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Who Will Pay for Guaranteed Tender Steak?

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Meat tenderness is one of the most important quality characteristics to beef consumers. Current beef quality grading standards are poorly correlated with meat tenderness. Even within the same quality grade, steak tenderness varies considerably. As a result of consumers frequently experiencing poor steak eating experiences, their confidence in, and demand for beef has been adversely affected. A new quality grading system, developed by the USDA, more accurately segregates beef into tenderness categories. This study evaluates consumer willingness to pay to steak tenderness in an effort to evaluate this new grading system. Consumers demonstrated a preference for tender steak. Blind taste tests revealed that 72% of consumers preferred tender steak relative to tough steak (as measured via Warner-Bratzler shear force tests) in terms of tenderness preferences. In these blind taste tests, 36% of consumers were also willing to pay an average of a $1.23/lb. premium for a tender relative to a tough steak. When information regarding tenderness was revealed to consumers together with a taste sample, 90% preferred the tender steak. Overall, 51% of consumers were willing to pay an average premium of $1.84/lb. for a tender relative to a tough steak when the level of steak tenderness was revealed to the consumers.

Introduction

Tenderness has been identified as the most important palatability attribute of beef (Dikeman, 1987 and Miller et al., 1995). A 1995 survey of packers, purveyors, restaurateurs, and retailers, indicated tenderness was the second highest beef quality concern, behind low overall uniformity and consistency (Smith et al., 1995). Problems with consistency, uniformity, and tenderness were also among the top 10 concerns listed in the 1991 National Beef Quality Audit, indicating that tenderness concerns are not new to the industry (Smith et al., 1992).

The importance of meat tenderness to consumers can be viewed in monetary terms. The positive relationship at the retail level between the price of a cut of meat and its relative tenderness confirms the general willingness of consumers to pay a premium for more tender steaks (Savell and Shackelford, 1992). Boleman et al. (1997) concluded that consumers were able to distinguish between varying levels of steak tenderness and were willing-to-pay more for a guaranteed level of tenderness. Consumers demand tender meat products and they often reject

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tough meat. A supermarket chain that requested consumers return undesirable steaks had $364,000 worth of steaks returned over a three-year period. Over 78 percent of the steaks were returned because of tenderness problems (Morgan, 1992).

The importance of meat tenderness to consumers suggests that tenderness should be the primary determinant of meat quality. However, the current USDA quality grading system, which uses intramuscular fat or marbling as a measure of quality, provides an inadequate measure of tenderness. Savell et al. (1987, 1989) found that consumers perceived varying degrees of tenderness within different marbling categories. Wheeler et al. (1994) concluded that marbling explains, at most, five percent of the variation in palatability characteristics. Numerous studies have found inconsistency in meat tenderness to be a major problem facing the beef industry (Morgan et al.1991; Morgan 1992; Savell and Shackelford, 1992; and Smith 1992). Wheeler et al. (1994, p. 3150) concluded, "USDA quality grade does not sufficiently segregate carcasses for palatability differences, and thus a direct measure of meat tenderness is needed to supplement USDA quality grade."

The objective of this study is to determine consumer willingness-to-pay for tender steaks in an actual grocery store setting. In particular, the aims are to: 1) determine the price premium consumers will pay for steak tenderness, 2) quantify how economic and demographic factors influence consumer willingness-to-pay for steak tenderness, 3) compare consumer willingness-to-pay for tenderness to the costs of implementing a particular tenderness measurement system, 4) determine how information about tenderness affects willingness-to-pay for steak tenderness, and, 5) examine the implications of consumer willingness-to-pay for steak tenderness for beef quality grading systems. Results should prove helpful to USDA, beef producers, processors, and retailers evaluating the merits of alternative grading systems which provide improved measures of beef tenderness compared to the current quality grading system.

