When Bigger Isn't Better: Steak Size and Consumer Preferences

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Abstract

The average cattle slaughter weight has increased more than 330 pounds over the past 40 years. With larger cattle have come larger steaks. In response, many retailers have begun offering thinner cuts to combat high total package prices. This article estimates consumer willingness to pay for beef steak dimensions using data from a national survey. Results imply that most consumers prefer thicker to thinner cuts steaks and that smaller surface areas are preferred to larger ones. Our estimates suggest that the forty-year increase in carcass weight has led to an $8.6 billion annual loss in consumer welfare resulting from changing steak size.

Introduction

The number of cattle slaughtered in the U.S. is near the lowest levels in decades. However, total beef production has actually increased since 1977 (figure 1). The U.S. produced approximately the same amount of beef in 2015 as in 1977 but did so with 13 million fewer cattle (USDA, NASS, 2016). This feat was accomplished through growing carcass sizes. Improved nutrition, growth promotion technologies, better genetics, and economic conditions have all played a role in cattle becoming more efficient (Lusk, 2013).

While it is difficult to disentangle which factors have most contributed to rising carcass weights, the culmination of these factors has led to adjustments in the production and flow of cattle throughout the supply chain. Average slaughter weight for cattle has increased by about 330 pounds (lbs.) over the past 40 years and approximately 100 lbs. in the past 10 years (USDA, NASS, 2016). Carcasses weighing between 600 lbs. to 900 lbs. will generally not receive a

discount based on carcass weight (USDA, AMS, 2016). The average carcass weights have been trending toward the upper bound of this range. Steer carcass weights in October 2015 averaged 926 lbs. which is the all-time monthly high and is a 26 lb. increase over October 2014 (USDA, NASS, 2016). Many meat packers have decreased or adjusted penalties for larger carcasses (USDA, AMS, 2016; CAB 2012). The average discount for a carcass between 900 lbs. and 1,000 lbs. was $6.82 per cwt in 2001-2002 and decreased to $1.59 per cwt in 2014-2015 (USDA, AMS, 2016). Even branded beef programs such as Certified Angus Beef have increased their carcass weight thresholds to allow larger cattle to qualify (Suther, 2006).

Not surprisingly, the increase in cattle slaughter weight has had a direct effect on the size of many beef cuts. Although some products (e.g., ground beef) are largely unaffected by changing carcass size, cuts from subprimal muscles such as the longissimus muscle (LM), the muscle containing the ribeye, are highly correlated with the carcass size. The National Beef Quality Audits, which have been conducted about every five years since 1991, reported average carcass weight and average ribeye area for each year audited (Lorenzen et al., 1993; Boleman et al., 1998; McKenna et al., 2002; Garcia et al., 2008; Gray et al., 2012). Between the 1991 audit and the 2011 audit, the average carcass weight increased from 761 lbs. to 825 lbs. and the average ribeye area increased from 12.9 square inches (in^2) to 13.8in^2. Not surprisingly, across these five audits, the correlation between the mean carcass weight and the mean ribeye area is 0.97. Thus, as carcass size has increased over the years, so has the size of steaks from these muscles (Rutherford, 2013; NBQA, 2011).

Larger carcass sizes have brought about benefits related to the environment (fewer cattle needed to produce a given quantity of beef) and for the consumer (larger supplies, leading to lower priced ground beef). However, larger steak sizes pose a concern for the beef industry as it

becomes more difficult to fabricate consistent sized retail cuts and profitability meet the expectations of foodservice and retail consumers (e.g., Behrends et al., 2009; Leick et al., 2012; Peel, 2015). The most recent National Beef Quality Audit listed weight and size as one of the top six quality challenges (NBQA, 2011). As a response to varying muscle sizes such as the ribeye, grocery stores and restaurants are often forced to adjust the thickness to which the steaks are cut in order to meet a target weight. Thus, a ribeye steak from a carcass with a large LM will likely be cut thinner than a ribeye steak from a carcass with a smaller LM. This has led to the introduction of "thin cut" steaks in some grocery stores. Compounding the issue of altering larger steaks are the historically strong beef prices. Some retailers utilize target prices for packages of steaks. Therefore, consumers are not only facing high beef prices, but also an increase in total package price due to the larger dimensions of the steak. This has caused retailers to reduce thickness to meet a target package price.

