1998) who analyzed preferences for country-of-origin for beef; and Holland and Wessells (1998) who investigated preferences for safety inspection of fresh salmon. SC data have usually been analyzed using a multinomial or nested logit model. The mixed logit model applied in this paper is a generalization of the multinomial logit model. The inclusion of a correlated and heteroskedastic error term enables the mixed logit model to capture a larger variety of substitution patterns than the multinomial and nested logit models. The mixed logit model has previously been applied to problems in transportation (Bath, 1996; Brownstone and Train, 1999; Brownstone, Bunch, and Train, 2000), recreation (Train, 1998), energy (Revelt and Train, 1998), and marketing (Bonnet and Simioni, 2001). For a thorough survey of SC methods and applications, see Louviere, Hensher, and Swait (2000).

The contributions of this paper are as follows. First, the responses to a series of statements regarding Norwegian consumer attitudes toward domestic and imported food are analyzed using an order logit model. Second, a stated choice experiment focusing on country

of origin and hormone status of beef is analyzed using a panel version of the mixed logit model. Third, simulations of a liberalized Norwegian beef market are used to examine the substitution patterns predicted by the mixed logit model.

Survey

The survey was conducted by ACNielsen in April 2000. They interviewed 1066 individuals, 15 or older, in their homes. The sample selection was made in a randomized manner. First, a set of addresses was chosen at random. Second, up to eight addresses close to each of the initial addresses were included. At each address, the interviewer asked for the individual in the household next having a birthday. The dataset includes weights to correct for sampling errors and the weighted sample is representative of the Norwegian population. The summary statistics for the survey sample are presented in table 1.

The survey included questions about eating habits, a series of food related statements, and an SC experiment. Before the food related statements and the SC experiment, the participants were informed that imported beef might soon be available in Norway; see table 2. The SC experiment included beef from Norway, Sweden, Ireland, the U.S., and Botswana. Sweden is a neighboring country, Ireland is Europe's largest net exporter of beef, the U.S. is the world's largest producer of beef, and Botswana is Africa's largest net exporter of beef. To investigate the importance of hormone status, both U.S. hormone-treated and U.S. hormone-free beef were included.

Only combinations of country of origin and hormone status that were available in the world market were included in the SC experiment. Furthermore, all combinations of country of origin, hormone status, and price that we, a priori, believed to be strictly dominated by the other alternatives (e.g., high priced imported hormone-treated beef) were excluded. This left 20 alternatives shown in table 3. These alternatives were allocated to 16 choice sets with three

alternatives in each set. The first alternative was always Norwegian rib-eye steak, not treated with growth-promoting hormones, and costing NOK 99. The two other alternatives were imported rib-eye steak described by country of origin and hormone status, and offered at prices ranging between NOK 39 and NOK 89.

Each participant was shown four choice sets. The participants were asked firstly to choose their preferred alternative in each choice set, and secondly to choose their preferred alternative given that their first choice was unavailable. Table 4 gives an example of the choice questions.

Ordered Logit Model

The participants were asked to indicate on a scale from 0, "strongly agree", to 4, "strongly disagree", whether they agreed with a series of statements. Their responses were analyzed with an ordered logit model (Train, 2003). The outcome were viewed as a reflection of the underlying regression:

$$(1) \qquad y_{ns}^{*} = \delta_{s}' x_{n} + \varepsilon_{ns} \quad ,$$

where y_{ns}^{*} is participant *n*'s true opinion about statement *s*; δ_{s} are a vector of parameters representing the impact of the socioeconomic variables on the respondent's opinion; x_{n} is a vector of socioeconomic variables; and ε_{ns} is a logistically distributed error term. The dependent variable y_{ns}^{*} is unobserved, but we observe the responses to the statement. We assume that the response, y_{ns}, and the true opinion are related in the following way:

$$(2) \qquad \begin{aligned} y_{ns} = \quad & 0 \text{ if } y_{ns}^{*} \le \mu_{0s},\ 1 \text{ if } \mu_{0s} < y_{ns}^{*} \le \mu_{1s},\ 2 \text{ if } \mu_{1s} < y_{ns}^{*} \le \mu_{2s}, \\ & 3 \text{ if } \mu_{2s} < y_{ns}^{*} \le \mu_{3s},\ \text{and } 4 \text{ if } y_{ns}^{*} > \mu_{3s} \quad , \end{aligned}$$

where the μ's are unobserved parameters that must be estimated jointly with the δ's. For all probabilities to be positive, we must have $\mu_{0s} < \mu_{1s} < \mu_{2s} < \mu_{3s}$. For identification μ_{0s} is normalized to zero. The probability of the answer "strongly agree" is then:

$$\begin{aligned} \text{Prob}_{ns}(\text{strongly agree}) &= \text{Prob}(y_{ns}^{*} < \mu_{0s}) \\ &= \frac{e^{\mu_{0s} - \delta_s' x_n}}{1 + e^{\mu_{0s} - \delta_s' x_n}} \end{aligned} \quad . \tag{3}$$

The probability of "agree" is:

$$\begin{aligned} \text{Prob}_{ns}(\text{agree}) &= \text{Prob}(\mu_{0s} < y_{ns}^{*} < \mu_{1s}) \\ &= \frac{e^{\mu_{0s} - \delta_s' x_n}}{1 + e^{\mu_{0s} - \delta_s' x_n}} - \frac{e^{\mu_{1s} - \delta_s' x_n}}{1 + e^{\mu_{1s} - \delta_s' x_n}} \end{aligned} \quad . \tag{4}$$

The probabilities for the other answers are obtained analogously. Note that the parameters for each statement consist of the δ_s giving the impact of the socioeconomic variables on the respondents' opinion about the statement as well as the cut-off points μ_{0s}, μ_{1s}, μ_{2s}, and μ_{3s}. The endogenous cut-off points imply that the difference between a zero and a one response is not necessarily the same as the difference between a one and a two response.

Mixed Logit Model

The multinomial logit model is based on a random utility model with independently and identically distributed error terms. In models without individual-specific variables, this error structure corresponds to Luce's *Independence of Irrelevant Alternative* (IIA) property, which states that "the relative odds of one alternative being chosen over a second should be

independent of the presence or absence of unchosen third alternatives" (McFadden, 1974). As a result of the IIA property, the multinomial logit model predicts that a change in the attributes of one alternative changes the choice probability of the other alternatives proportionally, such that the probability ratios are unaffected (Brownstone and Train, 1999).

Discrete choice models with correlated error terms like the nested logit, multinomial probit, and mixed logit model allow a more flexible substitution pattern than the multinomial logit model. In these models, a change in one alternative will not have a proportional effect on the choice probabilities of the other alternatives. The multinomial probit and mixed logit models allow heteroskedastic and freely correlated error terms. However, the two models are very computer intensive. Error correlation has therefore, in the main, been implemented using nested logit models, where IIA is assumed within each nest but not between the nests (Ben-Akiva and Lerman, 1985). Recently, increased computer speed, improved simulation algorithms (e.g., Halton draws), and readily available computer packages (e.g., Limdep with Nlogit and Proc MDC in SAS) have resulted in more frequent use of mixed logit models. Furthermore, McFadden and Train (2000) showed that under mild regularity conditions, any discrete choice model derived from random utility maximization has choice probabilities that can be approximated as closely as one pleases by a mixed logit model.

An individual's choice among *J* alternatives can be analyzed with a mixed logit model. Let us assume that the individual's utility from each alternative can be decomposed into a nonstochastic and linear-in-parameters part that depends on observable variables, a stochastic part that is normally distributed and potentially correlated and heteroskedastic, and a second stochastic part that is independently and identically extreme value distributed. Given these assumptions the utility of individual *n* from alternative *i* in choice situation *t* is denoted by:

$$U_{nit} = \beta_i' x_{nit} + \left[\eta_{ni} + \varepsilon_{nit}\right] \quad , \tag{5}$$

where x_{nit} is the vector of observed non-stochastic variables including socioeconomic characteristics of individual n and attributes of alternative i in choice situation t;β_i is a vector of structural parameters; η_{ni} is an error term that is normally distributed over individuals and alternatives; and ε_{nit} is an extreme value distributed error term that is independently and identically distributed over individuals, alternatives, and choices by the same individual. We note that the specified model is a panel model, where the normally distributed error term for alternative i is the same for all choices made by one individual. In the rest of the discussion we suppress the subscript t.

The density of η is denoted by $f(\eta|\Omega)$ where Ω are the fixed parameters of the distribution. For a given η, the IIA property holds and the conditional choice probability is a standard multinomial logit:

$$(6) \qquad L_{ni}(\eta) = \frac{e^{\beta_i' x_{ni} + \eta_{ni}}}{\sum_{j \in J} e^{\beta_j' x_{nj} + \eta_{nj}}} \quad .$$

Consequently, the unconditional choice probability, P, in the mixed logit model is the logit formula integrated over all values of η with the density of η as weights:

$$(7) \qquad P_{ni} = \int L_{ni}(\eta) f(\eta \mid \Omega) d\eta \quad .$$

This choice probability cannot be calculated exactly and is approximated through simulation (Brownstone and Train, 1999).

As noted above, for a given η the conditional choice probability is standard multinomial logit. In this paper we will refer to the multinomial logit model we get by

excluding the normally distributed error term (or restricting it to zero) as the corresponding multinomial logit model or simply the multinomial logit model.

In all choice models based on random utility maximization only the relative magnitude of the parameters matter. The individual parameters have no direct interpretation, except for in their signs and statistical significance. In logit models, the scale of the parameters is inversely related to the variance of the extreme value distributed error term. Since the mixed logit models include a normal distributed error term that captures some of the variance of the unobserved factors, the magnitude of the mixed logit parameters are, in general, larger than the corresponding multinomial logit parameters. This difference in scale between the two models must not be interpreted as difference in utility (Brownstone and Train, 1999; Train, 2003).

The estimated mixed logit model can be used to simulate choice probabilities for each of the participants in various market scenarios. The individual choice probabilities can be summed to predict the market shares for each market scenario. The simulated market shares, *S*, are computed as the average of the participants' simulated choice probabilities:

$$(8) \qquad S(\text{alternative } i) = N^{-1} * \sum_{n=1}^{N} \hat{P}_{ni} \quad ,$$

where N is the number of participants and $\hat{P}_{ni}$ is the simulated probability that individual n will chose alternative i. For a further discussion of simulations in Limdep, see Greene (2002). For a further discussion of discrete choice models in general, see Train (2003).

Results and Discussion

In the upper half of table 5, seven food-related statements are presented. The participants' responses to the statements were analyzed with the following specification of the ordered logit model:

$$
\begin{aligned}
y_{ns}^{*} &= \delta_{0s} + \delta_{1s} Gender_n + \delta_{2s} Age_n + \delta_{3s} Income_n + \delta_{4s} Education_n + \delta_{5s} Urban_n \\
&+ \delta_{6s} Travel_n + \delta_{7s} Farm_n + \delta_{8s} Region2_n + \delta_{9s} Region3_n + \delta_{10s} Region4_n + \delta_{11s} Region5_n \\
&+ \delta_{12s} Region6_n + \varepsilon_{ns} \quad ,
\end{aligned} \tag{9}
$$

where *Gender*, *Age*, *Income*, *Education*, *Urban*, *Travel*, *Farm, Region2, Region3, Region4, Region5,* and *Region6* are socioeconomic variables presented in table 1.

In the lower half of table 5, the mean responses to each of the seven statements, and the results of the ordered logit model are presented. A positive parameter indicates that the probability of saying "strongly agree" ($y = 0$) decreases as the variable increases. From the mean responses, we note that, on average, the respondents agree to statements 1, 2, and 3, slightly agree with statement 4, neither agree to nor disagree with statements 5, and (strongly) agree to statements 6 and 7. With respect to future import of beef to Norway, it is especially worth noting that consumers are significantly more reluctant to buy imported beef in grocery stores than in restaurants.

Probabilities can be calculated for all five levels for each of the seven statements and the marginal effect of a change in each of the socioeconomic variables can be calculated for all the probabilities. This results in 420 (= 7 statements * 5 levels * 12 variables) marginal probabilities. Reporting all the 420 marginal probabilities are outside the scope of this paper. However, we include some representative examples. Females were 4.4% more likely than men to answer "strongly agree" (y = 0) to statement 1, and people raised on a farm were 9.9%

more likely to do so than those not raised on a farm. For statement 4 the corresponding numbers are 9.1% and 7.7%, respectively, and for statement 7 they are 5.4% and 4.9%.

In general, older women living in Northern Norway, raised on a farm, and rarely traveling abroad are most likely to answer in support of Norwegian agricultural products. The distribution of the responses over the socioeconomic variables will be discussed in greater dept below, together with the results of the SC experiment.

In the SC experiment, the participants were asked to make eight choices between varieties of rib-eye steak offered at various prices. The choices were analyzed with a mixed logit model with a non-stochastic part contained alternative-specific constants (ASC), a price variable, and socioeconomic variables. The estimated model was specified as:

$$
\begin{aligned}
U_{nit} &= \beta_{0i} + \beta_{Price} Price_{nit} + \beta_{1i} Gender_n + \beta_{2i} Age_n + \beta_{3i} Income_n \\
&+ \beta_{4i} Education_n + \beta_{5i} Urban_n + \beta_{6i} Travel_n + \beta_{7i} Farm_n + \beta_{8i} Region2_n \\
&+ \beta_{9i} Region3_n + \beta_{10i} Region4_n + \beta_{11i} Region5_n + \beta_{12i} Region6_n + [\eta_{ni} + \varepsilon_{nit}] \quad , \qquad (10)
\end{aligned}
$$

where β_{0i} is the ASC for alternative *i*; β_{Price} is the price sensitivity parameter; $Price_{nit}$ is the price of alternative *i*; *Gender*, *Age*, *Income*, *Education*, *Urban*, *Travel*, *Farm, Region2, Region3, Region4, Region5,* and *Region6* are the same socioeconomic variables used in equation (9). The normally distributed error terms, η, are freely correlated between the alternatives and perfectly correlated over choices made by the same individual. The latter property was imposed by clustering the choices made by the same individual, using the panel specification in Limdep (Greene, 2002). For identification, all domestic-specific parameters were normalized to zero.

Table 6 shows the estimated parameters, standard errors, and P values for the mixed logit model. The corresponding results of the multinomial logit model, obtained by excluding the normally distributed error term, were included for comparison. All 32 significant mixed

logit parameters (with corresponding parameters in the multinomial logit model), had the same sign in the two models. However, the relative sizes of the parameters were not identical. The most important difference between the two models was nevertheless the error structure. The five normally distributed residuals in the mixed logit model were heteroskedastic and correlated. The first can be seen from the standard deviations of the five ASC. They are significant and they differ significantly. The U.S. hormone treated beef has the largest standard deviation, and the Swedish beef has the smallest. The correlation in error terms is reported in the lower part of table 6. The error terms of the four non-Scandinavian alternatives are positively correlated, indicating that they are closer substitutes than what can be seen from the non-stochastic part of the model.

The average preferences elicited from the SC experiment are consistent withprevious research on country-of-origin effects on food (Juric and Worsley, 1998) and hormone-status effects of beef (Alfnes and Rickertsen, 2003; and Lusk, Roosen, and Fox, 2003). The average consumer preferred domestic to imported beef; beef from a neighboring country (Sweden) to beef from more distant countries (Ireland, Botswana, and the U.S.); beef from developed countries (Sweden, Ireland, and the U.S.) to beef from a less developed country (Botswana); and finally, U.S. hormone-free beef to U.S. hormone-free beef.

Men and women ranked, on average, the six alternatives identically, but women were more likely to choose domestic beef. The gender differences were largest for the U.S. hormone-treated beef, and smallest for the Swedish beef. The gender effect is supported by the negative *Gender* parameter for the statements reported in table 5.

The probability of choosing imported and hormone-treated beef decreased with the age of the respondent. The age was least important for Swedish beef and most important for hormone-treated beef. The age effect is also supported by the five significantly negative *Age* parameters in table 5.

People with only elementary schooling were least worried about the long-term effects of modern agricultural production and least reluctant to choose hormone-treated beef. However, people with little education were most likely to agree that the quality of Norwegian agricultural products is better than that of comparable foreign products, and they were most supportive of Norwegian agricultural subsidies.

Income had no effect on the stated choices reported in table 6. However, people with a low income were most likely to agree with the statement that the quality of Norwegian agricultural products is of higher quality than comparable foreign products, and they were most supportive of the Norwegian agricultural subsidies. By contrast, it was less important for them than for high-income participants to know where the beef they buy was produced.

People raised on a farm or living in a rural area were least likely to choose imported beef; most likely to agree that the quality of Norwegian agricultural products is higher than that of comparable foreign products; and most supportive of Norwegian agricultural subsidies. One likely explanation is that people raised on a farm or living in rural areas have a closer relationship to domestic agricultural production.

The country of origin of beef was least important for people who travelabroad frequently. One possible interpretation of this result is that travel increases knowledge about foreign foods and thereby reduces the reluctance to buy imported beef. Alternatively, the positive parameters indicate that traveling choices and choices regarding country of origin are affected by the same underlying preferences. The positive *Travel* parameters in table 6 are supported by the positive *Travel* parameter for the statements in table 5.

Five regional dummies were included to capture regional differences in the preferences for imported beef. These differences are probably a result of factors such as availability of foreign beef in local stores and restaurants, closeness to Sweden, experience with foreign beef, and the regions dependency on agricultural production. The population in

Region 1 has easy access to foreign produced beef in neighboring Sweden, and has, as a result, more experience with foreign produced beef than the population in the other regions. It is therefore not surprising that the respondents from Region 1 were most positive to imported beef, and that they were significantly less likely to be supportive of Norwegian agricultural production than respondents from other parts of the country.

Low price sensitivity and a corresponding high willingness to pay are common problems in stated preference studies (List and Gallet, 2001; Harrison and Rutström, forthcoming). The average willingness to pay for each of the imported alternatives relative to the Norwegian beef can be calculated by dividing the average utility difference between the two alternatives by the absolute value of the price parameter. The average willingness to pay values estimated from the mixed logit model were (in NOK): -16, -128, -145, -252, and -426, for the Swedish, Irish, U.S. hormone-free, Botswanan, and U.S. hormone-treated beef, respectively. For a further discussion of the willingness to pay for these alternatives, see Alfnes and Rickertsen (2002).

A series of disaggregated market simulations were conducted to investigate the substitution patterns and the cannibalization effects predicted by the estimated mixed logit and multinomial logit models. The individual respondent's probability of choosing each of the alternatives under various market scenarios was estimated, and summed to obtainthe simulated market shares in each scenario, as described by equation (8).