Alternative Tenderness Grading System

One direct method for measuring tenderness is the Warner-Bratzler (W-B) shear force test. The W-B test measures the amount of force required to penetrate a cut of meat and assigns a numerical value to a cut of steak indicating its tenderness level. The W-B method explains more of the variation in meat tenderness than any other tenderness testing system (Shackelford et al., 1996). Recently, Koohmaraie et al. (1993, 1996) have developed a beef processing system that incorporates the W-B test and can be used in a commercial processing plant. An outline for the on-line tenderness grading system can be found in Shackelford et al., (1996). The tenderness grading system segregates carcasses into different tenderness classifications – guaranteed tender, probably tender, and probably tough - with 90 percent accuracy, which is higher than any system previously devised. In addition to providing a consistent prediction of eating quality, this tenderness classification system would result in more carcasses segregated into the highest quality grade than do current USDA quality grades. This occurs because some carcasses in the Choice and Select grades would likely achieve the guaranteed tender classification.

Costs and Benefits of an Alternative Tenderness Grading System

Adoption of a tenderness assessment system is costly. Shackelford et al. (1996) estimated the cost of using their tenderness classification system in a commercial beef packing plant to be $4.36/carcass or $0.62/cwt. Their estimates include the costs of: 1) a 1-inch ribeye steak removed from each carcass for shear-force testing, 2) labor (it is estimated that four additional employees will be required for tenderness based classification), and 3) machinery for the tenderness classification system. The cost estimates are based on the following assumptions: 1) a plant will process 3,000 carcasses per day, 5 days a week, 52 weeks per year, 2) a ribeye removed from the carcass will cost $4.00, and 3) employees are paid $10 per hour. The estimates did not include the cost of capital financing, i.e. the interest rate charged for the capital investment, and additional carcass sorting costs for packers. Therefore, the actual costs per carcass are likely to be somewhat greater than those identified by Shackelford et al. (1996).

Boleman et al. (1997) investigated consumer preferences for three tenderness levels of steaks (segregated via the W-B test) and determined that consumers would pay more for steaks with higher tenderness levels. In that study, consumers were allowed to sample three steaks – tender, intermediate, and tough. The experiment consisted of two components. In part 1, participants were not told which steaks were more tender and all three steaks were priced the same – at $8.46/kg. In part 2, participants were informed of the W-B test and steak tenderness levels were revealed. In this test, steaks were priced as follows: 1) tender - $9.56/kg, 2) intermediate - $8.46/kg, and 3) tough - $7.36/kg. When all steaks were priced the same and tenderness levels were not revealed, approximately 55 percent of consumers purchased the most tender steak, 12 percent bought the intermediate tender steak, and 32 percent bought the tough steak. However, in part 2, when the level of steak tenderness was revealed to consumers and prices of the three tenderness levels differed by $1.10/kg, almost 95 percent of consumers purchased the most tender steak and approximately four percent purchased the intermediate tender steak.

Although Boleman et al. confirmed that consumers prefer tender steaks and concluded that consumers were willing to pay more for tender steaks, it did not extract full willingness-to-pay for more tender steaks and its findings are based on a limited number of observations (47 families). A larger and more representative study is needed to draw more reliable inferences about consumers' willingness-to-pay for beef tenderness and the impact of different demographic characteristics on willingness-to-pay.

Methods

In this study, experimental market procedures are used to elicit consumer willingness-to-pay for different tenderness levels of steaks. Non-hypothetical experimental methods have the potential to provide more reliable measures of willingness-to-pay than a hypothetical survey method. Experimental valuation using the Vickery auction is well established in the economics literature. In the Vickery auction system, the highest bidder receives a product but pays the amount of the second highest bid, for the product in question. The Vickery 2nd price auction is used because it is incentive compatible – i.e. respondents have an incentive to bid an amount equal to their true maximum willingness-to-pay. It has been used to examine differences in willingness-to-pay and willingness-to-accept values (Shogren et al., 1994), the value of safer

food (Hayes et al., 1995), and the value of pork chop characteristics (Melton et al., 1996). This study expands on previous work in experimental valuation by moving from a controlled laboratory setting, to a grocery store where consumers' actual purchasing decisions are made.

Procedures

Data were collected from shoppers at retail grocery stores owned by a Midwestern chain in several locations within Kansas. Two experimental treatments were used and the procedure was as follows.