The purpose of this research is to estimate consumers' preferences for steak size dimensions in order to gain insights into the welfare effects that have resulted from the increase in average carcass weight. Such size dimensions include steak surface area (the length and width) and steak thickness; we consider the trade-off among these attributes and steak price for two types of steak.

Little research has examined the relationship and tradeoffs between steak surface area and steak thickness as it pertains to consumers' preferences. Leick et al. (2012) examined consumers' preferences for price, color, marbling, thickness, and visual texture by recruiting participants from college football picnickers. They found that consumers tended to select thinner ribeye steaks and thicker sirloin steaks, although not statistically significant at conventional

levels. They concluded that marbling, color, and thickness were more important to consumers than price in their experiment.

Sweeter et al. (2005) analyzed South Dakota consumer preferences for the size of beef cuts. They divided 50 carcasses into 5 different LM size categories with similar backfat and marbling scores. The ribeye area range for cattle in the smallest category (average 659 lb. carcass weight) was 9.4 in^2 to 10.5 in^2. For the largest category (average 853 lb. carcass weight) the ribeye area range was 16.3 in^2 to 18.4 in^2. They found consumers were willing to pay \$0.68 per pound more for the large (average 17.3 in^2) over average (average 13.2 in^2) sized steaks. Large steaks cut in half were also included and consumers discounted the "half-steaks" by \$0.46 per pound compared to the average sized steaks.

A large number of other studies have analyzed consumer preferences for other beef attributes such as marbling, tenderness, labelling, food safety assurances, and animal feed using survey or experimental methods (e.g., Lusk, Roosen and Fox, 2003; Killinger et al., 2004; Lusk, Fields, and Prevatt, 2008; Tonsor et al., 2009; Umberger, Boxall, and Lacy, 2009; Tonsor, Schroeder, and Lusk, 2013). Other studies have analyzed meat attribute preferences using retail price or scanner (e.g., Parcell and Schroeder, 2007; Taylor and Tonsor, 2013; Ward, Lusk, and Dutton, 2008). Some of these later hedonic studies found that retail price per pound is decreasing in package weight. However, none of these previous studies have focused specifically on preferences for the area and thickness of steaks.

The next section describes our survey instrument, which was delivered to a national sample of N=1,027 consumers. We then discuss how our data are analyzed, and results are presented. The results allow us to draw conclusions about how the increase in the average carcass size impacts consumers' preferences for steaks.

Methods

We developed a survey to determine how differing levels of surface area, thickness, type of steak, and price influence consumers' choices among alternatives. The attributes and the levels used in the survey are shown in Table 1. The first section of the survey included questions about consumers' steak purchasing habits. Only respondents who identified that they eat steaks were included in the sample.

The second section of the survey administered the choice experiment questions in which respondents chose between two steaks with varying levels of the attributes. The attributes were displayed and varied graphically as a consumer would see them in the meat case at a grocery store. A sample question is shown in Figure 2. Each question included a choice between a ribeye steak, a top sirloin steak, and a "none" or no-purchase option. These cuts were chosen because they are readily available in most grocery store settings and they include a higher value cut (ribeye) and a lower value cut (top sirloin).