The simulated market shares are conditional on the market scenarios (prices and available products) and the estimated preference structure. As pointed out by Hensher, Louviere and Swait (1999), stated preference methods are not capable of fully resembling all market constraints, and should preferably be combined with real market data to predict market shares accurately. However, stated preference data are rich in trade-off information and provide important information on substitution patterns and cannibalization effects.

Four market scenarios were constructed: A, B, C, and D. In scenario A, all alternatives were available for all participants for NOK 99. In scenario B, all alternatives were available for all participants, but the prices of the imported alternatives were reduced to NOK 79. In scenario C, only the European alternatives (Norway, Sweden, and Ireland) were available and all were offered at NOK 99. In scenario D, only the European alternatives were available and the prices were differentiated as in scenario B.

The estimated mixed logit model, as well as the corresponding multinomial logit model, was used to simulate market shares in the four market scenarios. The results of the mixed logit simulations are presented as simulations 1 to 4 in table 7. The results of the multinomial logit simulations are presented as simulations 5 to 8. The differences in simulated market shares between the mixed and the multinomial logit model have two sources. First, the relative size of the parameter estimates was not identical in the two models. Second, the mixed logit model had heteroskedastic and correlated error terms. We will here focus on the latter source of disparity to illustrate some of the general features of the mixed logit model.

There are two important factors to keep in mind when studying the simulation results. First, both the mean and the variance of the utility distribution affect the predicted market shares. If the taste parameters are small relative to the error variance, the stochastic part of the utility will dominate the non-stochastic part. Furthermore, the relative variance of the utility distributions affects the simulated market shares. An alternative with a relatively low mean utility and a high variance can get a large share of the market due to the thick tails of the utility distribution. Furthermore, the simulated market shares for alternatives with large error variance are least responsive to changes in the systematic part of the utility model (e.g., price changes). Second, the correlation in utility between the alternatives affects the predicted market shares. The correlation can come from the non-stochastic part of the utility function - same signs on socioeconomic parameters – as well as from correlated error terms.

Alternatives with positively correlated utilities compete for the same consumers. In the extreme case where the utility of several alternatives have identical mean and variance and are perfectly correlation, the joint market share for these alternatives are independent of how many of them that are offered in the market. This is known as cannibalization of market shares between close substitutes.

In market scenario A, the mixed logit model predicted market shares of 37%, 27%, 7%, 10%, 13%, and 5% for the Norwegian, Swedish, Irish, U.S., Botswanan, and U.S. hormone-treated beef, respectively. The corresponding market shares from the multinomial logit model were 38%, 28%, 13%, 13%, 6%, and 2%. First, we notice the effect of the heterogeneous error terms in the mixed logit model. The alternatives with largest standard deviations, Botswana and U.S. hormone-treated beef, have significantly larger market share in simulation 1 than in simulation 5. They have increased their market shares at the expense of the other alternatives, and especially at the expense of their close substitutes, Irish and U.S. beef.

In market scenario B, the price of the five imported alternatives was reduced to NOK 79. In the multinomial logit simulation, the increases in market share for the imported alternatives are almost proportional to the initial market shares. In the mixed logit simulation, however, Swedish beef captures most of the market share lost by the domestic alternative. The other four alternatives have positively correlated error terms, and compete forthe same consumers.

In market scenarios C and D, the choice sets were reduced to the three European alternatives: Norwegian, Swedish, and Irish beef. Comparing scenario C to scenario A (and scenario D to scenario B), the market share of all three alternatives increases. Again, we find the most disproportional changes in the mixed logit simulations, where the market share of Irish beef triple. In the mixed logit model, the utility of the Irish beef and the three removed

alternatives are positively correlated in error terms, as well as along the socioeconomic variables. The Irish beef therefore gains more than the other two alternatives from the reduced competition.

Conclusions

On average, the survey participants preferred domestic to imported beef, Swedish beef to other imported beef, and beef from developed countries to beef from less developed countries. Irish and U.S. hormone-free beef were perceived as being of almost identical quality, while U.S. hormone-treated beef was perceived as being inferior to all hormone-free alternatives.

There was a large variety in the preferences for country of origin and hormone status of beef. First of all, many participants stated that the importance of the country of origin depends on where the beef is bought. Country of origin is important for beef bought in grocery stores, but not for beef bought in restaurants. Second, there were large gender and age differences. Young males were most willing and older females were least willing to buy imported beef. Third, there were large regional differences. Participants living in urban areas or living in areas with an extensive trade with neighboring Sweden were most willing to buy imported beef.

The mixed logit model allows correlated error terms and is therefore better than the multinomial logit model for identifying close substitutes and predicting cannibalization of market shares. In the mixed logit market simulations, it was illustrated that the non-Scandinavian alternatives were competing about the same consumers. Consumers that chose Irish beef in the European-only simulation were most likely to switch to non-European beef when these alternatives were included. The more restrictive multinomial logit model did not detect these substitution patterns, and predicted proportional changes in market shares.

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Table 1. Definitions of Variables and Summary Statistics

Variable	Definition	Mean	St.dev.[a]
Gender	Gender of respondent Male = -1; Female = 1	0.02	1.00
Age	Age of respondent 0.1*(Actual age – 44 years)	-0.01	1.82
Income	Total income of household (14 levels) NOK 0 = -8 to NOK 600 000+ = 6	0.24	3.49
Education	Highest completed education Elementary school = -1 High school = 0 College/University = 1	-0.04	0.72
Urban	Population density/Urbanization Rural area = -1 Relatively densely populated area = 0 Urban area = 1	0.25	0.81
Travel	Frequency of traveling abroad (4 levels) Never = -3 to Every month = 3	0.03	1.91
Farm	Raised on farm No = 0; Yes = 1	0.27	0.44
*Region*1	South-East Norway No = 0; Yes = 1	0.17	0.38
*Region*2	Oslo, Capital of Norway No = 0; Yes = 1	0.11	0.31
*Region*3	Eastern Norway No = 0; Yes = 1	0.22	0.41
*Region*4	Southern and Western Norway No = 0; Yes = 1	0.28	0.45
*Region*5	Middel Norway No = 0; Yes = 1	0.14	0.35
*Region*6	Northern Norway No = 0; Yes = 1	0.08	0.27

[a]The sample means and standard deviations are based on the weighted sample used in the estimation.

Table 2. Information Given to the Participants

Beef produced in countries such as Sweden, Ireland, the U.S., and Botswana may soon be available in Norway. In the U.S., 80% of all cattle are treated with growth-promoting hormones to enhance growth and tenderize the meat. For the beef to have natural levels of hormones, farmers are not allowed to use hormones during the last 90 days before slaughter. American authorities state that consuming hormone-treated meat produced in accordance with stipulated guidelines does not represent any hazard to health.

Table 3. Alternatives

Country of Origin	Hormone Treated	Price
Norwegian	No	NOK 99
Sweden	No	NOK 89, 79, 69
Ireland	No	NOK 79, 69, 59, 49
US	No	NOK 79, 69, 59, 49
US	Yes	NOK 69, 59, 49, 39
Botswana	No	NOK 79, 69, 59, 49

Table 4. Stated Choice Questions Asked by the Interviewer

a) If you were to buy rib-eye steak today, and the following alternatives were available, which alternatives would you then choose?

b) If your first choice were not available, which of the other two alternatives would you then choose?

Product Attributes	Alternative 1	Alternative 2	Alternative 3
Country of origin	Norway	US	US
Beef cut	Rib-eye	Rib-eye	Rib-eye
Hormone treated	No	No	Yes
Price per kilogram	NOK 99	NOK 79	NOK 69

Table 5. Preferences for Food Origin

Results from the ordered logit model (9) estimated on the response to the statements S1 to S7 below. Strongly agree is coded as zero and strongly disagree is coded as four.

S1: The quality of Norwegian agricultural products is better than the quality of comparable foreign products.
S2: The Norwegian agricultural subsidies should be maintained at least at the current level.
S3: It is very important for me to know where the beef I buy is produced.
S4: It is very important that the beef I buy is produced in Norway.
S5: It is very important that the beef I buy in restaurants is produced in Norway.
S6: It is very important that Norwegian public authorities control all beef.
S7: I am worried about the long-term effects of medicine, pesticide, and additives in modern agricultural production.

Variable	S1	S2	S3	S4	S5	S6	S7
Constant	1.40*	0.49*	0.41	1.49*	2.32*	-0.51*	-0.90*
Gender	-0.10	-0.23*	-0.21*	-0.21*	-0.05	-0.02	-0.13
Age	-0.05	0.05	-0.21*	-0.27*	-0.20*	-0.19*	-0.20*
Income	0.02*	0.02*	-0.02*	0.00	-0.00	-0.00	-0.02
Education	0.27*	0.29*	0.02	0.09	0.03	0.04	-0.09
Urban	0.25*	0.48*	0.22*	0.32*	0.06	0.24*	0.21
Travel	0.15*	0.10*	0.07*	0.15*	0.12*	0.07*	0.08*
Farm	-0.43*	-0.76*	-0.37*	-0.35*	-0.43*	-0.56*	-0.24*
*Region*2	-0.76*	-0.78*	-0.62*	-0.85*	-0.85*	-0.91*	0.10
*Region*3	-1.05*	-0.64*	-0.19	-1.11*	-0.69*	-0.45*	0.07
*Region*4	-0.85*	-0.35	0.00	-0.80*	-0.53*	-0.84*	-0.30
*Region*5	-1.10*	-0.42	-0.50*	-1.10*	-1.17*	0.17	0.14
*Region*6	-0.57*	-0.43	-0.25	-0.79*	-1.12*	0.29	0.18
μ_1	1.63*	0.98*	1.03*	1.23*	1.12*	1.34*	1.29*
μ_2	2.45*	1.84*	1.64*	1.98*	2.03*	2.05*	2.12*
μ_3	3.57*	2.82*	2.34*	2.78*	2.75*	3.18*	2.78*
Mean response	1.14	1.02	1.15	1.44	2.08	0.46	0.47
St. dev.	1.20	1.28	1.39	1.42	1.47	0.88	0.91
N	947	924	989	992	952	997	988
Log likelihood	-1245	-1167	-1326	-1394	-1447	-851	-862
Log likelihood res.	-1331	-1248	-1393	-1512	-1510	-930	-913

*Parameters significant at the 5 percent level.

Table 6. Estimated Parameters for the Mixed Logit and the Multinomial Logit Model

	Mixed logit			Multinomial logit		
Variable	Parameter	Std. err.	P value	Parameter	Std. err.	P value
Swedish hormone-free beef						
ASC (S)	-0.20	0.32	0.53	0.66	0.09	0.00
St. dev. of *S*	3.79	0.26	0.00			
S × *Gender*	-0.42	0.14	0.00	-0.12	0.04	0.00
S × *Age*	-0.37	0.08	0.00	-0.13	0.02	0.00
S × *Income*	0.01	0.02	0.56	0.00	0.01	0.92
S × *Education*	0.16	0.20	0.42	0.13	0.05	0.02
S × *Urban*	0.30	0.20	0.13	0.13	0.05	0.02
S × *Travel*	0.36	0.08	0.00	0.10	0.02	0.00
S × *Farm*	-1.38	0.34	0.00	-0.27	0.09	0.00
Irish hormone-free beef						
ASC (I)	-2.64	0.41	0.00	-0.19	0.10	0.06
St. dev. of *I*	5.95	0.32	0.00			
I × *Gender*	-0.87	0.21	0.00	-0.28	0.05	0.00
I × *Age*	-0.46	0.12	0.00	-0.16	0.03	0.00
I × *Income*	0.02	0.03	0.45	0.00	0.01	0.65
I × *Education*	-0.04	0.30	0.90	0.08	0.07	0.22
I × *Urban*	0.85	0.29	0.00	0.31	0.07	0.00
I × *Travel*	0.46	0.12	0.00	0.11	0.03	0.00
I × *Farm*	-2.19	0.49	0.00	-0.43	0.11	0.00
U.S. hormone-free beef						
ASC *(US)*	-3.31	0.44	0.00	-0.33	0.10	0.06
St. dev. of *US*	6.67	0.40	0.00			
US × *Gender*	-1.12	0.24	0.00	-0.34	0.05	0.00
US × *Age*	-0.76	0.15	0.00	-0.25	0.03	0.00
US × *Income*	0.04	0.03	0.15	0.00	0.01	0.52
US × *Education*	0.10	0.32	0.75	0.14	0.07	0.03
US × *Urban*	1.15	0.32	0.00	0.37	0.07	0.00
US × *Travel*	0.52	0.13	0.00	0.13	0.03	0.00
US × *Farm*	-2.37	0.54	0.00	-0.44	0.11	0.00
Botswanan hormone-free beef						
ASC *(B)*	-7.43	0.69	0.00	-0.17	0.13	0.00
St. dev. of *B*	9.94	0.68	0.00			
B × *Gender*	-1.51	0.38	0.00	-0.38	0.06	0.00
B × *Age*	-0.58	0.21	0.00	-0.16	0.04	0.00
B × *Income*	0.07	0.05	0.13	0.00	0.01	0.84
B × *Education*	0.37	0.50	0.46	0.31	0.09	0.00

B × *Urban*	1.88	0.50	0.00	0.53	0.09	0.00
B × *Travel*	0.50	0.19	0.01	0.10	0.03	0.00
B × *Farm*	-2.39	0.84	0.00	-0.38	0.16	0.02
U.S. hormone-treated beef						
ASC *(H)*	-21.17	2.66	0.00	-2.37	0.17	0.00
St. dev. of *H*	16.40	0.88	0.00			
H × *Gender*	-4.62	0.91	0.00	-0.64	0.10	0.00
H × *Age*	-3.04	0.54	0.00	-0.46	0.06	0.00
H × *Income*	-0.03	0.09	0.73	-0.01	0.01	0.51
H × *Education*	-3.24	1.02	0.00	-0.17	0.13	0.18
H × *Urban*	0.56	0.89	0.53	0.21	0.12	0.08
H × *Travel*	0.61	0.35	0.08	0.13	0.05	0.01
H × *Farm*	-2.49	1.71	0.14	-0.56	0.24	0.02
All imported (*AI*)						
AI × *Region*2	-1.10	0.45	0.01	1.71	0.11	0.00
AI × *Region*3	-2.51	0.41	0.00	1.07	0.10	0.00
AI × *Region*4	-1.98	0.39	0.00	0.82	0.09	0.00
AI × *Region*5	-2.45	0.47	0.00	0.77	0.11	0.00
AI × *Region*6	-3.08	0.56	0.00	0.98	0.14	0.00
Generic						
Price	-0.05	0.00	0.00	-0.01	0.00	0.09

Correlation Matrix for non-iid residuals

	Sweden	Ireland	U.S.	Botswana	Hormone
Sweden	1.00	-0.90	-0.90	-0.66	-0.47
Ireland		1.00	0.92	0.79	0.57
U.S.			1.00	0.65	0.44
Botswana				1.00	0.59
Hormone					1.00

Summary statistics

Number of choices observations	8156
Log likelihood random choice	-7315
Log likelihood of multinomial logit at convergence	-5681
Log likelihood of mixed logit at convergence	-4055

Notes: Estimated with Nlogit 3.0. Mixed logit is estimated as panel data. Halton draws. Replications for simulated probability = 500.

Table 7. Simulated Market Shares

	Scenario	Choice set	Prices[a]	Logit
Simulation 1	A	All	All NOK 99	Mixed
Simulation 2	B	All	Differentiated	Mixed
Simulation 3	C	European only	All NOK 99	Mixed
Simulation 4	D	European only	Differentiated	Mixed
Simulation 5	A	All	All NOK 99	Multinomial
Simulation 6	B	All	Differentiated	Multinomial
Simulation 7	C	European only	All NOK 99	Multinomial
Simulation 8	D	European only	Differentiated	Multinomial

Simulated market shares

	N	S	I	US	B	H
Simulation 1	37%	27%	7%	10%	13%	5%
Simulation 2	26%	34%	8%	12%	14%	6%
Simulation 3	46%	30%	24%	-	-	-
Simulation 4	34%	38%	28%	-	-	-
Simulation 5	38%	28%	13%	13%	6%	2%
Simulation 6	35%	30%	14%	13%	6%	2%
Simulation 7	46%	37%	17%	-	-	-
Simulation 8	43%	39%	18%	-	-	-

[a]In the simulations with differentiated prices the price of the Norwegian alternative is NOK 99 and the price of the imported alternatives is NOK 79.

Paper 2

European Consumers' Willingness to Pay for U.S. Beef in Experimental Auction Markets

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Abstract: Consumer willingness to pay for Irish, Norwegian, U.S. hormone-free, and U.S. hormone-treated beef was studied in an experimental auction market. We ran four simultaneous second-price auctions to efficiently elicit the complete distribution of willingness to pay between our four alternatives. Most participants preferred domestic to imported beef, and half the participant preferred Irish to U.S. hormone-free beef. Hormone-treated beef received the lowest mean bid, but 28% of the participants were indifferent or preferred U.S. hormone-treated to U.S. hormone-free beef.

Key words: auctions, beef, experimental economics, growth hormones, international trade, willingness to pay.

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European Consumers' Willingness to Pay for U.S. Beef in Experimental Auction Markets

Frode Alfnes and Kyrre Rickertsen

Consumers' willingness to pay for Irish, Norwegian, U.S. hormone-free, and U.S. hormone-treated beef was studied in an experimental auction market. We ran four simultaneous second-price auctions to elicit efficiently the complete distribution of willingness to pay differences among our four alternatives. Most participants preferred domestic to imported beef, and half the participants preferred Irish to U.S. hormone-free beef. Hormone-treated beef received the lowest mean bid, but 28% of the participants were indifferent or preferred U.S. hormone-treated to U.S. hormone-free beef.

Key words: auctions, beef, experimental economics, growth hormones, international trade, willingness to pay.