Treatment 1

1. Shoppers at the meat counter were asked to participate in an experiment conducted by the Agricultural Economics Department at Kansas State University.
2. Once a consumer agreed to participate in the experiment, a short written survey was completed which required disclosure of basic demographic information including age, gender, household size, household income, education level, and preference for steak doneness and USDA quality grade[1].
3. When the survey was completed, consumers were asked to sample two different types of steaks labelled Red and Blue: Red was "guaranteed tender" (according to a slice shear force test) and Blue was "probably tough"[2]. In experimental treatment 1, consumers were not told that the samples differed in tenderness - they had to make this assessment independently. Consumers then responded to questions about which steak they preferred in terms of taste, tenderness, texture, juiciness, and overall palatability.
4. Consumers were given, free of charge, a Blue (tough) steak for participating in the experiment. If they indicated a preference for the Red (tender) steak, consumers were asked to indicate their willingness-to-pay to exchange their Blue (tough) steak for the Red (tender) steak. Bids were elicited in a procedure designed to reveal their true valuation for the upgrade. In particular, consumers were informed that if their bid exceeded a predetermined price level (unknown to them), they would make the exchange at the predetermined price. If their bid was less than the predetermined price, then they kept their Blue (tough) steak. In this setting, as in the Vickery auction, the exchange price is unknown (exogenous) to the consumer and thus their incentive is to reveal their true willingness-to-pay. The instructions included an explanation of why it was best to bid true willingness-to-pay in this setting.

Treatment 2

The second treatment of the experiment was identical to the first except that the words Red and Blue were replaced with "Guaranteed Tender" and "Probably Tough", respectively. The following statement was provided to consumers in Treatment 2: "The USDA has developed a technology to categorize steaks according to tenderness. The classification system uses shear force to give an actual value of steak tenderness. Steaks are separated into different categories

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[1] A copy of the written survey instrument is included in Appendix A.

[2] "guaranteed tender" steaks have a slice shear force value of ≤ 15Kg and "probably tough" steaks have a slice shear force value of > 35 Kg.

according to shear force values. The three categories are: Guaranteed Tender, Intermediate Tender, and Probably Tough." The steaks used in this study were deemed tender or tough according to a slice shear test using the procedures outlined in Shackelford et al. (1996) and carried out by the Meat Animal Research Center at Clay Center, Nebraska. Tender and tough steaks were categorized under the supervision of Shackelford, Wheeler, and Koohmaraie.

Results

1. Demographics and Consumption Habits

A total of 313 consumers participated in the study, 227 in the first treatment and 86 in the second. Table 1 provides summary statistics for the combined groups of consumers. Almost 66 percent of the consumers in the study were female reflecting the population in the grocery store during the experiments. The average age of the participants was approximately 48 years. Participants, on average, had at least some college education and between $40,000 and $50,000 of annual household income. Only six percent of the respondents were full time students.

Table 1 - Variable Definitions and Summary Statistics

Variable	Definition	Mean	Std. Dev.
Gender	1 if female, 0 if male	0.66	0.48
Age	age in years	47.51	15.25
Education	education level of respondent. 1 = less than 12th grade, 2 = high school graduate 3 = some technical, trade, business school, 4 = some college, 5 = B.S. B.A., complete, 6 = some graduate work, 7 = M.S., M.A. complete, 8 = Ph.D., D.D.S., M.D., J.D., etc.	4.44	1.80
Income	household income level 1 = less than $20,000, 2 = $20,000 to $29,000, 3 = $30,000 to $39,999, 4 = $40,000 to $49,999, 5 = $50,000 to $59,999, 6 = $60,000 to $69,999, 7 = $70,000 to $79,999, 8 = $80,000 to $89,999, 9 = $90,000 to $99,999, 10 = $100,000 to $109,999, 11 = $110,000 to $119,999, 12 = more than $120,000	4.79	2.80
Adults	number of adults in household	1.97	0.65
Children	number of children in household	0.72	1.12
Student	1 if full time student, 0 otherwise	0.06	0.24
Beef home	number of times per week respondent consumes ground beef (hamburger) at home	2.26	1.54
Beef away	number of times per week respondent consumes ground beef (hamburger) away from home	1.28	1.49
Steak home	times per week respondent consumes steak at home	1.10	0.84
Steak away	times per week respondent consumes steak away from home	0.57	0.82
Doneness	preference of steak doneness; 1 = rare, 2 = medium rare, 3 = medium, 4 = medium well, 5 = well	3.17	1.04