The levels of the attributes were chosen based on industry averages and previous research. The linear relationship between carcass weight and ribeye area which is evident by the high correlation between these variables across the five National Beef Quality Audits allows for the use of carcass weight to estimate that the average ribeye area in 1977 was 9.8 in^2 for heifers and 11.5 in^2 for steers (USDA, NASS, 2016). Further, we estimated the average ribeye area to be 14.3in^2 for heifers and 15.5in^2 for steers in the last quarter of 2015. From these estimates, we chose 14 in^2 as the medium attribute level for ribeye area and varied the attribute by 4 in^2 to obtain the small and large levels of 10 in^2 and 18 in^2, respectively. The levels of top sirloin

steaks area were proportional to those of the ribeye steaks. The three thickness areas, 0.5, 1 and 1.5 inches, are similar to that of Leick et al. (2012) and are consistent with the ranges found by Bass et al. (2009) and Dunn et al. (2000). The range of prices was $5.00 to $15.00 per package for ribeye steaks and $2.00 per package to $10.00 per package for top sirloins. We chose to utilize price per package rather than per pound in our experimental design because package weight is linearly determined by the steak's area and thickness; to avoid price being perfectly collinear with these size attributes, it could not be based on the product's weight. Thus, we varied price on a per package basis in a way that it is completely uncorrelated with area and thickness.

Because these attributes are not the only ones which consumers notice when purchasing steaks, we took steps to minimize the influence of any other attributes besides those included in our study. To ensure that the steaks were as uniform as possible across varying sizes and thicknesses, only two steak photographs were actually used in the survey: one ribeye and one top sirloin. The steaks were purchased from a local grocery store. Photograph editing software was utilized to increase and decrease the size of the steaks while keeping the package and logos the same size. This was done to ensure that each steak for each cut has the same color and marbling. Because the thickness of steaks is often hard to see without actually picking up the package in a grocery store, only the overhead view of the steaks was presented. Respondents were told how thick each steak was and labels were affixed to each package indicating whether the steak was thin cut, medium cut, or thick cut. These labels are used by some retailers.

Given the attributes and attribute levels, the total number of possible combinations of steaks is 108 ($3^3 \times 2^2$) which is too many combinations to include on a single survey. Thus, an orthogonal fractional factorial design was generated such that all main effects and two way

interaction effects can be estimated. The final design included 27 choice questions. The 27 questions were blocked into three sets of nine. Each respondent was randomly assigned to a block, and each respondent answered nine choice experiment questions.

The survey was administered online to a sample of U.S. residents who are a part of a panel maintained by Survey Sampling, Inc. As indicated, the first two survey questions screened respondents by whether they had ever eaten or purchased as steak. Thus, we focus our sample on respondents who identified themselves as having eaten or purchased a steak at some point. The survey was completed by 1,027 respondents, a sample size sufficient to yield a sampling error of about +/- 3 percent for a dichotomous choice question at the 95 percent confidence level. The sample consists of a diverse mix of individuals with demographics broadly consistent with the U.S. population. Table A1 in the appendix shows the demographic characteristics of the sample.

Econometric model

Analysis of the choice data is based on the random utility framework of McFadden (1973). The probability that individual *i* choose steak option *j* in question *t* is given by:

2) $$Prob(option\ j\ is\ chosen) = \frac{e^{V_{ijt}}}{\sum_{k=1}^{3} e^{V_{ikt}}},$$

where

3) $$V_{ijt} = \beta_0 + \beta_1 thin_{jt} + \beta_2 thick_{jt} + \beta_3 small_{jt} + \beta_4 large_{jt} + \beta_5 none_{jt} + \beta_6 ribeye_{jt} + \beta_7 P_{jt}$$

where V_{ijt} is the systematic portion of the utility function determined by the steak attributes, $thin_{jt}$ is a dummy variable which equals one if the option is a 0.5 inch steak and zero otherwise, $thick_{jt}$ is a dummy variable which equals one if the option is a 1 and 0.5 inch steak and zero otherwise (coefficients for $thin$ and $thick$ are relative to the middle level of a 1 inch steak),

$small_{jt}$ is a dummy variable which equals one if the option is a 10 in^2 surface area steak and zero otherwise, $large_{jt}$ is a dummy variable which equals one if the option is an 18 inch surface area steak and zero otherwise (coefficients for $small$ and $large$ are relative to the middle level of a 14 in^2 surface area steak), $none$ is a dummy variable which equals one if the respondent chooses neither of the steaks in the question, $ribeye$ is a dummy variable that equals one if the option chosen is the ribeye steak (the *none* and *ribeye* coefficients are estimated relative to the *sirloin*, which is normalized to zero), and P_{jt} denotes price per package of steak.