For more than fifteen years the United States and the European Union (EU) have disputed the safety of using growth hormones in the production of beef. In 1989, the EU banned imports of beef from cattle treated with growth-promoting hormones, effectively cutting off North American exports of beef to the EU.[1] Considering the ban to be a protectionist measure, the United States and Canada made a complaint to the World Trade Organization (WTO) in 1996. After a review of the scientific evidence, the WTO supported the North American position and ruled that there was insufficient scientific evidence to support the ban. The EU was given fifteen months to remove the ban unless scientific evidence proving that hormone-treated beef constituted a risk to human health was provided. Although no evidence had been provided by the May 1999 deadline, the ban remained as a provisional measure. The EU argues that there is a lack of knowledge about the long-term effects of consuming hormone-treated beef and, furthermore, that European consumers are unwilling to accept the risk. The latter claim is clearly supported by consumer surveys; see, for example, Storstad and Haukenes, who report that 94% of Norwegian respondents believe that the use of hormones in agriculture has a potentially negative effect on public health. Because of the EU's noncompliance, the United States was allowed to impose punitive tariffs on European agricultural products worth $117 million a year. Since July 1999, a 100% duty has been levied to a range of products.

Increasing U.S. access to the European market for hormone-free beef may be a solution to the conflict. The appropriate quota will depend on the European market potential for U.S. hormone-free and hormone-treated beef. The market potential depends on consumers' preferences and willingness to pay (WTP) for both varieties of beef. We investigate Norwegian consumers' WTP for hormone-treated U.S. beef and hormone-free U.S., Irish, and domestic beef to evaluate the market potential for U.S. beef. As a member of the European Economic Space, Norway has adopted the EU's ban on hormone-treated beef. In addition, Norway has high import tariffs on beef and only 3% of the market supply is imported through reduced-tariff arrangements. Most of this beef is sold unlabeled through the restaurant market.

Ireland is the largest exporter of beef in Europe producing 2 million cattle per year.

Frode Alfnes and Kyrre Rickertsen are PhD student and professor, respectively, in the Department of Economics and Social Sciences, Agricultural University of Norway.

The authors thank Todd L. Cherry, John A. Fox, Dermot J. Hayes, Jason F. Shogren, two anonymous referees, and seminar participants at the Agricultural University of Norway and at the 2000 Economic Science Association Conference in New York City for useful comments. The authors are especially grateful to Dermot J. Hayes for his valuable assistance with the importation of beef to Norway. The Research Council of Norway, grant No. 119843/530, provided financial support for this research.

[1] U.S. beef producers have used growth-promoting hormones for more than thirty years. Six hormones are authorized: 17 beta-oestradiol, progesterone, testosterone, zeranol, trenbolone, and melengestrol acetate. Presently, more than 80% of all cattle in the United States are treated with growth-promoting hormones to increase feed conversion efficiency, accelerate attainment to market weight, and improve carcass quality.

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Table 1. Distribution of the Sample and the Local Population

	Age (Male)			Age (Female)		
	20–34	35–59	60–70	20–34	35–59	60–70
Proportion of population[a]	0.16	0.27	0.06	0.17	0.27	0.06
Proportion of sample	0.15	0.23	0.08	0.14	0.34	0.06

Source: Statistics Norway.
[a] At the beginning of 1999, 40,782 people in the age group twenty to seventy lived in the sampling area.

Most of the beef is exported to other European countries. Given increased U.S. market access Irish beef would be a major competitor. We have no reason to believe that Norwegian consumers' preferences for U.S. compared to Irish beef are different from those in many other European countries. Our results regarding the WTP for U.S. compared with Irish beef will therefore provide valuable insights into the market potential for U.S. beef in Europe.

Stated preference methods are commonly used to elicit consumers' preferences for products with no existing market (Green and Srinivasan). However, several studies have found that consumers overstate their WTP in stated preference studies; see Harrison and Rutström. To avoid this hypothetical bias, we used an experimental auction market designed to elicit real differences in WTP between the four qualities of beef. The experiments involved the use of representative consumers faced with a nonhypothetical trade-off between money and the four varieties of beef.

Shogren et al. (1994b) described the basic procedure in a seminal paper on the disparity between WTP and willingness to accept (WTA) for various consumer goods. Their procedure has since been used to evaluate U.S. consumers' WTP for new food products, such as milk from cows treated with bovine somatotropin (Fox et al., 1994), pork treated with porcine somatotropin (Buhr et al.), and risk-reduction from food-borne pathogens (Hayes et al.; Shogren et al., 1999).

The contributions of this article are as follows. First, we estimate the consumers' valuation of the use of growth promoters by comparing participants' WTP for U.S. beef produced with and without the use of growth-promoting hormones. Second, we investigate the importance of European versus North American origin by comparing WTP for Irish and U.S. beef. Third, we modify the experimental design in Shogren et al. (1994b) to efficiently elicit the complete distribution of WTP differences when the participants' preference ranking over the alternatives is heterogeneous.

Experimental Design and Implementation of Auctions

We conducted ten sessions during six nights in a cafeteria at the Agricultural University of Norway. Each session included between 9 and 12 participants, with a total of 106 participants. A market research company recruited a representative sample of the population in the age group twenty to seventy years in an area 30 km south of Oslo.[2] All participants claimed to eat beef at least occasionally. The participants were paid NOK 300 to participate in focus groups about meat, lasting about 90 minutes.[3] The age and sex distribution of the sample is representative of the population in the area, as shown in table 1.

The extensive literature on second-price sealed-bid auctions goes back to Vickrey, who showed that the second-price sealed-bid auction is strategically equivalent to the English auction. In both types of auctions, the participants' weakly dominant strategy is to bid their own reservation prices. Because of this property, the second-price sealed-bid auction is an incentive compatible method of eliciting WTP. However, it is an unusual market mechanism and the dominant strategy is not immediately obvious. Experimental research has shown that many participants need extensive training to understand the theoretical properties of the auction (e.g., Coppinger, Smith, and Titus).

Shogren et al. (1994b) utilized the extensive literature on second-price sealed-bid auctions and designed an experimental auction market to study the disparity between WTP and WTA for private goods.[4] They endowed the

[2] The participants were recruited by AC Nielsen, Norway from the counties of Frogn, Ski, Vestby, and Aas.
[3] At the time of the experiments (April 2000), $1 was approximately NOK 8.60; and NOK 300 was approximately $35.
[4] Knetsch, Tang, and Thaler criticize the repeated-trial second-price auctions used by Shogren et al. (1994b) for not engaging off-the-margin bidders. To give all bidders stronger incentives, Shogren et al. (1994a) implemented an nth price auction, with randomized selection of n, but found no significant difference from the

Table 2. Information Presented to the Participants (Translated from Norwegian)

We have four types of rib-eye steak available: Norwegian, Irish, U.S. hormone-free, and U.S. hormone-treated; from cattle that have been treated with growth-promoting hormones. All four types of steak are frozen. The Norwegian rib-eye steak is from a local grocery store. The other products are imported from leading exporters of beef in Ireland and the United States. The beef is imported vacuum packed and frozen, and it is cut and repacked in Norway.
The exporters are approved for export to Norway. We are registered as beef importers by the Norwegian Food Control Authority. We have followed the normal reporting and control procedures for the import of beef.
The Norwegian Food Control Authority has given us permission to import rib-eye steak from cattle that have been treated with growth-promoting hormones and states that: "Investigations so far indicate that consuming hormone-treated meat produced in accordance with stipulated guidelines does not represent any hazard to health."
In the United States, beef producers have used growth-promoting hormones for thirty years. Today 80% of all cattle are treated with growth hormones to enhance growth and tenderize the meat. Only hormones naturally produced by the animal are used.[a] To secure that the cattle have natural levels of hormones at the time of slaughter, farmers are not allowed to use hormones within ninety days of slaughter.

[a]Six hormones are authorized for growth-promoting purposes in the United States and Canada: 17 beta-oestradiol, progesterone, testosterone, zeranol, trenbolone, and melengestrol acetate. Of these, 17 beta-oestradiol, progesterone, and testosterone are natural hormones, whereas zeranol, trenbolone, and melengestrol are synthetic products that mimic the natural hormones. Therefore, to state that: "Only hormones naturally produced by the animal are used" is inaccurate, but this simplification probably did not affect the valuation of the products.

participants with a conventional product, hereafter referred to as the base product, and asked them to bid for an exchange to a presumed superior substitute. The winner paid a price equal to the second highest bid and had to give up the base product. They ran training trials with candy bars to demonstrate the mechanism and used multiple trials to allow the participants to refine their bids to more accurately reflect their valuations. To avoid income effects, they randomly selected one trial to be binding.

We followed the design in Shogren et al. (1994b) with some modifications.[5] We ran four auctions simultaneously. To avoid substitution effects the participants were allowed to buy only one of the alternatives. If one participant was the highest bidder for more than one alternative, he or she was allowed to choose which alternative to buy. The remaining alternative went to the second highest bidder for a price equal to the third highest bid. If several participants shared the highest bid, a random draw determined the winner.[6]

We sold 500 grams of Norwegian, Irish, U.S. hormone-free, and U.S. hormone-treated rib-eye steak in four simultaneous auctions.[7] Rib-eye steak is a well-known beef cut that sells for between NOK 129 and NOK 169 per kilogram in local stores. A local meatpacking company cut and packed the beef. Labeling indicated the country of origin and whether or not growth-promoting hormones had been used. Table 2 shows the information about the beef presented to the participants. The participants were allowed to inspect our import license, registration papers as meat importers, shipping documents, and the beef packages.

As in Shogren et al. (1994b), the participants received their participation fee on arrival at the experiment. The take-home amount was the endowed money less the amount paid for the products bought in the auction. In addition, we endowed each participant with 250 grams of beef to stimulate active engagement in the auction. Without this endowment some participants could have chosen to bid low for the

second-price auction. Since there is no evidence that the *n*th price auction is more efficient and the second-price auction is easier to understand and implement, we used the second-price auction.

[5] The instructions are available at http://www.nlh.no/ios/publikasjoner/d2001/d2001-06.pdf.

[6] Roosen et al. used a similar auction design with simultaneous bids on multiple products. However, they used the product sold in local stores as base product and asked the participants to bid for an exchange to four new substitutes. More than one-third of the participants bid zero for each of the alternatives and 70% bid zero for the lowest value alternative. Roosen et al.'s approach gives the WTP for the participants willing to pay more for the new products than for the base product but does not reveal the WTP for those participants preferring the base product.

[7] The legal procedures surrounding the import of U.S. hormone-treated beef were quite extensive because of the EU's ban on imports. We used about three months to obtain an exemption from the ban for scientific purposes. We were only allowed to use approved meat exporters in the United States and it was difficult to find an exporter willing to sell the small quantity of beef to a country within the European Economic Space. The shipping company contaminated the U.S. hormone-free beef by improper storage. The U.S. supplier was not willing to ship more, because of the extensive bureaucracy surrounding EU's new testing procedures for U.S. hormone-free beef. Since we were unable to find a new supplier, we decided to label Irish beef as U.S. hormone-free beef. The import documents were available and nobody questioned that we actually used U.S. hormone-free beef.

sake of convenience (i.e., not having to take beef home).

The highest bidder for each alternative had to give up the endowed package and pay a price equal to the second highest bid. Therefore, the total value of each bid is the bid plus the participant's valuation of the endowed package. When we compare the WTP for one alternative with the WTP for another, the value of the endowed package cancels out and the difference in bids equals the difference in WTP. To reduce any bias from our choice of base product, we used domestic and U.S. hormone-treated beef in five sessions each.

Following Shogren et al. (1994b), we ran training trials with candy bars to familiarize the participants with the auction mechanism. Each participant received a small candy bar as a base product and was asked to simultaneously bid for four different brands of larger candy bars. We explained to the participants that it was in their best interests to bid their true WTP for an exchange to each of the four alternatives. After the third trial, we drew the binding trial and completed the sale.

In the beef auctions, we conducted six trials in each session. The prices and identification number of the highest bidder for each alternative were written on a whiteboard after each trial. We let participants taste the Norwegian, Irish, and U.S. hormone-treated beef after the third trial.[8] At the end of the session, one of the trials was randomly selected as the binding trial and the sales were completed.

Framing and learning effects in multi-trial auctions have been studied in several papers (e.g., Knetsch, Tang, and Thaler; List and Shogren; Shogren et al., 1994a; Shogren, List, and Hayes). One of the most persistent results is a positive trend in second-price auctions. List and Shogren also found some evidence of bids being correlated with posted prices, but concluded that most of the increase in bids comes from participants learning their optimal strategy. Knetsch, Tang, and Thaler found that in strategically equivalent ninth-price auctions bids are decreasing and they concluded: "It appears that the value subjects announce in a Vickrey auction depends greatly on the rules being used." However, bidding on all alternatives simultaneously ensures that the rules and the learning process are the same for all alternatives. The differences in bids are therefore likely to be robust estimators for the differences in WTP between the alternatives.

Bidding on all alternatives and comparing the bids is an efficient method of eliciting WTP differences. It is efficient in the sense that all bids can be used and, furthermore, the complete distribution of WTP differences can be elicited in one experiment. Some participants prefer domestic to hormone-treated beef while others prefer hormone-treated to domestic beef. Given such heterogeneity in preferences, using one of the alternatives as base product and bidding on the others will elicit only a part of the distribution. Participants preferring the base product will bid zero, so we are unable to find their true WTP differences. Buhr et al. solved the heterogeneity problem by splitting the sample into groups with different alternatives as base product. They were unable to find the true WTP differences for all participants, but with a large sample they were able to find the complete distribution of WTP differences. Fox et al. (1998) modified Buhr et al.'s design by letting the participants rank the alternatives before they were allocated to an auction with their least preferred alternative as base product. However, they faced the problem of participants changing preference ranking as new information was introduced. Our design is independent of the participants' preference ranking, and we elicit the difference in WTP between all alternatives for all participants without asking sensitive questions during the recruitment process.

If the participants' WTA for the base product are higher than their WTP for it, the bids will underestimate the difference in WTP between the base product and the alternatives. Many experiments report a WTP-WTA disparity, and theoretical (e.g., Hanemann; Tversky and Kahneman) and empirical (e.g., Bateman et al.; Shogren et al., 1994b) research has been conducted to reveal the reasons for the disparity.[9] Hanemann showed that given a positive income elasticity, standard economic theory

[8] Before the tasting, we told the participants that the quantities of imported U.S. hormone-free beef were insufficient to allow tasting. We also told them that the U.S. hormone-free beef was from the same breed as the Irish beef and tasted similar.

[9] Tversky and Kahneman explained the disparity between WTP and WTA as the result of reference dependent preferences. They argued that there is an endowment effect, which increases a person's valuation of a good when it becomes a part of that person's endowment. Consequently, a person will demand more to give up a good than he is willing to pay to acquire it. Several studies (e.g., Bateman et al.) have found evidence of an endowment effect using the incentive compatible Becker-DeGroot-Marschak mechanism. Shogren et al. (2001) studied the WTP-WTA disparity for readily available products in three auction mechanisms. They found that the WTP-WTA disparity disappears rapidly in second and *n*th price auctions. Therefore, they concluded that there is no evidence of a persistent endowment effect in the Vickrey auction. However,

Table 3. Descriptive Statistics for the Bids

	Alternatives	Sessions Using Norwegian Beef as Base Product	Sessions Using U.S. Hormone-Treated Beef as Base Product
Mean	Domestic hormone free	40.10	40.78
	Irish hormone free	38.18	34.62
	U.S. hormone free	34.32	30.17
	U.S. hormone treated	25.16	19.40
Median	Domestic hormone free	40.00	40.00
	Irish hormone free	40.00	36.00
	U.S. hormone free	36.00	30.00
	U.S. hormone treated	30.00	20.00
Standard deviation	Domestic hormone free	12.96	12.58
	Irish hormone free	13.81	12.75
	U.S. hormone free	14.20	14.41
	U.S. hormone treated	18.37	15.37
Percentage of zero bids	Domestic hormone free	1.57	0.40
	Irish hormone free	3.14	2.48
	U.S. hormone free	5.03	2.48
	U.S. hormone treated	24.21	25.00

Note: The mean, median, and standard deviation are measured in NOK.

predicts a WTP-WTA disparity for products without perfect substitutes. For products with perfect substitutes, no disparity is predicted. Shogren et al. (1994b) confirm Hanemann's theoretical result in an experimental auction market. After repeated trials no significant WTP-WTA disparity was found for products with perfect substitutes. For products without perfect substitutes, the disparity was persistent throughout the auction. Domestic beef has perfect substitutes in local stores, while U.S. hormone-treated beef has no perfect substitute in Europe. Therefore, the largest WTP-WTA disparity is expected for U.S. hormone-treated beef. A WTP-WTA disparity for the base product makes the interpretation of the level of the bids difficult. However, the value of the base product cancels out when we calculate the differences between the bids. Therefore, any WTP-WTA disparity for the base product has no effect on the differences.

Results

Table 3 shows descriptive statistics for the bids.[10] In local stores, the typical price range for 250 grams of rib-eye steak is between NOK 32.25 and NOK 42.25 or between NOK 129 and NOK 169 per kilogram. The mean bid for an exchange from 250 grams to 500 grams of domestic beef is NOK 40.10 and within this observed price range.[11] On average, the bids are highest for the domestic beef, higher for Irish than for U.S. beef, and lowest for the U.S. hormone-treated beef. About 25% of the participants bid zero for the U.S. hormone-treated beef, demonstrating that a substantial proportion of the participants was opposed to hormone-treated beef. The preferences for country of origin can be a result of perceptions regarding production method and control system, and there may be a negative spillover effect from U.S. hormone-treated to U.S. hormone-free beef.

The results in table 3 indicate that there is a larger WTP-WTA disparity for U.S. hormone-treated than for domestic beef. On average,

they could not reject the presence of a persistent endowment effect in the strategically equivalent Becker-DeGroot-Marschak mechanism.

[10] The results presented are based on the bids in sessions two to ten. In the first session, one participant did not follow the instructions, but argued that the experiment was not what he had expected. Since the session was affected by this disruption, we did not include the results. We also made some minor changes in the instructions after the first session. The average bids in the first session were significantly lower than the bids in later sessions: NOK 34 for the Norwegian, NOK 19 for the Irish, NOK 14 for the U.S. hormone-free beef, and NOK 8 for the U.S. hormone-treated beef. However, including the bids of the first session would not have changed any of the conclusions in this article.

[11] The average bid for an upgrade from 250 grams to 500 grams of Norwegian beef is within the price range found in local stores, but some participants were bidding more than the upper limit of this price range. One possible explanation for this phenomenon is mental accounting suggesting that people have a tendency to spend relatively more when using allocated money rather than earned money; see Thaler (1985, 1999).