Concerning consumption habits, consumers ate ground beef about 2.3 times a week at home and 1.3 times a week away from home. Participants indicated that steak was consumed 1.1 times per week at home and 0.57 times a week away from home. Thirty-eight percent of consumers indicated they typically purchased USDA Choice beef whereas 22 percent indicated they did not know the grade of beef they typically purchased. Both USDA Select and store brand beef were typically purchased by about 19 percent of the respondents. Respondents, on average, preferred their steak cooked to a medium doneness.

The fact that almost one in four respondents did not know what grade of beef they purchased is important. USDA quality grades are intended to inform consumers about beef quality. The fact that such a large proportion of participants failed to recognise USDA grades as an indicator of quality may be attributed to several factors including difficulty in understanding the current grading system.

2. Consumer Preferences for Sampled Steak

Consumers who participated in the study and sampled the two types of steaks were asked which steak they preferred for taste, tenderness, texture, juiciness, and overall palatability. In treatment 1, where tenderness levels were not revealed to the consumers, the Red (Guaranteed Tender) steak was preferred overall by 69 percent of participants. Of the four quality attributes, more people indicated they preferred the Red steak for tenderness (72 percent) than for any of the other attributes. Sixty-five percent of participants preferred the Red steak for taste and texture, and 60 percent preferred the Red steak for juiciness. Importantly, consumers were able to determine independently that the distinguishing characteristic between the two steaks was tenderness.

In treatment 2, consumers were told that one steak was guaranteed tender and the other was probably tough. Interestingly, results from the first and second treatments suggest that consumers were more likely (84 percent compared to 69 percent) to prefer the Red or Guaranteed Tender steak when the difference in the steak samples was revealed. This suggests that merely labelling the steaks can affect consumers' preferences.

When asked to evaluate samples based upon tenderness, almost 90 percent of consumers in treatment 2 indicated they preferred the guaranteed tender steak. However, 9 percent of treatment 2 consumers still preferred the probably tough steak for overall palatability after sampling the steaks. This can be attributed to a number of factors. While degree of doneness was held constant among samples (cooked to an internal temperature of 75 degrees celcius, or a medium doneness) consumers may have had perceptions about the color of one steak versus another that also influenced their opinion. Another possibility is that juiciness, taste, and texture could have varied across samples since the only quality attribute controlled in the experiment was tenderness.

This study was designed to determine whether consumers are willing to pay more for a tender vs. a tough steak and, secondly, if consumers are willing to pay more for tender steaks, how much are they willing to pay? While most consumers preferred the tender steak, some were not willing to pay more to exchange their tough steak for a tender one. In treatment 1, 69 percent of respondents preferred, but only 36 percent were willing to pay extra to obtain, a Red (tender)

steak. In treatment 2, 84 percent preferred, but only 51 percent were willing to pay more for, the Guaranteed Tender steak.

3. Comparison of Cost and Willingness to Pay

Overall, the average willingness-to-pay (only those consumers who were willing to pay for the tender steak) was $0.923 in treatment 1 and $1.38 in treatment 2. Since the steaks used in the experiment were 12 oz., the willingness-to-pay bids can be converted to a per pound basis. Thus, the average willingness-to-pay per pound was $1.23 and $1.84 per pound for treatments 1 and 2 respectively. Some consumers, although preferring tender steak, placed no value on it relative to the tough steak. In both treatments, the modal value of willingness-to-pay is zero. The next largest category of willingness-to-pay values for both groups was $1.33 per pound. In treatment 1, the third largest category was $0.67, whereas in treatment 2, the third largest category was $2.67 per pound. The maximum willingness to pay was $3.33 and $4.00 per pound in treatments 1 and 2 respectively.