In addition to the conditional logit model, a latent class model is estimated to allow for heterogeneity. This model captures respondent heterogeneity by estimating different marginal utilities for a finite set of consumer segments (Swait, 1994; Louviere et al., 2000; Nilsson et al., 2006). The unconditional choice probability is:

4) $$Prob(option\ j\ is\ chosen) = \sum_{m=1}^{M} s_m \frac{e^{V_{ijtm}}}{\sum_{k=1}^{3} e^{V_{iktm}}}$$

where *m* denotes the class, and s_m is the probability (or size) of class *m*. The estimation procedure is further discussed by Boxall and Adamowicz (2002), Greene and Hensher (2003), and Hu et al (2004). Following these authors, the number of classes is chosen based on the model with class size that minimizes the AIC and BIC model selection criteria. Willingness to pay for a change in a particular attribute are given in the conventional fashion as the ratio of the marginal utility estimates to the negative estimated price effect.

We are also interested in the overall welfare effects that have come about from the joint shift from smaller to larger steak areas and from thicker to thinner steaks. That is, we are interested in the welfare change brought about by the change in the steak choices available to consumers today and those available a few decades ago. To calculate the welfare change, we evaluated consumer welfare in the presence of choices between ribeye and sirloin steaks of

varying sizes and thicknesses. To accomplish this task, we compared a choice scenario in which the smallest surface area and thickest cut steaks (roughly equal to the choices that existed 40 years ago scenario) is compared with a choice among the largest surface area and thinnest cut steaks (roughly equal to the choices that exist today). In the comparison, prices are held constant at $10 per package for ribeye steak and $6 per package for sirloin steak[1]. As shown by Small and Rosen (1981) and Morey (1999), the expected maximum utility (CV) from making a choice from each choice set in scenario g is:

5) $$CV_g = \ln(e^{V_{ijt}}) + C$$

where C is Euler's constant and other variables are as previously defined. The change in consumer welfare (ΔW) in moving from one scenario (say with size attributes 40 years ago to those today) is:

6) $$\Delta W = \left(\frac{-1}{\beta_7}\right)[CV_1 - CV_2]$$

where β_7 is the estimated price effect.

Results

Estimates from the conditional logit model are presented in Table 2. The estimates for the surface area and thickness variables are relative to the middle level for each attribute, respectively. The estimates for ribeye and none are relative to the sirloin option (the coefficient for the none option represents the utility of not purchasing either of the steaks shown). The

[1] It is certainly true that these scenarios do not encompass all of the choices available to consumers at either time considered. Since steaks are a relatively heterogeneous product with respect to size, one could have purchased a large and thin steak 40 years ago. Likewise, small and thick ribeye or sirloin steaks can still be purchased today, although likely much harder to find than 40 years ago. However, due to the large increase in carcass size, we assume the choices available to consumers have shifted from small and thick steaks to large and thin steaks.

estimates are marginal utilities and all estimates are statistically significant at the one percent level.

Of particular interest are the relationships between the size levels. Considering the smallest levels for the area and thickness attributes, choosing the 10 in^2 area ribeye relative to the 14 in^2 ribeye decreased utility by 0.197 units while choosing the 0.5 inch thick ribeye relative to the 1 inch thick ribeye decreased utility by 0.521 units. For the largest levels, choosing the 18 in^2 area ribeye relative to the 14 in^2 ribeye increased utility by 0.098 units and choosing the 1.5 inch thick ribeye relative to the 1 inch thick ribeye increased utility by 0.13 units. This indicates that, in general, larger steaks are preferred. Choosing neither option decreased utility by 2.182 units and choosing the ribeye decreased utility by 0.249 units relative to the sirloin option. A one dollar increase in price per package implied a 0.028 unit decrease in utility.