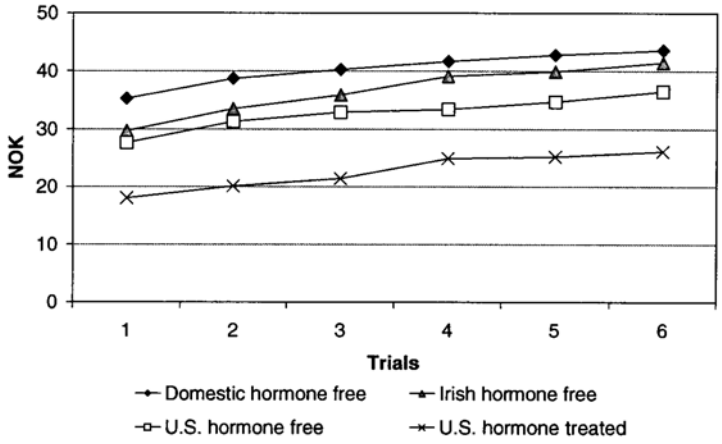


Figure 1. Mean bids over trials

participants endowed with U.S. hormone-treated beef as base product valued an exchange to one of the alternatives by NOK 3.20 less than the participants endowed with the domestic base product. Since there are perfect substitutes for domestic beef, we can assume that the WTA for the endowed 250 grams is equal to the WTP for additional 250 grams or NOK 40.10. Under this assumption, the average total values of the bids are NOK 80.20, NOK 78.28, NOK 74.42, and NOK 65.16 for 500 grams of Norwegian, Irish, U.S. hormone-free, and U.S. hormone-treated beef in the sessions using Norwegian base product. To make the average total values of the bids identical in the sessions using U.S. hormone-treated beef as base product, the participants' valuation of the base product must be NOK 43.30. This is more than twice the average bid of NOK 19.40 for an additional 250 grams of U.S. hormone-treated beef. This disparity suggests that the WTA for 250 grams of U.S. hormone-treated beef is significantly higher than the WTP for additional 250 grams. The bids for an exchange from 250 grams of U.S. hormone-treated beef to 500 grams of the four alternatives may, consequently, underestimate the difference in WTP between the base product and the four alternatives.

The mean bids are increasing over trials, as shown in figure 1. List and Shogren found that bids increase over trials in most experimental auction markets. They also found some evidence of bids being correlated or "affiliated" with the posted price.[12] We test for increasing bids and affiliation by estimating the following equation for each alternative:

$$(1)\quad \Delta \text{Bid}_{i,r,t} = \beta_{1r} + \beta_{2r} t + \beta_{3r} P_{i,r,t-1} + \beta_{4r} D_t + \varepsilon_{i,r,t}$$

where $\Delta \text{Bid}_{i,r,t}$ denotes the change in participant i's bid from trial $t-1$ to trial t for alternative r, $P_{i,r,t-1}$ denotes the difference between the posted price and individual i's bid in trial $t-1$ for alternative r, D is a dummy variable taking the value 1 in trial four (immediately after tasting) and 0 otherwise, and ε is an error term. The parameter β_1 measures the increase in bids over trials, β_2 measures the change in the rate of increase in bids, β_3 measures the affiliation, and β_4 measures the effect of tasting.

The ordinary least squares (OLS) estimates of equation (1) are presented in table 4. We find a positive but declining trend in the bids for all alternatives. One likely explanation for the positive trend is that participants need some time to fully understand the market mechanism (List and Shogren). If learning is the complete explanation, the bids will have a common trend and we performed a test for β_{1r} and β_{2r} being identical for the four alternatives. The F-value of this test is 0.30 (with 6 and 1,884 df). The corresponding p-value is 0.93 and we cannot reject a common trend.

As in List and Shogren, we find that the participants' bids are positively correlated with the other participants' valuation of the products. Increasing the posted price for an alternative with NOK 1 increases the average bid for the alternative in the next trial with NOK 0.1. This correlation indicates that the price

[12] See Milgrom and Weber for a discussion about affiliated private values in auctions.

Table 4. Estimation Results for Trend and Affiliation

Dependent Variable	Independent Variable	OLS Parameter	OLS *t*-value
ΔBid (domestic hormone free)	Constant	2.49	2.72
	Trial number[a]	−0.55	2.71
	Posted price[b]	0.12	5.81
	Taste dummy[c]	−0.23	0.33
ΔBid (Irish hormone free)	Constant	2.89	2.88
	Trial number	−0.64	2.83
	Posted price	0.14	6.55
	Taste dummy	1.49	1.86
ΔBid (U.S. hormone free)	Constant	1.96	1.94
	Trial number	−0.40	1.78
	Posted price	0.15	6.77
	Taste dummy	−1.31	1.63
ΔBid (U.S. hormone treated)	Constant	1.52	1.48
	Trial number	−0.39	1.67
	Posted price	0.07	3.84
	Taste dummy	2.43	3.00

[a]Trial number takes the value 2 to 6.
[b]Posted price is the price posted for the alternative in the previous trial.
[c]Taste dummy takes the value of unity in trial four, immediately after the tasting of the domestic, Irish, and U.S. hormone-treated beef, and zero otherwise. The participants did not taste the U.S. hormone-free beef.

information given in the auction is partially responsible for the increasing bids.

We calculated the mean bid for each alternative in the six trials and tested if the differences between the bids for the U.S. hormone-free beef and the other alternatives were constant over the trials. We rejected this hypothesis with an F-value of 2.17 (with 15 and 1692 df) and a corresponding p-value of 0.01. However, when we allow for a structural break after the tasting, we cannot reject constant differences with an F-value of 1.50 (with 12 and 1692 df) and a corresponding p-value of 0.12.

To further investigate the differences in WTP between U.S. hormone-free beef and the other alternatives, ΔWTP, we estimated the following equation for each alternative:

$$(2) \quad \Delta WTP_{i,r} = \gamma_{1r} + \gamma_{2r} Base_i + \gamma_{3r} Taste_i + u_{i,r}$$

where *Base* is a dummy variable taking the value 0 when U.S. hormone-treated beef is used as base product and 1 when domestic beef is used, *Taste* is a dummy variable taking the value 0 before tasting and 1 after tasting, u is an error term, the γ's are parameters to be estimated, subscript i denotes the participant, and subscript r denotes the alternative.

In table 5, we present the OLS estimates for equation (2). The average participant is willing to pay NOK 2.48 more for Irish, NOK 9.88 more for domestic, and NOK 11.99 less for U.S. hormone-treated beef than for U.S. hormone-free beef. These differences in WTP are all statistically significant at the 1% level. The WTP for Irish beef increases significantly relative to U.S. hormone-free beef after tasting. Tasting did not significantly change the WTP differences between the other alternatives.

The results suggest that the differences in WTP between the alternatives are affected by the choice of base product. The WTP for the Norwegian relative to the U.S. hormone-free beef is lower in the sessions using Norwegian base product than in the sessions using U.S. hormone-treated base product. Similar, the lowest relative WTP for U.S. hormone-treated beef is found in the sessions using the U.S. hormone-treated base product. Irish and U.S. hormone-free beef were not used as base products and the difference in WTP between them is unaffected by the choice of base product. These results suggest a negative bias for the WTP of the quality used as base product. We can avoid this bias by using the bids from the sessions with U.S. hormone-treated base product when comparing the WTP for Norwegian beef with Irish and U.S. hormone-free beef. In a corresponding way, the bids from the sessions with Norwegian base product should be used when comparing the WTP for U.S. hormone-treated beef with Irish and U.S. hormone-free beef.

Table 5. Differences in WTP Between the U.S. Hormone-Free Beef and the Other Alternatives

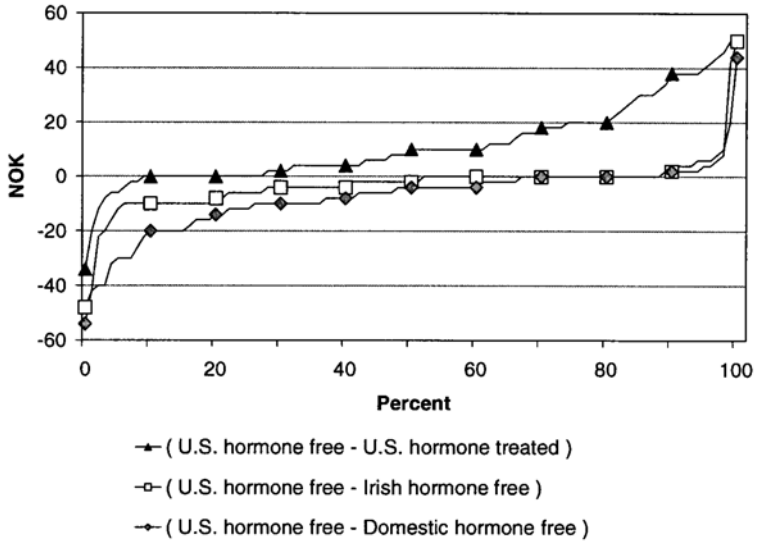
Dependent Variable[a]	Independent Variable	OLS	
		Parameter	*t*-value
U.S. hormone free and ΔWTP between domestic hormone free	Constant	−9.88	10.26
	Taste[b]	−0.38	0.36
	Base[c]	4.29	4.00
U.S. hormone free and ΔWTP between Irish hormone free	Constant	−2.48	3.02
	Taste	−2.86	3.15
	Base	0.06	0.06
U.S. hormone free and ΔWTP between U.S. hormone treated	Constant	11.99	10.54
	Taste	−1.35	1.08
	Base	−2.15	1.70

[a]The dependent variables measure the differences in WTP between the U.S. hormone-free beef and the other alternatives in NOK.
[b]Taste is a dummy variable taking the value zero before tasting the domestic, Irish, and U.S. hormone-treated beef, and unity thereafter. The participants did not taste the U.S. hormone-free beef.
[c]Base is a dummy variable taking the value zero when 250 grams of U.S. hormone-treated beef is used as base product and unity when domestic beef is used.

Figure 2 shows the cumulative distributions of the differences in bids between U.S. hormone-free beef and the other alternatives in the third trial before tasting. Seventy-two percent of the participants prefer U.S. hormone-free to U.S. hormone-treated beef, 18% are indifferent between these alternatives, and 10% prefer U.S. hormone-treated beef. Eleven percent of the participants prefer U.S. hormone-free to Irish beef, 37% are indifferent, and 52% prefer Irish beef. Finally, 11% of the participants prefer U.S. hormone-free to domestic beef, 22% are indifferent, and 67% prefer domestic beef.

Conclusions

In our design, the participants bid on all alternatives simultaneously under the restriction



Note: These results are from the third trial, i.e., before the participants were allowed to taste the Norwegian and Irish hormone-free, and U.S. hormone-treated beef.

Figure 2. Cumulative distributions of the differences in WTP between U.S. hormone-free beef and the other alternatives

that no one can purchase more than one alternative. This design is independent of the participants' preference ranking and we can efficiently elicit WTP differences between the alternatives for each participant. Even though the bids increased over the trials, the average differences between bids are constant when we allow for a structural break after tasting. This stability suggests that one trial is sufficient to find the premium people are willing to pay for one product relative to another.

A majority of the participants were willing to pay more for domestic than for imported beef and had a slight preference for Irish over U.S. hormone-free beef. The Irish and domestic beef received bids indicating average premiums of NOK 5 and NOK 20 per kilogram in comparison to U.S. hormone-free beef. However, half of the participants were willing to pay at least as much for U.S. hormone-free as for Irish beef, and one-third were willing to pay at least as much for U.S. hormone-free as for domestic beef. Since Ireland is Europe's biggest exporter of beef, the results suggest that U.S. hormone-free beef has a substantial market potential in Europe.

U.S. hormone-treated beef received the lowest mean bid. Moreover, a quarter of the participants bid zero, showing that many consumers strongly oppose hormone-treated beef. The average bid represents a discount of NOK 20 per kilogram in comparison to U.S. hormone-free beef. However, 28% of the participants preferred U.S. hormone-treated to U.S. hormone-free beef or were indifferent, and 10% were willing to pay more for the hormone-treated beef than for any of the hormone-free alternatives. These results show that consumers' preferences are heterogeneous and suggest that there is a potential niche market for U.S. hormone-treated beef in Europe.

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Errata

Table 5, page 55: The three dependent variables in table 5 should be "ΔWTP between U.S. hormone free and domestic hormone free", "ΔWTP between U.S. hormone free and Irish hormone free", and "ΔWTP between U.S. hormone free and U.S. hormone treated", respectively.

Paper 3

SC-X: Calibrating Stated Choice Surveys with Experimental Auction Markets

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Abstract: Experimental auctions (X) use real economic incentives but are limited by available products and locally recruited samples. Stated choice (SC) surveys can use a representative sample to estimate the willingness to pay (WTP) for hypothetical products with unavailable characteristics. However, a number of studies conclude that surveys give biased WTP estimates. We designed a method, SC-X, to calibrate the WTP estimates from stated choice surveys with WTP observed in experimental auctions. This method allows us to extend the results from auctions to products with unavailable characteristics and to socioeconomic groups not included in the auction. The SC-X method is illustrated using Norwegian consumers' preferences for country-of-origin and hormone status for beef.

Key words: beef, calibration, experimental auctions, stated choice, willingness to pay

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SC-X: Calibrating Stated Choice Surveys with Experimental Auction Markets

Stated choice (SC) methods are frequently used to assess the market potential for products with no or limited market data. Recent examples in agricultural marketing include Burton *et al*. (2001) who investigated the demand for GMO food; Blend and van Ravenswaay (1999) and Wessells, Johnston, and Donath (1999) who studied the demand for ecolabeled food; and Unterschultz *et al*. (1998), Quagrainie, Unterschultz, and Veeman (1998), and Alfnes (2002) who analyzed preferences for country-of-origin for beef.

In SC surveys, the respondents are presented with alternatives defined by their attributes (e.g., price and country-of-origin) and are asked to choose the preferred alternative. The choices can be used to assess the willingness to pay (WTP) for each alternative. However, the evidence strongly suggests that most survey participants exaggerate their WTP for private as well as public goods - see List and Gallett (2001), List (2001), List and Shogren (2002), Harrison and Rutström, and Shogren.

To avoid the hypothetical bias, experimental auctions (X) with participants facing non-hypothetical trade-offs between money and goods can be used. In their seminal paper, Shogren *et al*. (1994) used a second-price sealed-bid auction with repeated trials to elicit WTP. Similar auction mechanisms have been employed to elicit WTP for pork attributes (Melton *et al*., 1996), food safety (Hayes *et al*., 1995 and Fox *et al*., 1998), reduction in pesticide use (Roosen *et al*., 1998), GMO food (Noussair, Robin, and Ruffieux, 2002), and hormone-treated beef (Alfnes and Rickertsen). However, experimental auctions are limited to available products with existing product characteristics and are usually conducted in a laboratory setting with a relatively small and locally recruited sample.

Given the limitations of surveys and experimental auctions, it is of considerable interest to combine the results of the two methods. To reduce the problem of hypothetical bias, Blackburn, Harrison, and Rutström (1994); Fox *et al*. (1998); List, Magrolis, and

Shogren (1998); List and Shogren (1998); and List and Shogren (2002) use experimental auctions to calibrate values elicited in hypothetical settings. Two approaches have been used to calibrate the WTP values found in contingent valuation (CV) studies. First, Blackburn, Harrison, and Rutström (1994) investigated the potential hypothetical bias in answering discrete choice (take it or leave it offers) and estimated a statistical "bias function" to examine whether the hypothetical bias (accepting the offer in a hypothetical case but rejecting the same offer in a real case) for a particular good in one sample of subjects is transferable to a different good in another sample of subjects. They found few conclusive relationships between hypothetical bias and socioeconomic variables. Second, in the CVM-X method, developed by Fox *et al*. (1998), a large survey with open-ended WTP questions is conducted and some of the survey respondents participate in an experimental auction for the same good. The bids in the experimental auctions are used to calibrate the hypothetical WTP estimated from the survey. List, Magrolis, and Shogren (1998), List and Shogren (1998), and List and Shogren (2002) further investigated the method outlined in Fox *et al*. (1998).

In this paper, we deal with calibration of results from SC surveys rather than CV studies. We designed and implemented a method, SC-X, to calibrate the hypothetical WTP estimates from SC surveys with the WTP found in experimental auctions. This method allowed us to extend the results from auctions to hypothetical products with unavailable characteristics and to socioeconomic groups not included in the auction.

We illustrate the SC-X method here using Norwegian consumers' preferences for country-of-origin and hormone status for beef. First, the WTP values for Norwegian, Irish, US hormone-free, and US hormone-treated beef found in auctions are used to construct a calibration function for the WTP values found in the survey. Second, we use the calibration function to calculate WTP values for socioeconomic groups not participating in the auction.

Third, hormone-treated European beef is unavailable in the market and we use the calibration function to calibrate the survey WTP results for such beef.

Experimental Auction

In April 2000, we conducted an SC survey and an experimental auction to study Norwegian consumers' preferences for country-of-origin and hormone status for beef. A representative sample of the population in four counties 30 kilometers south of Oslo were recruited by ACNielsen Norway to take part in the experimental auction. The participants claimed to eat beef at least occasionally and they were paid NOK 300 to take part in the experiment.[1] We conducted ten sessions with a total of 106 participants in a cafeteria at the Agricultural University of Norway. The summary statistics of the auction and survey (see below) samples are presented in table 1. The auction participants are socioeconomically similar to the survey participants in the same region.

We generally followed the experimental design used in Shogren *et al*. (1994); however, we ran four simultaneous auctions as described in Alfnes and Rickertsen.[2] The participants were allocated with 250 grams of rib-eye steak, hereafter referred to as the base product, and asked to bid for an exchange to 500 grams. The winner paid a price equal to the second highest bid and had to give up the base product. We ran trials with candy bars to demonstrate the mechanism and used multiple trials to allow the participants to refine their bids to more accurately reflect their valuations. To avoid income effects, one trial was randomly selected as binding.

The participants bid simultaneously on 500 grams of four alternatives: hormone-free Norwegian, hormone-free Irish, hormone-free US, and hormone-treated US rib-eye steak. To avoid substitution effects, we imposed a winning restriction. If a participant was the highest

bidder for more than one alternative, he or she could choose which alternative to buy and the remaining alternative went to the second highest bidder.

We used 250 grams of Norwegian hormone-free and US hormone-treated beef as base product in five sessions each. In the comparison of the bids for the four alternatives, each participant's valuation of the base product is canceled out and the differences in bids represent differences in WTP for 500 grams of the four alternatives.