4. Willingness to Pay for Tender Steaks – Regression Models

Regression analysis can provide information about the determinants of consumer willingness-to-pay for guaranteed tender steaks and thus guide the development of a marketing strategy. If processors adopt tenderness technology, they will likely want to market their product by concentrating on demographic groups that have the most potential to buy guaranteed tender steak at profitable prices. In this study, consumers have three different decision nodes at which they reveal information about their preferences and willingness-to-pay. These include; I) tenderness preferences, II) willing or not willing to pay for tenderness, and III) amount willing to pay. These three choices are all independently modelled in this study.

I. Choice of Tender or Tough Steak

The first regression model examines consumers' steak choice in the experiment. Each participant, after sampling the tender and tough steak, indicated which steak they preferred. A multinomial logit model is used to examine the probability that a consumer will choose the tough steak, the tender steak, or be indifferent between the two, given their demographic and steak preference characteristics. Table 2 presents the marginal effects for the model. The results indicate whether, given a one unit increase in the value of an explanatory variable such as age, the respondent is more or less likely to fall into one of three categories – preferring the tender steak, preferring the tough steak, or being indifferent between them. For a given explanatory variable, the sum of the marginal probabilities across the three categories always sums to zero. The model contains 245 observations – lower than the total number of participants due to some respondent failure to answer one or more survey questions.

Table 2 – Multinomial Logit - Marginal Probabilities of factors affecting Consumers Preference for Guaranteed Tender Steaks

		Category[c]	
Variable	**Prefers Tender**	**Prefers Tough**	**Indifferent**
Age	0.004[a] (0.002)	-0.003[b] (0.002)	-0.001 (0.001)
Education	0.040[a] (0.014)	-0.027[a] (0.012)	-0.013 (0.008)
Gender	0.071 (0.060)	-0.027 (0.053)	-0.044 (0.033)
Income	-0.005 (0.011)	0.007 (0.010)	-0.002 (0.007)
Treatment	0.181[a] (0.069)	-0.142[a] (0.061)	-0.039 (0.041)
Doneness	-0.044[b] (0.025)	0.035 (0.022)	0.009 (0.014)
Steak Home	0.027 (0.034)	-0.047 (0.032)	0.020 (0.016)
Steak Away	-0.003 (0.034)	0.006 (0.029)	-0.003 (0.019)
Quality Grade	-0.004 (0.066)	0.032 (0.059)	-0.028 (0.035)

[a] Statistically Significant at 5% level

[b] Statistically Significant at 10% level

[c] Numbers in parenthesis are standard errors

number of observations = 245

Among consumers that prefer tender steak, the marginal probabilities for age and education are positive and statistically significant. The estimates indicate that for every one year increase in age, a participant is 0.4% more likely to indicate a preference for the tender steak. Thus, a forty-five year old would be expected to be 8% more likely to prefer tender steak than would a twenty-five year old. For a one "unit" increase in the respondent's level of education (e.g. from "some college" to "B.S., B.A. complete"), the results indicate that a respondent is 4% more likely to prefer the tender steak. Perhaps the most important result here is the relatively large, positive, and statistically significant result for the treatment variable. It indicates that participants in the second treatment, where the tender and tough steaks were identified prior to tasting, were 18% more likely to prefer tender steak, than participants in treatment one where the steaks' tenderness levels were not identified. The only steak preference variable that influenced steak choice was cooking doneness - consumers who preferred their steaks cooked to a higher degree of doneness were less likely to prefer the tender steak.

II. Choice of Payment for Tender Steak

The second choice consumers made was whether they would pay to exchange their tough steak for a tender one, given that they previously expressed a preference for tender steak. Thus, it is important to note that this choice is conditional upon the first choice in that only those consumers who preferred the tender steak were given the opportunity to pay for it. Accordingly, the number of observations falls to 180. A logit model was estimated calculating the effects of certain demographic and steak preference characteristics on the probability that a consumer will indicate a willingness to pay more for tender steak. None of the estimated marginal probabilities were statistically significant. Thus, the results of the model have been excluded from the paper due to space constraints.