We estimate the following money-metric function, which relates the WTP differences to socioeconomic variables, using OLS:

$$
\begin{aligned}
WTP_{nit} = {} & \gamma_{COi} + \gamma_H H_i + \gamma_{1i} Gender_n + \gamma_{2i} Age_n + \gamma_{3i} Income_n + \gamma_{4i} Education_n \\
& + \gamma_{5i} Urban_n + \gamma_{6i} Travel_n + \gamma_{7i} Farm_n + \gamma_8 H_i Gender_n \\
& + \gamma_9 H_i Age_n + \gamma_{10} H_i Income_n + \gamma_{11} H_i Education_n \\
& + \gamma_{12} H_i Urban_n + \gamma_{13} H_i Travel_n + \gamma_{14} H_i Farm_n + \varepsilon_{nit} \ ,
\end{aligned} \tag{1}
$$

where WTP_{nit} is the difference in price individual *n* is willing to pay for one kilogram of alternative *i* and one kilogram of Norwegian beef in trial *t;*[3] γ_{COi} is the country-of-origin specific constant for alternative *i*; H_i is a dummy with the value 1 if the alternative is hormone treated, otherwise zero; *Gender*, *Age*, *Income*, *Education*, *Urban*, *Travel*, and *Farm* are socioeconomic variables as defined in table 1; the γ_{1i} to γ_{7i} are the country-specific marginal effects on WTP from changes in the associated socioeconomic variables; γ_8 to γ_{14} are the marginal effects on WTP for hormone-treated beef from changes in the associated socioeconomic variables, and ε_{nit} is an error term. The WTP difference observed in the auction between alternative *i* and the domestic alternative will hereafter be referred to as the observed WTP for alternative *i.*

Stated Choice Survey

ACNielsen Norway conducted 1066 home interviews of persons that were 15 years or older and the weighted survey sample is representative of the Norwegian population. An SC

experiment was completed as part of the survey. The participants were told that hormone-treated beef and beef produced abroad are likely to become available in the domestic market. Each participant was presented four choice sets with three alternatives in each set. Domestic hormone-free rib-eye steak costing NOK 99 per kilogram was included in all the choice sets. The remaining two alternatives were imported rib-eye steak with various combinations of country-of-origin, hormone status, and price. The participants were asked to choose the preferred alternative in each set. Next, they were asked to choose the preferred alternative given that their first choice was unavailable. The survey design is described in greater detail in Alfnes (2002).

To model the repeated choices made by the participants, we specify a mixed logit model for panel data (Greene, 2002). We assume that the utility from each alternative can be decomposed into a non-stochastic component containing country-specific constants, a hormone-status dummy, a price variable, and socioeconomic characteristics; one stochastic component (η) that is distributed normally over individuals and alternatives, independently over individuals, constant over repeated choice by one individual, and potentially correlated and heteroscedastic over alternatives; and a second stochastic component (ε) that is independently and identically extreme value distributed over individuals, alternatives, and choices. The utility of individual *n* from alternative *i* in choice situation *t*, U_{nit}, is:

$$
\begin{aligned}
(2) \qquad U_{nit} = {} & \beta_{CO_i} + \beta_H H_i + \beta_{Price} Price_{nit} + \beta_{1i} Gender_n + \beta_{2i} Age_n + \beta_{3i} Income_n \\
& + \beta_{4i} Education_n + \beta_{5i} Urban_n + \beta_{6i} Travel_n + \beta_{7i} Farm_n + \beta_8 H_i Gender_n \\
& + \beta_9 H_i Age_n + \beta_{10} H_i Income_n + \beta_{11} H_i Education_n + \beta_{12} H_i Urban_n \\
& + \beta_{13} H_i Travel_n + \beta_{14} H_i Farm_n + \beta_{15} Region2_n + \beta_{16} Region3_n \\
& + \beta_{17} Region4_n + \beta_{18} Region5_n + \beta_{19} Region6_n + [\eta_{ni} + \varepsilon_{nit}],
\end{aligned}
$$

where the variables are as defined in table 1; β_{COi} is the country-specific constant for alternative *i*; H_i is a dummy with the value 1 if the alternative is hormone treated, otherwise zero; $Price_{nit}$ is the price of alternative *i*; *Gender*, *Age*, *Income*, *Education*, *Urban*, *Travel*, and

Farm are socioeconomic variables as defined in table 1; the β_{1i} to β_{7i} represent the country-specific marginal effects on the utility from a change in the associated socioeconomic variables; β_8 to β_{14} represent the marginal effects on the utility for hormone-treated beef from changes in the associated socioeconomic variables; β_{15} to β_{19} represent the marginal effects on the utility for all imported beef from a change of region, and η_{ni} and ε_{nit} are error terms. Region 1, Southeast Norway, is used as the reference region. For identification, all domestic-specific parameters are normalized to zero.

The parameter estimates in equation (2) can be used to predict WTP for alternative *i* compared to the domestic alternative. We will refer to this WTP estimate as the hypothetical WTP for alternative *i*, $HWTP_i$. Individual *n*'s hypothetical WTP in choice situation *t* is the difference in utility between alternative *i* and the domestic alternative divided by the price parameter:

$$(3) \qquad \widehat{HWTP}_{nit} = -\frac{\hat{\beta}_{0i} + \hat{\beta}_{1i}Gender_n + \hat{\beta}_{2i}Age_n + ... + \hat{\beta}_{19}Region6_n}{\hat{\beta}_{Price}}.$$

SC-X: Calibration Method

The SC-X calibration method consists of four steps and involves the construction of a calibration function relating hypothetical and observed WTP. We use superscript *A* and *S* to denote the auction and survey data. The four steps are as follows:

Step 1: Estimate a mixed logit model using the survey data:

$$(4) \qquad U_{nit} = \beta_i' x_{nit}^S + [\eta_{ni} + \varepsilon_{nit}].$$

In our case, we estimate equation (2).

Step 2: Use the estimated survey parameters from step 1 and calculate each auction participant's predicted hypothetical WTP, $\widehat{HWTP}_{nit}^A$, for the products included in the auction:

(5) $$\widehat{HWTP}^{A}_{nit} = \frac{\hat{\beta}'_{Domestic} x^{A}_{n} - \hat{\beta}'_{i} x^{A}_{n}}{\hat{\beta}_{Price}}.$$

In our case, we use equation (3) to calculate $\widehat{HWTP}^{A}_{nit}$.

Step 3: Use the observed WTP from the auction, WTP^{A}_{nit}, and the hypothetical WTP, $\widehat{HWTP}^{A}_{nit}$, estimated in step 2 to estimate a calibration function:

(6) $$WTP^{A}_{nit} = f(\widehat{HWTP}^{A}_{nit}) + \varepsilon_{nit},$$

where $f(\ )$ denotes a non-decreasing function with $f(0) = 0$. In our case we estimate:

(7) $$WTP^{A}_{nit} = \alpha_1 \widehat{HWTP}^{A}_{nit} + \alpha_2 (\widehat{HWTP}^{A}_{nit})^2 + \alpha_3 (\widehat{HWTP}^{A}_{nit})^3 + \varepsilon_{nit}.$$

The estimated calibration function is presented at the bottom of table 3.

Step 4: Use the model estimated in step 1 to calculate hypothetical WTP for any combination of product characteristics and socioeconomic attributes included in the survey model, $\widehat{HWTP}^{S}_{nit}$, and the parameters of the calibration function estimated in step 3 to calculate the calibrated WTP for the survey participants $\widehat{WTP}^{S}_{nit}$:

(8) $$\widehat{WTP}^{S}_{nit} = \hat{f}(\widehat{HWTP}^{S}_{nit}).$$

In our case, we use the estimated parameters of equation (7) and calculate:

(9) $$\widehat{WTP}^{S}_{nit} = \hat{\alpha}_1 \widehat{HWTP}^{S}_{nit} + \hat{\alpha}_2 (\widehat{HWTP}^{S}_{nit})^2 + \hat{\alpha}_3 (\widehat{HWTP}^{S}_{nit})^3.$$

Empirical Illustration of the SC-X Method

Because of high import tariffs, domestic beef accounts for 97% of beef sales in Norway. The remaining beef is imported mainly from developing countries. It is illigal to produce or sell hormone-treated beef in Norway (or the EU). Hence, there are no available market data for hormone-treated-beef and only few and scattered data for imported hormone-free beef.

We will illustrate the SC-X method using the choice data from the survey and the observed WTP from the auction discussed above. Norwegian, Irish, US hormone-free, and US hormone-treated beef were included in the survey as well as in the auction. We used the observed WTP for these products to calibrate the hypothetical WTP from the survey. Only people living in Southeast Norway (Region 1) participated in the auctions and we used the SC-X method to predict the WTP for people living in other regions of the country. The survey also included Swedish and Botswanan hormone-free beef and we predicted the WTP for these two products. Finally, we predicted the WTP for the hypothetical products Norwegian, Swedish, Irish, and Botswanan hormone-treated beef.

Comparison of Survey and Auction Results

The survey and auction parameters for Irish, US hormone-free, and US hormone-treated beef from equations (1) and (2) are presented in table 2. The negative country-specific parameters show that the average participant prefers domestic to imported beef. The average auction participant had a slight preference for Irish over US hormone-free beef, while the average survey participant showed no preference between the two alternatives. The negative hormone dummies suggest that the average participant in both studies prefer US hormone-free to US hormone-treated beef. Twenty-one of the survey parameters and nine of the auction parameters are significant at the 5 percent level of significance. All the significant parameters in one model are either significant with the same sign or insignificant in the other model.

The upper half of table 3 presents the hypothetical WTP estimates calculated from the survey using equation (3). The hypothetical WTP results are, as expected, considerably higher than the corresponding WTP amount observed in the auction, indicating a substantial bias. For Region 1, the hypothetical WTP for Irish, US hormone-free, and US hormone-treated beef are respectively NOK 60.46, NOK 58.18, and NOK 386.55 lower per kilogram

than the WTP for domestic beef, while the corresponding WTP amounts in the auction are respectively NOK 14.16, NOK 18.75, and NOK 37.56 lower per kilogram.

Extension to other Socioeconomic Groups

The parameter estimates reported in table 2 indicate that there are large regional differences in the WTP for imported beef. These differences cannot be captured using a locally recruited sample. Furthermore, a locally recruited sample will often be more homogenous with respect to socioeconomic variables, such as urbanization, than a nationally representative sample. We conducted our auction in Region 1, which has a substantial trade with neighboring Sweden. According to the estimates, people living in Region 1 are less reluctant to buy imported beef than people living in other parts of the country.

The lower half of table 3 shows the calibrated survey WTP values. For example, the numbers indicate that the WTP for Irish beef is NOK 6.32 higher in Region 1 than the average for all regions. The least willing to buy imported beef are people living in Region 6, Northern Norway. The average participant in Region 6 is willing to pay NOK 12.72 less than the average participant in Region 1 for Irish beef.

The calibrated national mean WTP values in the last row of table 3 show that the mean WTP amounts for Irish, US hormone-free, and US hormone-treated beef are NOK 19.66, NOK 19.44, and NOK 37.75 lower per kilogram than the WTP for domestic beef. The mean values are respectively 68%, 67%, and 9% higher for Irish, US hormone-free, and US hormone-treated beef than the corresponding values for Region 1.

The marginal effects of a change in a socioeconomic variable on the calibrated WTP values are calculated by inserting the predicted values of equation (3) into equation (9) and differentiating with respect to the socioeconomic variable of interest. Table 4 presents the calibrated marginal WTP for the imported alternatives. Women are coded as 1 and mens as –

1, and the results indicate that females are willing to pay on average NOK 10.14 less for US hormone-treated beef than men. For each ten-year increase in age, the WTP for US hormone-treated beef decreases on average by NOK 3.21. *Income* has no effect on the WTP for imported beef, while *Education* has a negative effect for US hormone-treated beef. As expected, the variables *Travel* and *Urban* have positive effects for the imported alternatives, while *Farm* has a negative effect.

Extension to Unavailable Products

Swedish and Botswanan hormone-free beef were included in the survey but not in the auction. We used the estimated calibration function (9) to predict the WTP for these two alternatives based on the survey results. In the lower half of table 3, the calibrated mean WTP amounts for all regions for Swedish and Botswanan hormone-free beef are respectively NOK 9.95 and NOK 29.72 lower per kilogram than for domestic beef.

Given identical hormone effects for European and Botswanan beef as for US beef, we can predict the WTP for European and Botswanan hormone-treated beef. Using equation (2) and the calibration function (9), the WTP estimates for hormone-treated Norwegian, Swedish, Irish, and Botswanan beef are respectively NOK 33.80, NOK 35.12, NOK 37.81, and NOK 46.83 lower than for domestic hormone-free beef. The WTP for Norwegian and Swedish hormone-treated beef is lower than the WTP for hormone-free Botswanan beef but higher than the WTP for US and Irish hormone-treated beef.

Concluding Remarks

Experimental auctions and stated choice surveys have complementary strengths. We designed and implemented the SC-X method to calibrate the hypothetical WTP estimates from SC surveys with the WTP observed in auctions. The method combines the product

flexibility and sample representativity of SC surveys with the economic incentives of experimental auctions. The method can be used to extend the WTP estimates from an auction to product characteristics and socioeconomic groups not included in the auction. The flexibility regarding product characteristics makes the method useful for evaluating the market potential for new food products under development.

Footnotes

1. In April 2000, US$1 was approximately NOK 8.60.
2. The instructions are available at http://www.nlh.no/ios/Publikasjoner/d2001/d2001-06.pdf
3. The bids are multiplied by two to obtain the WTP per kilogram.

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Table 1. Variables Definitions and Summary Statistics

Variable	Definition	Survey National Mean[a]	Survey Region 1 Mean[b]	Auction Mean[c]
Gender	Gender of respondent	0.02	0.07	0.08
	Male = -1; Female = 1	(1.00)	(1.00)	(1.00)
Age	Age of respondent	-0.01	-0.24	0.05
	0.1*(Actual age – 44 years)	(1.82)	(1.60)	(1.29)
Income	Total income of household (14 levels)	0.24	1.56	2.18
	NOK 0 = -8 to NOK 600,000+ = 6	(3.49)	(3.58)	(3.02)
Education	Highest completed education	-0.04	0.07	0.23
	Elementary school = -1	(0.72)	(0.76)	(0.70)
	High school = 0			
	College/University = 1			
Urban	Population density/Urbanization	0.25	0.13	-0.28
	Rural area = -1	(0.81)	(0.47)	(0.45)
	Relatively densely populated area = 0			
	Urban area = 1			
Travel	Frequency of traveling abroad (4 levels)	0.03	0.72	1.33
	Never = -3 to Every month = 3	(1.91)	(1.90)	(1.63)
Farm	Raised on farm	0.27	0.16	0.20
	No = 0 and Yes = 1	(0.44)	(0.37)	(0.40)
*Region*1	Southeastern Norway	0.17	1.00	1.00
	No = 0 and Yes = 1	(0.38)	(0.00)	(0.00)
*Region*2	Oslo, capital of Norway	0.11		
	No = 0 and Yes = 1	(0.31)		
*Region*3	Eastern Norway	0.22		
	No = 0 and Yes = 1	(0.41)		
*Region*4	Southern and Western Norway	0.28		
	No = 0 and Yes = 1	(0.45)		
*Region*5	Central Norway	0.14		
	No = 0 and Yes = 1	(0.35)		
*Region*6	Northern Norway	0.08		
	No = 0 and Yes = 1	(0.27)		

[a] The sample means and standard deviations are based on the weighted sample used in the estimation. Standard deviations are given in parentheses.
[b] Means and standard deviations of the weighted Region 1 survey subsample.
[c] Means and standard deviations of the auction participants. The participants were drawn from four counties in Region 1.

Table 2. Survey and Auction Results for Imported Beef Relative to Domestic Beef

	Survey			Auction	
Variable	Parameter[a]	P value	HWTP[b,c]	WTP[c]	P value
Irish origin					
Country dummy (I)	-4.02	0.00	-66.98	-12.64	0.00
I × *Gender*	-1.55	0.00	-25.83	-1.64	0.24
I × *Age*	-0.94	0.00	-15.74	1.01	0.28
I × *Income*	-0.02	0.76	-0.41	-0.50	0.28
I × *Education*	0.34	0.32	5.58	3.27	0.10
I × *Urban*	0.69	0.03	11.54	0.10	0.97
I × *Travel*	0.48	0.00	8.01	0.96	0.24
I × *Farm*	-1.61	0.00	-26.79	-11.84	0.00
US origin					
Country dummy (US)	-4.00	0.00	-66.59	-17.22	0.00
US × *Gender*	-1.54	0.00	-25.61	-1.68	0.23
US × *Age*	-1.11	0.00	-18.45	0.31	0.78
US × *Income*	0.01	0.92	0.12	0.20	0.67
US × *Education*	0.53	0.08	8.89	-4.11	0.04
US × *Urban*	0.62	0.04	10.39	1.70	0.57
US × *Travel*	0.43	0.00	7.17	1.03	0.21
US × *Farm*	-1.27	0.03	-21.13	-9.15	0.01
Hormone dummy (H)	-19.48	0.00	-324.61	-22.30	0.00
H × *Gender*	-3.54	0.00	-58.94	-7.71	0.00
H × *Age*	-2.10	0.00	-34.99	1.60	0.31
H × *Income*	-0.10	0.62	-1.58	-0.27	0.68
H × *Education*	-2.69	0.00	-44.84	-5.50	0.05
H × *Urban*	-0.75	0.33	-12.56	-3.04	0.47
H × *Travel*	0.00	1.00	0.00	3.69	0.00
H × *Farm*	-1.68	0.34	-28.07	0.95	0.84
All imported (*AI*)					
AI × *Region*2	-0.46	0.43	-7.58		
AI × *Region*3	-2.38	0.00	-39.68		
AI × *Region*4	-1.62	0.00	-26.92		
AI × *Region*5	-2.90	0.00	-48.36		
AI × *Region*6	-3.43	0.00	-57.21		
Generic					
Price	-0.060	0.00			

[a] The complete list of mixed logit parameters is available from the authors.

[b] The hypothetical survey willingness to pay is the survey parameters multiplied by -1 and divided by the price parameter, $\hat{\beta}_{Price}$ = -0.060.

[c] All willingness to pay estimates are given in NOK.

Table 3. Average WTP for Imported Beef Compared to Domestic Beef

	Hormone free				Hormone treated
Region	Sweden	Ireland	US	Botswana	US
	Survey HWTP[a]				
Region 1[b]	-5.45	-60.46	-58.18	-154.88	-386.55
Region 2	-10.01	-52.54	-53.52	-139.24	-392.99
Region 3	-57.76	-115.67	-114.85	-211.28	-457.44
Region 4	-42.03	-99.72	-97.72	-193.77	-428.60
Region 5	-67.37	-130.78	-128.38	-229.92	-461.22
Region 6	-87.74	-158.74	-156.62	-263.01	-503.47
All regions	-42.80	-100.32	-98.77	-195.51	-434.16
	Auction WTP[c]				
Region 1	NA	-14.16	-18.75	NA	-37.56
	Calibrated SC-X WTP[d]				
Region 1[e]	-1.41	-13.34	-12.93	-25.72	-35.46
Region 2	-2.56	-11.87	-12.06	-24.25	-35.71
Region 3	-12.85	-21.64	-21.54	-29.61	-39.30
Region 4	-9.79	-19.57	-19.30	-28.61	-37.43
Region 5	-14.57	-23.37	-23.11	-30.51	-39.59
Region 6	-17.85	-26.06	-25.87	-31.78	-43.50
All regions	-9.95	-19.66	-19.44	-28.72	-37.75

SC-X calibration function:

$$WTP_{nit}^{A} = 0.263 * \widehat{HWTP}_{nit}^{A} + 0.749 * (\widehat{HWTP}_{nit}^{A})^2 / 10^3 + 0.790 * (\widehat{HWTP}_{nit}^{A})^3 / 10^6 \,.$$ [f]

[a] The results are the predicted hypothetical WTP for the average respondent.
[b] Using the socioeconomic variables from the auction gives the following hypothetical WTP results for Region 1: -4.84, -67.52, -65.03, -171.67, and -412.19 respectively.
[c] The average WTP found in the auction.
[d] The SC-X WTP is found by using the hypothetical survey WTP in the SC-X calibration function.
[e] Using the socioeconomic variables from the auction gives the following calibrated SC-X WTP results for Region 1: -1.26, -14.59, -14.16, -27.10, and -36.56 respectively.
[f] Corresponding *p* values of the parameter estimates are: 0.00, 0.00, and 0.01.

Table 4. Calibrated Marginal WTP for Imported Beef Relative to Domestic Beef[a]

	Hormone free				Hormone treated
Variable	Sweden	Ireland	US	Botswana	US
National mean	-9.95	-19.66	-19.44	-28.72	-37.75
Gender	-2.24*	-3.62*	-3.59*	-2.35*	-5.07*
Age	-1.99*	-2.20*	-2.59*	-1.47*	-3.21*
Income	0.00	-0.06	0.02	0.08	-0.09
Education	1.45*	0.78	1.24	0.88	-2.16*
Urban	-0.13	1.61*	1.45*	1.70*	-0.13
Travel	1.20*	1.12*	1.00*	0.30	0.43
Farm	-2.70*	-3.75*	-2.96*	-1.05	-2.95*
Slope[b]	0.20	0.14	0.14	0.06	0.06

*The corresponding mixed logit parameters are significant at the 5% level of significance.
[a]The calibrated marginal effects are the marginal effects of the socioeconomic variables on the hypothetical survey WTP (as reported in table 2) multiplied by the slope of the calibration function at the national mean.
[b]Slope of calibration function at national mean.

Paper 4

Combining Stated Choice and Experimental Auction Data

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Abstract: This paper proposes a practical method for combining experimental auction data with stated choice data. Norwegian consumers' preferences for country of origin and hormone status of beef are used in an empirical illustration of the method. Willingness to pay observed in an experimental auction is used to simulate a choice experiment. The simulated choice data is pooled with data from a stated choice experiment, and a joint logit model for the two data sets is estimated. The survey results are largely confirmed by the experimental auction, however, price sensitivity differs significantly between the two data sets.

Key words: beef, experimental auctions, simulated choice, stated choice, willingness to pay

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Combining Stated Choice and Experimental Auction Data

Stated choice (SC) methods are used to investigate consumers' preferences for product attributes with little or no variation in the market place. Consumers are presented with hypothetical products described by their attributes, and asked to choose their preferred alternative. From the stated choices, researchers estimate the value consumers assign to individual product attributes. Recent examples of SC studies in agricultural marketing are Lusk, Roosen, and Fox (2003) who compared preferences for hormone-treated and GMO fed beef across countries; Burton *et al*. (2001) who investigated the demand for GMO food; Blend and van Ravenswaay (1999) who studied the demand for ecolabeled food; and Unterschultz *et al*. (1998) who analyzed preferences for country-of-origin for beef.

Stated preference (SP) methods, including SC, are very flexible with respect to product attributes, and can capture a wider array of preference-driven behavior than revealed market methods. However, SP methods are hypothetical, and cannot take all real market constraints into account. As a result, choice models based solely on SP data may not predict well in existing markets (Louviere, Hensher, and Swait, 2000, ch. 8). Several methods for utilizing the strengths and alleviating the weaknesses of SP methods have been suggested. In the late 1980's procedures for combining stated and revealed preference data were developed, and are now widely applied in marketing, transportation, and environmental economics (Ben-Akiva et al., 2002). Typically, revealed choice and SC data are pooled, and a joint logit model for the pooled data is estimated (Swait and Louviere, 1993; Hensher and Bradley, 1993; Hensher, Louviere and Swait, 1999; Brownstone, Bunch and Train, 2000; Morikawa, Ben-Akiwa and McFadden, 2002). The resulting choice models combine the real market information in the revealed data, with the flexibility of the SP method.

The best documented weaknesses of SP methods is the hypothetical bias in willingness to pay (WTP) estimates; i.e., consumers are more willing to use money in hypothetical

settings than they are when facing real choices between money and goods – see List and Gallett (2001), List (2001), List and Shogren (2002), Harrison and Rutström (forthcoming), and Shogren (forthcoming). Unfortunately, price parameters and WTP may be difficult to identify from market data, due to lack of variance in the prices. Blackburn, Harrison, and Rutström (1994), Fox *et al*. (1998), and Alfnes and Rickertsen (2002) combine SP methods and experimental auctions to alleviate the hypothetical bias problem in WTP studies. Blackburn, Harrison, and Rutström (1994) investigated the potential hypothetical bias in answering discrete choice (take it or leave it offers). They estimated a statistical "bias function" to examine whether the hypothetical bias (accepting the offer in a hypothetical case, but rejecting the same offer in a real case) for a particular good in one sample of subjects is transferable to a different good in another sample of subjects. Fox *et al*. (1998) conducted a large survey with open-ended WTP questions. Some of the survey respondents later participated in an experimental auction for the same goods, and their bids were used to estimate a calibration function between the stated and the revealed WTP. Finally, Alfnes and Rickertsen (2002) conducted a large SC survey, and used an experimental auction on another sample to calibrate the WTP values predicted by the estimated logit model.

In this paper, we show how experimental auctions data can be incorporated into the general random utility framework used to combine SC and revealed choice data. Norwegian consumers' preferences for imported and hormone-treated beef are used in an empirical illustration. Due to high import tariffs, no market data exists. Therefore, an SC survey, and an experimental auction were conducted. The experimental auction data was transformed to choice data by simulating a choice experiment. The simulated choice (SIM) data was pooled together with the SC data and a joint logit model was estimated using the two data sets. The estimation results for the SIM data and the pooled data are compared with the estimation

results for each of the original data sets. Finally, WTP values are estimated using five different models.

Stated Choice Survey

In April 2000, we conducted an SC survey and an experimental auction to study Norwegian consumers' preferences for country-of-origin, and hormone status for beef. ACNielsen conducted 1066 home interviews of persons that were 15 years or older, and the weighted survey sample was representative of the Norwegian population. The variable definitions and summary statistics for survey and auction samples are presented in table 1.

An SC experiment was completed as part of the survey. The participants were told that hormone-treated beef, and beef produced abroad, were likely to become available in the domestic market. Each participant was presented four choice sets, with three alternatives in each set. Domestic, hormone-free rib-eye steak costing NOK 99 per kilogram was included in all four choice sets. The remaining two alternatives in each choice set were imported rib-eye steaks with various combinations of country-of-origin, hormone status, and price. The participants were asked to choose their preferred alternative in each set. Next, they were asked to choose their preferred alternative, given that their first choice was unavailable. Hormone-free beef from Norway, Sweden, Ireland, Botswana, and the US, as well as hormone-treated beef from the US were included in the survey. The survey is described in greater detail in Alfnes (2002).

Experimental Auction

A representative sample of the population in four counties south of Oslo were recruited by ACNielsen to take part in the experimental auction. The participants claimed to eat beef at least occasionally, and they were paid NOK 300 (≈US$35) to take part in the experiment. We

conducted ten sessions with a total of 106 participants at the Agricultural University of Norway.

We generally followed the experimental design used in Shogren *et al*. (1994); however, we ran four simultaneous auctions. The participants were asked to bid on four rib-eye steaks in sealed-bid second-price auctions. We ran trials with candy bars to demonstrate the auction mechanism, and used multiple trials to allow the participants to refine their bids to reflect their valuations more accurately. To avoid income effects, one trial was randomly selected as binding.

The participants bid simultaneously on hormone-free Norwegian, hormone-free Irish, hormone-free US, and hormone-treated US rib-eye steak. To avoid substitution effects, we imposed a winning restriction. If a participant was the highest bidder for more than one alternative, he or she could choose which alternative to buy, and the remaining alternative went to the second highest bidder. The experimental auctions are described in greater detail in Alfnes and Rickertsen (2003).

Generating Simulated Choice Data from the Auction Data

One hundred choice sets with Norwegian, Irish, US hormone-free, and US hormone-treated beef were generated for each participant. The prices were generated with a random number generator. The four price variables were distributed normally with a standard deviation of 20, and means equal to the mean WTPs found in the auction, or formally:

$$(1) \qquad P_i \sim N\left(\overline{WTP}_i, 20\right)$$

where P_i is the randomly generated price of alternative *i*, and $\overline{WTP}_i$ is the mean WTP for alternative *i* in the auction.

The dependent choice variable was created by assigning a value of 1 to the alternative with the highest consumer surplus, defined as WTP minus price; and a value of 0 to the other

three alternatives. Using the mean WTP for each alternative as the mean of the random price gave a balanced choice experiment, with equal choice probability for the four alternatives (25%, 24%, 23%, and 28%).

Econometric Modeling

In logit models, the scale of the parameters is inversely related to the variance of the residuals, and only the relative size of the parameters has economic interpretation. To efficiently estimate a joint logit model for two or more data sets, the magnitude of the parameters must be similar. This is obtained by rescaling all the data sets to maximize the likelihood of the joint model. The pooled SC and SIM data is analyzed using a joint logit model with source specific scale factors. For identification, the scale of the SC data is normalized to one. Formally, the joint logit model is specified as follows:

$$
\begin{aligned}
U_{nit}^{Joint} &= U_{nit}^{SC} + \sigma U_{nit}^{SIM} \\
U_{nit}^{SC} &= V_i^{SC}(x_{ni}^{SC}) + \varepsilon_{nit}^{SC} \\
U_{nit}^{SIM} &= V_i^{SIM}(x_{ni}^{SIM}) + \varepsilon_{nit}^{SIM} \\
\sigma^2 &= Var(\varepsilon_{nit}^{SC}) / Var(\varepsilon_{nit}^{SIM})
\end{aligned} \tag{2}
$$

where U_{nit}^{k} is the utility of participant *n* from alternative *i* in choice *t* in data set *k*, σ is a scaling parameter, $V_i^k(x)$ is a non-stochastic component of the utility containing alternative-specific constants, price variable, and socioeconomic characteristics; and ε_{nit}^{k} is an error term that is independently and identically extreme value distributed in data set *k*. The socioeconomic variables are included to show how the preferences are distributed within the population, and provide a straightforward way of accounting for the socioeconomic differences between the samples (Morrison et al., 2002).

Various estimation approaches for this joint logit model have been used in the literature. The "low-tech" solution is to rescale the SC data, so that the magnitude of the key

coefficients is similar before fitting a multinomial logit model on the joint data. Swait and Louviere (1993) refined this approach and conducted an iterative rescaling of the SP data until the joint likelihood was maximized. Hensher and Bradley (1993) used a nested logit model to identify the relative scale factors simultaneously with the other model parameters. They constructed an artificial tree structure with each data source represented by a branch in the tree. The estimated inclusive values of the branches in the nested logit model represent the relative scale factors. For identification, one inclusive value is fixed to one. This latter full information maximum likelihood approach is today the conventional method for estimating joint logit model with source specific scaling factors (e.g., Lusk, Roosen and Fox, 2003), and used in this paper. For an illustrative discussion of this nested logit approach, see chapter 8 in Louviere, Hensher, and Swait (2000).

The non-stochastic component of the utility function, $V(x)$, is specified as:

$$
\begin{aligned}
(3) \qquad V_i^k(x_{ni}) = {} & \beta_{0i}^k + \beta_{Price}^k Price_{nit} + \beta_{1i}^k Gender_n + \beta_{2i}^k Age_n + \beta_{3i}^k Income_n + \beta_{4i}^k Education_n \\
& + \beta_{5i}^k Urban_n + \beta_{6i}^k Travel_n + \beta_{7i}^k Farm_n + \beta_{8i}^k Region2_n + \beta_{9i}^k Region3_n \\
& + \beta_{10i}^k Region4_n + \beta_{11i}^k Region5_n + \beta_{12i}^k Region6_n
\end{aligned}
$$

where k indicate the data source, SC or SIM; β_{0i} is the alternative-specific constant for alternative i; $Price_{nit}$ is the price of alternative i; *Gender*, *Age*, *Income*, *Education*, *Urban*, *Travel*, *Farm, Region*2, *Region*3, *Region*4, *Region*5 and *Region*6 are the socioeconomic variables defined in table 1; the β_{1i} to β_{12i} represent the alternative-specific marginal effects on the utility from a change in the associated socioeconomic variables; and ε_{nit} is the error term. The five regional parameters, β_{8i} to β_{12i}, are the same for all five imported alternatives (e.g., $\beta_{8i} = \beta_{8j}$). For identification, Region1, Southeast Norway, is used as the reference region, and all domestic-specific parameters are normalized to zero. In the joint logit models estimated in this paper, we assume parameter equality between sources except for the price, were we estimate source specific parameters, $\beta_{Price}^{SC} \neq \beta_{Price}^{SIM}$.

A corresponding money metric utility function is estimated for the original auction data. The function relates the WTP differences found in the auction to the alternatives and the socioeconomic characteristics of the participants:

$$WTP_{ni}(x_{ni}) = \gamma_{0i} + \gamma_{1i}Gender_n + \gamma_{2i}Age_n + \gamma_{3i}Income_n + \gamma_{4i}Education_n + \gamma_{5i}Urban_n + \gamma_{6i}Travel_n + \gamma_{7i}Farm_n + \varepsilon_{ni}\ , \quad (4)$$

where WTP_{ni} is the premium participant *n* is willing to pay for one kilogram of alternative *i,* compared with one kilogram of Norwegian beef*;* γ_{0i} is the alternative-specific constant for alternative *i*; *Gender*, *Age*, *Income*, *Education*, *Urban*, *Travel*, and *Farm* are as defined above; the γ_{1i} to γ_{7i} are the alternative-specific marginal effects on WTP from changes in the associated socioeconomic variables; and ε_{ni} is the error term.

Results

Table 2 shows the estimation results of four logit models, and table 3 shows the willingness to pay estimates obtained from the logit models and from the original auction data. The first model is a standard multinomial logit model for the SC data. The alternatives have the expected ranking and all significant socioeconomic parameters have the expected sign. Domestic beef was preferred to imported beef, beef from neighboring countries (with similar culture and beliefs) were preferred to beef from more distant countries. Beef from developed countries were preferred to beef from less developed countries, and hormone-free beef was preferred to hormone-treated beef. Women, elderly people, people seldom traveling abroad, people living in rural areas, and people raised on farms were most reluctant to choose imported beef. Furthermore, it is worth noting that participants in the region where the experimental auction was conducted, Region1, were more positive towards imported beef than participants in other regions. This positive attitude is probably a result of Region1 consumers' easy access to relatively low-priced foreign beef in Sweden.

In the second and third model, we combine two data sources by pooling them under the assumption of equal taste parameters but unequal variance between the data sources. In both models, the price parameter is the only taste parameter allowed to vary between the data sources. In model 2, each SIM observation is weighted one-tenth of the weight used for the SC observations. As a result, the relative weight of the two data sets corresponds to the relative size of the two samples. In model 3, the weights of the two data sets are equal. All significant parameters in model 1 have the same sign in model 2 and 3, and as expected the parameter estimates in model 2 is least affected by the SIM data. From the scale parameters of the SIM data, we can see that the variance of the SIM data is larger in model 2 than in model 3. This is expected since the SIM data has less weight in the estimation in model 2 than in model 3.

The fourth model is a standard multinomial logit model for the SIM data and the fifth model is the ordinary least square model for the original auction data. Norwegian, Irish, and US beef were included in the auction, and only consumers from Region1 participated. Parameters for the Swedish and Botswanan beef and for Region2 to Region6 are, therefore, not estimated. The ranking of the alternatives are the same in model 4 and 5 as in the SC model, but several of the socioeconomic parameters have opposite signs. However, all parameters that are significant in the original auction data have the expected sign in both model 4 and 5.

The price parameter of the survey data is one tenth of the price parameter from the SIM data. This results in WTP estimates from the survey that is ten times larger than the results from the auction. In the estimation of the WTP from the combined models, the SIM price parameter is used. The magnitude of the WTP estimates from the joint model is in line with the magnitude of the WTP observed in the auction.

There are two special cases of the joint model worth noting. The first case is the pure calibration of the survey values. As illustrated with model 2, giving little weight to the SIM data in the joint logit estimation returns parameter estimates for all common parameters that are close to the original SC parameters. However, in addition to the SC parameters, the joint models also include the SIM price parameter, which can be used to estimate non-hypothetical WTP results. The second case is the pure enriching of the auction data. Giving a low weight to the SC data returns estimation results that are close to the auction results. However, in addition to the parameters estimated from the auction data the joint model also include product and socioeconomic variables with little or no variation in the auction model.

Conclusions

Joint logit estimation provides a method for utilizing the strengths and alleviating the weaknesses of the SP and revealed market data. However, neither SP nor reveled market data gives good price sensitivity estimates. SP data is flawed with the well-documented hypothetical bias, and the market price often displays too little variance. In this paper, we have shown how experimental auction data can be used to obtain a non-hypothetical price parameter in the joint logit framework. The non-hypothetical price parameter can be used to predict price effects in existing markets, or to predict WTP for new or hypothetical products.