III. Consumer Choice of How Much to Pay for the Tender Steak

The model in table 3 investigates how much consumers would be willing to pay for the upgrade to tender steak given that: 1) they have indicated a preference for tender steak and 2) they have indicated they would be willing to pay more for tender steak. The model contains 98 observations.[3]

Table 3 – Regression Coefficients of Consumer Willingness to Pay for Guaranteed Tender Steak

Variable	Coefficient	Standard Errors
Constant	2.725[a]	0.569
Age	-0.011[a]	0.005
Education	-0.486[a]	0.176
Education^2	0.054[a]	0.018
Gender	0.305[b]	0.165
Income	-0.279[a]	0.096
Income^2	0.027[a]	0.008
Treatment	0.624[a]	0.142
Doneness	0.102	0.066
Steak Home	-0.047	0.085
Steak Away	-0.119	0.087
Knowledge of Quality Grade	0.084	0.181

[a] Statistically Significant at 5% level

[b] Statistically Significant at 10% level

Adjusted R^2 = 0.26

number of observations = 98

All variables except those measuring consumption of steak, cooking preference, and knowledge of the USDA quality grading system were statistically significant at the 1 percent level. The coefficient on age was negative indicating that as an individual's age increases, the amount they would pay for a guaranteed tender steak decreases. However, for each additional 10 years in age, the amount they are willing to pay declines by only 11 cents/lb. Females had a higher willingness-to-pay than males. The model predicts that females are willing to pay $0.31 more per pound for a guaranteed tender steak than are males.

The coefficients on the quadratic terms for education and income suggest that consumers will pay more for a guaranteed tender steak at lower and higher education and income levels than they will pay at medium education and income levels. The estimates predict that minimum willingness-to-pay occurs at a household annual income level between $50,000 and $60,000 and at a level of education where one had completed a B.S. or B.A. This particular result is not consistent with prior expectations because the amount a person would be willing to pay for tender relative to tough beef would be expected to increase with income level. Possibly it is a

[3] This model includes a correction for heteroscedasticity (non-constant variance in the error term) - a common problem with cross sectional data. The correction models the error term as a log-linear function of age, education, sex, and income.

unique aspect of the consumers in this particular sample. Further work needs to be done to confirm or reject this result.

Finally, the positive and statistically significant sign on the treatment variable indicates that participants in treatment 2, where the tenderness levels of the steaks were revealed, were willing-to-pay about $0.62 more per pound for a guaranteed tender steak than were participants in treatment 1.

Summary and Conclusions

Consumers rank tenderness as the most important quality attribute in beef. Studies have shown that consumers perceive beef graded under the current USDA grading system to have too variable of tenderness. Recent advances in technology make more accurate measurement of beef tenderness possible. This study investigates the amount consumers are willing-to-pay for more tender steaks where steaks are classified according to one tenderness measurement system.

Results indicate that, in a blind taste test, 72 percent of consumers correctly identified and preferred tender relative to tough steak (as measured via Warner-Bratzler shear force tests). Moreover, when they relied only on steak taste samples to differentiate steaks, 36 percent of consumers were willing to pay an average of $1.23/lb. more for a tender than a tough steak.

Consumers provided with information regarding steak tenderness levels were more likely to choose a tender steak and willing to pay more for a tender versus a tough steak. When steaks were identified as guaranteed tender or probably tough prior to a taste test, 90 percent of consumers preferred the tender to the tough steak. Overall, consumers who received explicit information regarding steak tenderness levels were 18 percent more likely to choose a tender steak than they would have been without the tenderness information. Fifty-one percent of consumers informed of steak tenderness levels were willing to pay an average premium of $1.84 per pound (versus $1.23/lb. without tenderness information) to exchange a probably tough for a guaranteed tender steak.

Consumer demographics affected consumers' desire for tender vs. tough steak and the premium they were willing to pay for tender vs. tough steak. Older, more highly educated consumers were more likely to choose the tender over the tough steak. Among consumers willing to pay more for tender vs. tough steak, younger, more highly educated females with higher household income levels were willing to pay the largest premiums.

New technology makes it possible to grade steaks according to tenderness. Some consumers are willing to pay a significant premium for steaks that are guaranteed tender and the premium appears to exceed expected costs associated with implementing this tenderness classification system by a wide margin. Perhaps an advantage might be captured through niche marketing efforts resulting from implementing a tenderness-based quality grading system.

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