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Table 1. Variables Definitions and Summary Statistics

Variable	Definition	Survey National Mean[a]	Survey Region 1 Mean[b]	Auction Mean[c]
Gender	Gender of respondent	0.02	0.07	0.08
	Male = -1; Female = 1	(1.00)	(1.00)	(1.00)
Age	Age of respondent	-0.01	-0.24	0.05
	0.1*(Actual age – 44 years)	(1.82)	(1.60)	(1.29)
Income	Total income of household (14 levels)	0.24	1.56	2.18
	NOK 0 = -8 to NOK 600,000+ = 6	(3.49)	(3.58)	(3.02)
Education	Highest completed education	-0.04	0.07	0.23
	Elementary school = -1	(0.72)	(0.76)	(0.70)
	High school = 0			
	College/University = 1			
Urban	Population density/Urbanization	0.25	0.13	-0.28
	Rural area = -1	(0.81)	(0.47)	(0.45)
	Relatively densely populated area = 0			
	Urban area = 1			
Travel	Frequency of traveling abroad (4 levels)	0.03	0.72	1.33
	Never = -3 to Every month = 3	(1.91)	(1.90)	(1.63)
Farm	Raised on farm	0.27	0.16	0.20
	No = 0 and Yes = 1	(0.44)	(0.37)	(0.40)
*Region*1	Southeastern Norway	0.17	1.00	1.00
	No = 0 and Yes = 1	(0.38)	(0.00)	(0.00)
*Region*2	Oslo, capital of Norway	0.11		
	No = 0 and Yes = 1	(0.31)		
*Region*3	Eastern Norway	0.22		
	No = 0 and Yes = 1	(0.41)		
*Region*4	Southern and Western Norway	0.28		
	No = 0 and Yes = 1	(0.45)		
*Region*5	Central Norway	0.14		
	No = 0 and Yes = 1	(0.35)		
*Region*6	Northern Norway	0.08		
	No = 0 and Yes = 1	(0.27)		

[a] The sample means and standard deviations are based on the weighted sample used in the estimation. Standard deviations are given in parentheses.
[b] Means and standard deviations of the weighted Region1 survey subsample.
[c] Means and standard deviations of the auction participants. The participants were drawn from four counties in Region1.

Table 2. Results of Logit Estimation

Variable	Model 1 (SC) Parameter[a]	Model 2 (SC+SIM) Parameter	Model 3 (SC+SIM) Parameter	Model 4 (SIM) Parameter
Weight in estimation				
Survey	1.00	1.00	1.00	0.00
Simulation	0.00	0.10	1.00	1.00
Generic				
Price survey	-0.01 (0.00)	-0.01	-0.01	
Price simulation		-0.08	-0.07	-0.06(0.00)
Scale survey	1.00 (0.00)	1.00	1.00	
Scale simulation		0.83	1.06	1.06(0.00)
All imported				
*Region*2	-0.71 (0.11)	-0.59	-0.41	
*Region*3	-1.08 (0.10)	-0.95	-0.75	
*Region*4	-0.82 (0.09)	-0.68	-0.47	
*Region*5	-0.77 (0.11)	-0.63	-0.41	
*Region*6	-0.98 (0.14)	-0.84	-0.63	
Swedish hormone-free beef				
ASC (*S*)	0.66 (0.09)	0.47	0.26	
S×*Gender*	-0.12 (0.04)	-0.12	-0.06	
S×*Age*	-0.13 (0.02)	-0.13	-0.09	
S×*Income*	0.00 (0.01)	0.00	0.00	
S×*Education*	0.13 (0.05)	0.12	0.07	
S×*Urban*	0.13 (0.05)	0.14	0.18	
S×*Travel*	0.10 (0.02)	0.10	0.08	
S×*Farm*	-0.27 (0.10)	-0.29	-0.35	
Irish hormone-free beef				
ASC (*I*)	-0.19 (0.06)	-0.41	-0.61	-0.60 (0.06)
I×*Gender*	-0.28 (0.05)	-0.27	-0.14	0.04 (0.04)
I×*Age*	-0.16 (0.03)	-0.17	-0.11	0.08 (0.03)
I×*Income*	0.00 (0.01)	0.00	0.00	0.01 (0.01)
I×*Education*	0.08 (0.07)	0.10	0.09	0.14 (0.06)
I×*Urban*	0.31 (0.07)	0.34	0.43	0.58 (0.08)
I×*Travel*	0.12 (0.03)	0.11	0.08	0.05 (0.02)
I×*Farm*	-0.43 (0.11)	-0.46	-0.58	-0.65 (0.09)
US hormone-free beef				
ASC (*U*)	-0.33 (0.11)	-0.61	-0.94	-1.04 (0.07)
U×*Gender*	-0.34 (0.05)	-0.34	-0.21	-0.03 (0.04)
U×*Age*	-0.25 (0.03)	-0.24	-0.15	0.02 (0.03)
U×*Income*	0.00 (0.01)	0.00	0.01	0.03 (0.01)
U×*Education*	0.15 (0.07)	0.07	-0.15	-0.16 (0.06)

U×Urban	0.38 (0.07)	0.45	0.55	0.53 (0.08)
U×Travel	0.13 (0.03)	0.12	0.06	0.03 (0.02)
U×Farm	-0.44 (0.12)	-0.48	-0.57	-0.64 (0.09)
Botswana hormone-free beef				
ASC (*B*)	-1.17 (0.13)	-1.42	-1.63	
B×Gender	-0.38 (0.06)	-0.37	-0.29	
B×Age	-0.16 (0.04)	-0.16	-0.12	
B×Income	0.00 (0.01)	0.00	0.00	
B×Education	0.31 (0.09)	0.32	0.31	
B×Urban	0.53 (0.09)	0.55	0.59	
B×Travel	0.10 (0.03)	0.10	0.08	
B×Farm	-0.38 (0.16)	-0.40	-0.50	
US hormone-treated beef				
ASC (*H*)	-2.37 (0.17)	-2.54	-2.48	-2.30 (0.07)
H×Gender	-0.64 (0.10)	-0.68	-0.57	-0.42 (0.04)
H×Age	-0.47 (0.06)	-0.34	-0.03	0.17 (0.03)
H×Income	-0.01 (0.01)	-0.01	0.01	0.02 (0.01)
H×Education	-0.17 (0.13)	-0.30	-0.46	-0.43 (0.06)
H×Urban	0.21 (0.12)	0.15	0.00	0.06 (0.08)
H×Travel	0.13 (0.05)	0.21	0.27	0.24 (0.02)
H×Farm	-0.56 (0.24)	-0.83	-1.08	-1.08 (0.09)

Note: Estimated with Limdep 8.0/Nlogit 3.0.
[a]Standard errors in parentheses.

Table 3. Willingness to Pay for Imported Beef Relative to Domestic Beef (in NOK)

Variable	Model 1 (SC)	Model 2 (SC+SIM)	Model 3 (SC+SIM)	Model 4 (SIM)	Model 5 (Auction)
		Region1 WTP mean[a]			
Swedish hormone-free beef	94.40	5.24	2.08		
Irish hormone-free beef	-30.39	-5.83	-12.06	-12.45	-10.54*
US hormone-free beef	-46.64	-8.25	-15.25	-20.30	-17.50*
Botswana hormone-free beef	-164.13	-18.03	-23.43		
US hormone-treated beef	-332.19	-30.97	-36.88	-37.09	-39.39*
		National WTP mean[b]			
Swedish hormone-free beef	-15.99	-2.38	-3.50		
Irish hormone-free beef	-128.46	-13.05	-16.35		
US hormone-free beef	-145.46	-15.29	-20.45		
Botswana hormone-free beef	-251.58	-24.79	-30.61		
US hormone-treated beef	-425.68	-40.74	-46.95		
		Marginal effects[c]			
Swedish hormone-free beef					
Gender	-19.46	-1.43	-0.90		
Age	-21.23	-1.57	-1.38		
Income	-0.08	0.00	0.04		
Education	21.12	1.45	1.10		
Urban	20.33	1.77	2.60		
Travel	15.74	1.17	1.18		
Farm	-43.88	-3.54	-5.08		
Irish hormone-free beef					
Gender	-45.84	-3.27	-2.01	0.70	0.72
Age	-26.54	-2.05	-1.54	1.27	1.22
Income	-0.08	-0.03	0.01	0.13	-0.06
Education	12.96	1.20	1.34	2.28	4.07
Urban	50.53	4.15	6.28	9.40	6.57
Travel	18.97	1.35	1.18	0.52	0.79
Farm	-68.78	-5.56	-8.57	-10.56	-11.97*
US hormone-free beef					
Gender	-54.23	-4.11	-3.04	0.70	0.37
Age	-40.35	-2.93	-2.25	0.39	0.43
Income	0.63	0.05	0.18	0.43	0.30
Education	23.79	0.87	-2.15	-2.60	-2.13
Urban	60.85	5.44	8.06	8.53	3.98
Travel	21.05	1.44	0.93	0.52	1.19
Farm	-70.68	-5.84	-8.40	-10.29	-14.05*
Botswanan hormone-free beef					
Gender	-60.84	-4.50	-4.27		
Age	26.09	-1.99	-1.82		
Income	-0.27	-0.01	0.02		
Education	50.00	3.92	4.57		
Urban	85.72	6.66	8.68		
Travel	16.58	1.22	1.22		

Farm	-60.66	-4.93	-7.39		
US hormone-treated beef					
Gender	-102.98	-8.26	-8.39	-6.85	-6.80*
Age	-75.79	-4.20	-0.48	2.70	2.75
Income	-1.25	-0.08	0.15	0.31	0.26
Education	-27.44	-3.68	-6.83	-6.99	-7.71*
Urban	34.37	1.85	0.04	0.94	-1.06
Travel	21.47	2.62	4.02	3.91	5.52*
Farm	-89.91	-10.14	-15.85	-17.49	-16.24*
All imported					
*Region*2	-94.52	-7.25	-6.05		
*Region*3	-143.47	-11.56	-11.00		
*Region*4	-108.89	-8.32	-6.87		
*Region*5	-102.90	-7.67	-5.95		
*Region*6	-130.10	-10.21	-9.26		

Note: * indicates p<0.5 for the auction ordinary least square parameters.
[a]Calculated with the mean socioeconomic variables for the auction, as reported in table 1.
[b]Calculated with the mean socioeconomic variables for the survey, as reported in table 1.
[c]The marginal willingness to pay values estimated from the logit models is the individual parameters divided by the price parameter. In the two combined models, the *Price simulation* variable is used in the WTP calculations.

Appendix A

Instructions to the Participants (translated from Norwegian)

(We presented the instructions and gave a paper copy to each participant. We used two sets of instructions. In the first set, presented below, we used 250 grams of U.S. hormone-treated beef as base product. In the second set we used 250 grams of Norwegian beef as base product. Otherwise, the instructions were identical.)

You are about to participate in a market experiment about beef. Please follow the instructions carefully. The experiment consists of two stages and lasts approximately one and a half hours.

In stage one we ask you how much you are willing to pay to exchange one candy bar with other brands of candy bar. In stage two we ask you how much you are willing to pay to exchange one variety of beef with other varieties of beef.

After the experiment you have to fill in a questionnaire.

Please, do not fill in any of the papers before you are asked to do so.

You receive NOK 300, a candy bar, and a packet of rib-eye steak for participating in this experiment. You must pay for any product you choose to purchase, so your take-home income consists of NOK 300 minus the price paid for any products purchased.

Please pay attention to the monitor and do not hesitate to ask any questions about the instructions.

Instructions Stage One

This stage is designed to familiarize you with the procedure we use.

Step 1: You own the Milky Way candy bar in front of you.

Step 2: There are four other varieties of candy bar available:

1. Snickers
2. Bounty
3. Stratos
4. Firkløver

We want you to write down the highest amount that you are willing to pay to exchange your Milky Way with each of the four candy bars. You should only state what you are willing to pay to exchange your Milky Way with each of the other four candy bars. Think carefully about it, and circle the highest amount you are willing to pay for an exchange.

Step 3: The person stating the highest amount for each of the four alternative candy bars must exchange his or her Milky Way with the candy bar he or she is the highest bidder for. The person must pay a price equal to the second highest bid.

Step 4: There will be three trials. After each trial, the price for each variety and the identification number of the buyers will be written on the whiteboard.

Step 5: Only one trial is binding. After the three trials a random number between one and three will be drawn to determine which trial is binding. For each of the four candy bars, the highest bidder will exchange his or her Milky Way with the candy bar for which he or she was the highest bidder. The price equals the second highest bid for the respective candy bar in the binding trial.

Example:

Suppose that one participant thinks the Snickers is worth NOK 8 and the Milky Way is worth NOK 5. The Snickers is therefore worth NOK 3 more than the Milky Way to that participant. If the price is less than NOK 3, he or she wants to exchange the Milky Way with the Snickers. If the price is higher than NOK 3 he or she does not want to exchange the Milky Way with the Snickers. The participant should therefore indicate a willingness to pay NOK 3 to exchange the Milky Way with the Snickers.

If the price is less than NOK 3, the he or she exchanges the Milky Way with the Snickers, and if the price is higher he or she does not.

Suppose that after we have completed all three trials the second trial is randomly selected as the binding trial. If the highest amount anyone is willing to pay to exchange to the Snickers in the second trial is NOK 5 and the second highest amount is NOK 4, then the highest bidder will exchange his or her Milky Way with the Snickers and pay NOK 4.

The best action for everyone is to state the highest amount you are willing to pay to exchange the Milky Way for each of the four candy bars. If the price is below the amount you stated, you change. If the price is above, you do not exchange.

Note: Since you only own one Milky Way you are only allowed to exchange to one of the other candy bars. If one of you is the highest bidder for several candy bars, he or she can choose among those candy bars. The candy bars not chosen will go to the second highest bidder for a price equal to the third highest bid.

Note: In the event that there is a tie for the highest bid for one of the candy bars, we will decide who will exchange by a coin toss.

Note: It is in your best interest to bid the maximum amount that you are truly willing to pay to exchange your Milky Way candy bar for each of the other candy bars. If you bid more than you think the exchange is worth, you increase your chances of purchasing one of the other candy bars, but you may have to pay a price that is higher than you think the exchange is worth. On the other hand, if you bid less than you think the exchange is worth, you may lose the chance to purchase one of the other candy bars, even though the price may be lower than that you would be willing to pay.

Instructions Stage Two

We have four types of rib-eye steak available: Norwegian, Irish, U.S., and U.S. from cattle that have been given growth-promoting hormones. All four are frozen. The Norwegian rib-eye steak is from a local grocery store. The other products are imported from leading exporters of beef in Ireland and the U.S. The beef is imported vacuum packed and frozen, and is cut and repacked in Norway.

The exporters are approved for export to Norway. We are registered beef importers by the Norwegian Food Control Authority. We have followed the normal reporting and control procedures for the import of beef.

The Norwegian Food Control Authority has given us permission to import rib-eye steak from cattle that have been given growth-promoting hormones and states that: "Investigations so far indicate that consuming hormone-treated meat produced in accordance with stipulated guidelines does not represent any hazard to health."

In the U.S., beef producers have used growth-promoting hormones for 30 years. Today 80% of all cattle are treated with growth hormones to enhance growth and tenderize the meat. Only hormones naturally produced by the animal are used. For the beef to have natural levels of hormones at the time of slaughter, farmers are not allowed to use hormones within 90 days of slaughter.

Step 1: You own a 250-gram package of U.S. rib-eye steak from cattle treated with hormones.

Step 2: There are four other packages of rib-eye steak available:

1. 500 grams of Norwegian rib-eye steak not treated with hormones.
2. 500 grams of Irish rib-eye steak not treated with hormones.
3. 500 grams of US rib-eye steak not treated with hormones.
4. 500 grams of US rib-eye steak treated with hormones.

We will use the same procedure as in stage one to decide who will exchange to the other varieties of rib-eye steak. We want you to write down the highest amount you are willing to pay to exchange your 250-gram package of rib-eye steak with each of the four 500-gram packages of rib-eye steak. Please write on the bidding scheme the highest amount that you are willing to pay to exchange your 250-gram package for each of the four alternatives.

Step 3: The person stating the highest amount for each of the four alternatives must exchange his or her package of rib-eye steak with the 500-gram package for which he or she is the highest bidder. The person must pay a price equal to the second highest bid.

Step 4: There will be six trials. After each trial, the price for each alternative and the identification number of the buyers will be written on the whiteboard.

Step 5: After three trials, you will be allowed to taste the products.

Step 6: Only one trial is binding. After the six trials a random number between one and six will be drawn to determine which trial is binding. For each of the four alternatives, the highest bidder will exchange his or her 250 grams of rib-eye steak with the 500 grams of rib-eye steak for which he or she was the highest bidder. The price equals the second highest bid for the respective variety of rib-eye steak in the binding trial.

Example:

Suppose that after we have completed all six trials the second trial is randomly selected as the binding trial. If the highest amount anyone is willing to pay to exchange to 500 grams of Irish rib-eye steak in the second trial is NOK 40 and the second highest amount is NOK 30, then the highest bidder will exchange his or her 250 grams of rib-eye steak with the 500 grams of Irish rib-eye steak and pay NOK 30.

Note: Since you only own one 250-gram package of rib-eye steak you are only allowed to exchange to one of the 500-gram packages of beef. If one of you is the highest bidder for several packages, he or she can choose among those packages. The packages not chosen will go to the second highest bidder for a price equal to the third highest bid.

Note: In the event that there is a tie for the highest bid for one of the packages, we will decide who will exchange by a coin toss.

Note: It is in your best interest to bid the maximum amount that you are truly willing to pay to exchange your 250 grams of rib-eye steak for each of the other 500-gram packages. If you bid more than you think the exchange is worth, you increase your chances of purchasing one of the 500-gram packages of rib-eye steak, but you may have to pay a price that is higher than what you think the exchange is worth. On the other hand, if you bid less than you think the exchange is worth, you may lose the chance to purchase one of the other packages of rib-eye steak, even though the price may be lower than that you would be willing to pay.

Appendix B

SPØRRESKJEMA Ordrenr.: /AK

ACNIELSEN NORGE AS
2000- APRIL

Vi vil gjerne stille deg noen spørsmål om middags-måltider, og spesielt om kjøtt.

(1a) Hvor ofte spiser du vanligvis middag hjemme?

FEM ELLER FLERE GANGER I UKA 1
TRE TIL FIRE GANGER I UKA 2
EN TIL TO GANGER I UKA 3
MINDRE ENN EN GANG I UKA 4
SJELDENERE 5
ALDRI 6

(1b) Hvor ofte spiser du kjøtt eller kjøttretter til middag?

FEM ELLER FLERE GANGER I UKA 1
TRE TIL FIRE GANGER I UKA 2
EN TIL TO GANGER I UKA 3
MINDRE ENN EN GANG I UKA 4
SJELDEN ELLER ALDRI 5

(2) Hvor ofte spiser du biff av storfe til middag hjemme ?

EN ELLER FLERE GANGER I UKA 1
EN TIL TRE GANGER I MÅNEDEN 2
SEKS TIL TI GANGER I ÅRET 3
EN TIL FEM GANGER I ÅRET 4
MINDRE ENN EN GANG I ÅRET 5
ALDRI ..... 6GÅ TIL SPM. 4

(3) Hvor mye kjøtt spiste dere sist din husholdning spiste biff til middag hjemme ?

MER ENN ETT KILO 1
MELLOM 500 GRAM OG ETT KILO 2
MINDRE ENN 500 GRAM 3
HUSKER IKKE 4

TIL ALLE:

(4) Omtrent hvor mye av husstandens matinnkjøp vil du si at du står for?

ALT/ SÅ OG SI ALT... 1
MESTEPARTEN..... 2
CA HALVPARTEN... 3
CA EN FJERDEDEL. 4
BARE LITT 5
INGENTING 6

(5) Og hvor mye av matlagingen står du for?

ALT/ SÅ OG SI ALT... 1
MESTEPARTEN..... 2
CA HALVPARTEN... 3
CA EN FJERDEDEL. 4
BARE LITT 5
INGENTING 6

(6) Hvor ofte spiser du middag på restaurant/kafè?

EN ELLER FLERE GANGER I UKA 1
EN TIL TRE GANGER I MÅNEDEN 2
SEKS TIL TI GANGER I ÅRET 3
EN TIL FEM GANGER I ÅRET 4
MINDRE ENN EN GANG I ÅRET 5
ALDRI 6

(7) Hvor ofte reiser din husholdning til utlandet for å handle dagligvarer ?

EN ELLER FLERE GANGER I UKA 1
EN TIL TRE GANGER I MÅNEDEN 2
SEKS TIL TI GANGER I ÅRET 3
EN TIL FEM GANGER I ÅRET 4
MINDRE ENN EN GANG I ÅRET 5
ALDRI ..... 6 GÅ TIL SPM 9

(8) Hvor fornøyd var dere med kvaliteten på kjøttet som dere sist handlet i utlandet ?

SVÆRT FORNØYD 1
FORNØYD 2
LITT MISFORNØYD 3
SVÆRT MISFORNØYD 4
VET IKKE / HUSKER IKKE 5

VIS KORT "INNLEDNING", - OG LES OPP:

Om noen år kan norske forbrukere kanskje få kjøpe kjøtt produsert i bl.a. USA, Botswana, Sverige og Irland.

I USA blir 80% av alt storfe tilsatt vekstfremmende hormoner. Dette blir gjort for å øke veksten og for å få mørere kjøtt. For at kjøttet skal ha naturlige mengder hormoner, brukes ikke vekstfremmende hormoner de siste 90 dagene før slakting.
Det kan bli tillatt å selge kjøtt tilsatt vekstfremmede hormoner i Norge Amerikanske myndigheter sier det erlike trygt å spise kjøtt fra hormonbehnadlet storfe produsert i overensstemmelse med amerikanske retningslinjer, som annet kjøtt.

Jeg skal nå vise deg noen eksempler på kjøtt som vi i fremtiden kanskje kan få kjøpt i norske forretninger, - og vil gjerne vite hvilke du vil foretrekke å kjøpe. Entrecôte er mørt storfekjøtt som vanligvis serveres som biff.

I eksempelet har vi angitt pris pr. kilo. Dersom du kjøper mer eller mindre enn en kilo vil prisen være tilsvarende høyere eller laver.

(9) Hvis du i dag skulle kjøpe et halv kilo entrecôte og hadde følgende alternativer å velge mellom, hva ville du da valgt.

SKRIV 1 UNDER FØRSTEVALGET.

Hvis førstevalget ditt ikke var tilgjengelig, hvilket av de to andre alternativene ville du da valgt?

SKRIV 2 UNDER ANDREVALGET.

Egenskaper	Altern-ativ 1	Altern-ativ 2	Altern-ativ 3
Produksjonsland	Norge	USA	USA
Kvalitet	Entrecôte	Entrecôte	Entrecôte
Hormonbehandlet	Nei	Nei	Ja
Pris pr kilo	Kr 99 pr kilo	Kr 79 pr kilo	Kr 59 pr kilo
RANGERING	☐	☐	☐

(10) Hvis du i dag skulle kjøpe et halv kilo entrecôte og hadde følgende alternativer å velge mellom, hva ville du da valgt.

SKRIV 1 UNDER FØRSTEVALGET.

Hvis førstevalget ditt ikke var tilgjengelig, hvilket av de to andre alternativene ville du da valgt?

SKRIV 2 UNDER ANDREVALGET.

Egenskaper	Altern-ativ 1	Altern-ativ 2	Altern-ativ 3
Produksjonsland	Norge	Botswana	Irland
Kvalitet	Entrecôte	Entrecôte	Entrecôte
Hormonbehandlet	Nei	Nei	Nei
Pris pr kilo	Kr 99 pr kilo	Kr 79 pr kilo	Kr 89 pr kilo
RANGERING	☐	☐	☐

(11) Hvis du i dag skulle kjøpe et halv kilo entrecôte og hadde følgende alternativer å velge mellom, hva ville du da valgt.

SKRIV 1 UNDER FØRSTEVALGET.

Hvis førstevalget ditt ikke var tilgjengelig, hvilket av de to andre alternativene ville du da valgt?

SKRIV 2 UNDER ANDREVALGET.

Egenskaper	Altern-ativ 1	Altern-ativ 2	Altern-ativ 3
Produksjonsland	Norge	USA	Sverige
Kvalitet	Entrecôte	Entrecôte	Entrecôte
Hormonbehandlet	Nei	Nei	Nei
Pris pr kilo	Kr 99 pr kilo	Kr 59 pr kilo	Kr 69 pr kilo
RANGERING	☐	☐	☐

(12) Hvis du i dag skulle kjøpe et halv kilo entrecôte og hadde følgende alternativer å velge mellom, hva ville du da valgt.

SKRIV 1 UNDER FØRSTEVALGET.

Hvis førstevalget ditt ikke var tilgjengelig, hvilket av de to andre alternativene ville du da valgt?

SKRIV 2 UNDER ANDREVALGET.

Egenskaper	Altern-ativ 1	Altern-ativ 2	Altern-ativ 3
Produksjonsland	Norge	Sverige	Irland
Kvalitet	Entrecôte	Entrecôte	Entrecôte
Hormonbehandlet	Nei	Nei	Nei
Pris pr kilo	Kr 99 pr kilo	Kr 79 pr kilo	Kr 59 pr kilo
RANGERING	☐	☐	☐

(13) Jeg skal nå lese opp noen ulike påstander for deg, og vil gjerne høre hvor enig eller uenig du er i dem. Er du helt enig, nokså enig, verken enig eller uenig, nokså enig eller helt uenig i følgende påstander….

LES OPP EN FOR EN

	HELT ENIG	NOKSÅ ENIG	VERKEN ELLER	NOKSÅ UENIG	HELT UENIG	(VET IKKE)
KVALITETEN PÅ NORSKE JORDBRUKSPRODUKTER ER BEDRE ENN KVALITETEN PÅ TILSVARENDE UTENLANDSKE JORDBRUKSPRODUKTER	1	2	3	4	5	A
SMAKEN PÅ NORSKE JORDBRUKSPRODUKTER ER BEDRE ENN SMAKEN PÅ TILSVARENDE UTENLANDSKE JORDBRUKSPRODUKTER	1	2	3	4	5	A
NÅR JEG KJØPER KJØTT I BUTIKKEN ER DET SVÆRT VIKTIG FOR MEG Å VITE HVILKET LAND KJØTTET KOMMER FRA	1	2	3	4	5	A
DET ER SVÆRT VIKTIG AT KJØTTET JEG KJØPER I BUTIKKEN ER NORSKPRODUSERT	1	2	3	4	5	A
NÅR JEG KJØPER EN KJØTTRETT PÅ EN RESTAURANT ER DET SVÆRT VIKTIG FOR MEG Å VITE HVILKET LAND KJØTTET KOMMER FRA	1	2	3	4	5	A
DET ER SVÆRT VIKTIG AT KJØTTET JEG FÅR SERVERT PÅ RESTAURANT ER NORSKPRODUSERT	1	2	3	4	5	A
DET ER SVÆRT VIKTIG FOR MEG AT KONTROLLEN AV ALT KJØTTET ER UTFØRT AV NORSKE MYNDIGHETER	1	2	3	4	5	A
OVERFØRINGENE TIL JORDBRUKET BØR OPPRETTHOLDES PÅ DAGENS NIVÅ	1	2	3	4	5	A
NORGE BØR OPPRETTHOLDE JORDBRUKSPRODUKSJONEN PÅ DAGENS NIVÅ	1	2	3	4	5	A
PRISEN PÅ MAT ER RELATIVT BILLIG SAMMENLIGNET MED PRISEN PÅ ANDRE PRODUKTER	1	2	3	4	5	A
HUSHOLDNINGSUTGIFTENE TIL MAT ER SMÅ I FORHOLD TIL ANDRE UTGIFTER FOR MIN HUSSTAND	1	2	3	4	5	A
NÅR MAN KJØPER KJØTT I NORSKE BUTIKKER ER FAREN FOR Å BLI SMITTET AV SALMONELLA ELLER ANDRE SYKDOMMER LIKE LITEN UANSETT OM KJØTTET ER PRODUSERT I NORGE ELLER IMPORTERT FRA ANDRE LAND	1	2	3	4	5	A

(14) Hvor mange ganger har du reist ut av Norge de tre siste årene?

MER ENN TI GANGER I LØPET AV
SISTE TRE ÅR..... 1
FIRE TIL TI GANGER I LØPET AV
SISTE TRE ÅR 2
EN TIL TRE GANGER I LØPET AV
SISTE TRE ÅR 3
INGEN GANGER I LØPET AV
SISTE TRE ÅR 4

(15) Hvor mange ganger har du reist ut av Norden de tre siste årene?

MER ENN TI GANGER I LØPET AV
SISTE TRE ÅR..... 1
FIRE TIL TI GANGER I LØPET AV
SISTE TRE ÅR 2
EN TIL TRE GANGER I LØPET AV
SISTE TRE ÅR 3
INGEN GANGER I LØPET AV
SISTE TRE ÅR 4

(16) Hvor fornøyd har du vanligvis vært med maten du har spist på restauranter eller kafeer i utlandet?

SVÆRT FORNØYD 1
FORNØYD 2
LITT MISFORNØYD 3
SVÆRT MISFORNØYD 4
HAR ALDRI SPIST MAT I UTLANDET 5
HUSKER IKKE / VET IKKE 6

(17) Har du blitt matforgiftet eller hatt andre svært ubehagelige opplevelser med mat i utlandet ?

JA 1
NEI 2

(18) Driver du eller har du drevet gårdsbruk ?

JA 1
NEI..... 2

(19) Arbeider du eller har du arbeidet i næringsmiddelindustrien eller andre landbrukstilknyttede bedrifter?

JA 1
NEI..... 2

(20) Er du oppvokst på gård ?

JA 1
NEI..... 2

(21) Har du nær familie eller venner som driver gårdsbruk ?

JA 1
NEI..... 2

(24) Har du nær familie eller venner som jobber i næringsmiddelindustrien eller andre landbrukstilknyttede bedrifter?

JA 1
NEI..... 2

(25) Arbeider du selv eller noen i din husstand i dagligvarebutikk?

JA, SELV..... 1
JA, ANNEN I HUSSTANDEN..... 2
NEI..... 3

(26) Har du noen annen type kontakt med matproduksjon ?

JA 1
NEI..... 2

HVIS "JA"

Beskriv eventuell annen kontakt med matproduksjon:

TEMA: BAKGRUNN

SPØRRESKJEMA

1. Så et par spørsmål om politikk. Ville du stemme hvis det var stortingsvalg i morgen? (Hvis "ja"): Hvilket parti ville du stemme på?

ARBEIDERPARTIET 1
SOSIALISTISK VENSTREPARTI..... 2
FREMSKRITTSPARTIET..... 3
HØYRE 4
KRISTELIG FOLKEPARTI 5
SENTERPARTIET 6
VENSTRE..... 7
RØD VALGALLIANSE (RV) 8
ANNET PARTI,
NOTÈR:_____ 9
VILLE IKKE STEMME..... A

2. Stemte du ved stortingsvalget i september 1997? (Hvis "ja"): Hvilket parti stemte du på?

ARBEIDERPARTIET 1
SOSIALISTISK VENSTREPARTI..... 2
FREMSKRITTSPARTIET..... 3
HØYRE 4
KRISTELIG FOLKEPARTI 5
SENTERPARTIET 6
VENSTRE..... 7
RØD VALGALLIANSE (RV) 8
ANNET PARTI,
NOTÈR:_____ 9
STEMTE IKKE ..... A

3. Hva er ditt yrke?

STUDENT/SKOLEELEV..... 01
PENSJONIST/TRYGDET 02
ARBEIDER, UFAGLÆRT 03
ARBEIDER, FAGLÆRT 04
SELVSTENDIG GÅRDBRUKER..... 05
SELVSTENDIG, HÅNDVERKER..... 06
SELVSTENDIG, ANNET 07
FUNKSJONÆR/TJENESTEMANN, LAVERE..... 08
FUNKSJONÆR/TJENESTEMANN,HØYERE 09
HJEMMEVÆRENDE HUSMOR/ HUSFAR..... 10
ARBEIDSLEDIG 11

4. Hva er husstandens samlede brutto årsinntekt?

AVMERK UNDER SP 4 NEDENFOR

5. Og hva er din egen brutto årsinntekt?
AVMERK UNDER SP 5 NEDENFOR

	SP 4	SP 5
INGEN INNTEKT	01	01
UNDER KR 50.000	02	02
KR 50.000 - 99.999	03	03
KR 100.000 - 149.999	04	04
KR 150.000 - 199.999	05	05
KR 200.000 - 249.999	06	06
KR 250.000 - 299.999	07	07
KR 300.000 - 349.999	08	08
KR 350.000 - 399.999	09	09
KR 400.000 - 449.999	10	10
KR 450.000 - 499.999	11	11
KR 500.000 - 549.999	12	12
KR 550.000 - 599.999	13	13
KR 600.000 OG OVER	14	14

6. Hvor mange personer er det i denne husstanden, alle voksne og alle hjemmeboende barn medregnet?

NOTÈR ANTALL PERSONER:

7. Hva er din alder? Kan du også oppgi alderen til de andre husstandsmedlemmene?

INTERVJUER: NOTÉR I.O.'S ALDER PÅ LINJE 1 NEDENFOR, OG ØVRIGE HUSSTANDSMEDLEMMERS ALDER PÅ DE PÅFØLGENDE LINJENE

HUSSTANDSMEDLEM: NOTÈR ALDER :
1. (INTERVJU-OBJEKT)
_____
2.
_____
3.
_____
4.
_____
5.
_____
6.
_____
7.
_____

8. Hva er den høyeste skole du har tatt avsluttende eksamen fra?

FOLKESKOLE/FRAMHALDSSKOLE/ REALSKOLE/9 ÅRIG SKOLE/

UNGDOMSSKOLE..... 1
GYMNAS/VIDEREGÅENDE SKOLE (EVT. FOLKEHØYSKOLE,
YRKESSKOLE, HANDELSSKOLE, TEKNISK SKOLE ELLER
ANNEN UTDANNING, MEN IKKE PÅ HØGSKOLENIVÅ) 2
UNIVERSITET/HØGSKOLE (GYMNAS + STUDIER) 3
HVIS UTDANNING IKKE PASSER TIL GRUPPENE,
NOTÈR UTDANNING_____

9. Hva slags type distrikt bor du i? Bor du i et spredtbebygd distrikt, et tettbebygd distrikt, eller bor du i et område med klart bypreg?

SPREDTBEBYGD..... 1
TETTBEBYGD 2
KLART BYPREG 3

FYLLES UT AV INTERVJUER:

Intervjuobjektets kjønn:
MANN.....1
KVINNE 2

NOTER BOLIGTYPE:

BONDEGÅRD ELLER HUS
TILHØRENDE BONDEGÅRD..... 1
ENEBOLIG..... 2
TOMANNSBOLIG 3
TREMANNS, FIREMANNS-BOLIG,
REKKEHUS..... 4
BLOKK, LEIEGÅRD 5
HYBEL..... 6

Intervjuet er gjennomført i kommune:
(NOTER KOMMUNENAVN)_____

Minutter brukt på intervjuet:
(NOTÈR ANTALL MINUTTER)_____

Dato for intervjuet:
_____/_____ 2000

HUSK Å FYLLE UT INTERVJU-OBJEKTETS NAVN, ADRESSE OG POSTNR. PÅ ADRESSELISTEN.

Intervjuers signatur:

_____

FOR KONTORET I ACNIELSEN NORGE AS

KOMMUNE NR.:

URBANISERING (3ALTERNATIVER)

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Frode Alfnes was born in Trondheim in 1972. He holds a Master in Economics (*cand. oecon*) from the University of Oslo (1997).

The principal objective of this thesis is to investigate the willingness to pay for quality. The thesis consists of four papers exploring Norwegian consumer preferences for imported and hormone-treated beef. The first paper presents an analysis of a stated choice survey using a mixed logit model. Target markets for imported and hormone-treated beef are identified, and microsimulations are used to predict market shares and illuminate substitutions patterns. The second paper presents an analysis of an experimental auction market conducted to elicit realistic willingness to pay values for imported and hormone-treated beef. The third paper presents a new method for calibrating hypothetical willingness to pay values estimated from stated choice surveys with willingness to pay values obtained from experimental auctions. The fourth paper presents a new method for incorporating the results of an experimental auction into the joint logit model normally used to combine revealed and stated choice data. The new methods proposed in the third and fourth paper are illustrated with the data analyzed in the first and second papers.

Professor Kyrre Rickertsen was the advisor of this dissertation.

Frode Alfnes currently work as a researcher at the Department of Economics and Social Sciences, at the Agricultural University of Norway.

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