Table 3 presents the willingness to pay estimates for each attribute level. Each of these estimates were also statistically significant. The respondents' willingness to pay was \$7.07/package less for the 10 in^2 area ribeye and \$3.51 more for the 18 in^2 area ribeye each relative to the 14 in^2 ribeye, respectively. The preference for larger steaks is consistent with that found by Sweeter et al. (2005). The respondents' willingness to pay was \$18.67 less for the 0.5 inch thick ribeye relative to the 1 inch thick ribeye and \$4.66 more for the 1.5 inch thick ribeye relative to the 1 inch thick ribeye, respectively. The respondents' willingness to pay was \$8.92 less for the ribeye steak compared to the sirloin steak.

Table 4 presents the latent class model, which allows for respondent heterogeneity, and accounts for the panel nature of the choice data. The AIC and BIC model selection criteria

suggested a five-class model. These five classes differ by the influence of the attributes on respondents choices.

The two largest classes were significantly influenced by the price of steak per package. Classes one and two represented 41.6 percent and 33.7 percent or respondents, respectively, and each class had a statistically significant negative estimate for the package price attribute. This implies that respondents in these classes were less likely to purchase an option with higher price per package. Figures 3 and 4 show how the marginal utilities for each of the two largest classes change relative to steak area and thickness, respectively. As shown in figure 3, the marginal utilities for each class increase with surface area up to the average level (14 in^2). From 14 in^2 to 18 in^2, marginal utility decreases for class one respondents but increases for class two respondents. Figure 4 shows that class two respondents have a strong aversion to the thinnest steaks and marginal utility increases up to the 1 inch thickness then decreases slightly. Also shown is that class one respondents always exhibit increasing marginal utility as thickness increases. Class one had the only statistically significant estimate for the thickest attribute level (1.5 inches) relative to the average level (1 inch). Respondents in class one also significantly preferred ribeyes to sirloins and their utility increased by 0.137 units when choosing a ribeye relative to a sirloin steak. Respondents in class two preferred sirloins to ribeyes and prefer the larger area (18 in^2) relative to the average area (14 in^2). The marginal utilities with the largest magnitudes for classes one and two are those for the none option relative to the sirloin option which implies that these respondents preferred to purchase a sirloin relative to not purchasing a steak.

Surprisingly, the marginal utility estimates for price per package were positive in classes three and four which represented 14.7 percent and 6.2 percent of respondents, respectively.

However, these estimates were very small and not statistically significant at conventional levels. The results for these two classes suggest that attributes other than price were more important influences on purchase decisions. Other than the estimate on price, respondents in class three exhibited similar preferences as those in class two, although at lower magnitudes. The statistically significant estimates indicate that class three respondents preferred the large area sirloins and expressed a significant distaste for the thinnest steaks. Class four respondents can best be described as respondents who are only concerned with the type of steak they choose. This is evidenced by the fact that the only statistically significant marginal utility estimates were for the none and ribeye options relative to sirloin option. The positive estimate for ribeye implies that this class preferred ribeyes to sirloins and their utility was increased by 3.75 units by choosing a ribeye relative to a sirloin. This effect was greater than the ribeye vs. sirloin effect in any of the five classes and, thus, this small class of respondents can be described as "ribeye loyalists" who greatly prefer ribeyes to sirloins regardless of the other attributes, including price.

Similar to class four, class five represents a small percentage of respondents only concerned with steak types in general. Though we recruited only steak eaters, 3.8 percent of respondents made choices indicating that not purchasing either of the steaks was the most important factor. This is shown by the estimate for the none option being the only statistically significant estimate and this class being the only class in which the estimate for the none variable was positive. It is possible that while this small proportion of respondents identified as steak eaters, they simply do not like ribeyes or sirloins. An example would be a respondent who only consumes filet mignon steaks.

Approximately 90 percent of respondents were negatively influenced by the thinnest cuts of steaks (0.5 inches) relative to the average (1 inch) as shown by the statistically significant

estimates in classes one, two, and three. Classes four and five also reported negative estimates for the thinnest cuts, though not statistically significant at conventional levels. Class two exhibited the greatest dislike for thin steaks as choosing a 0.5 inch steak relative to a 1 inch steak resulted in a 1.947 decrease in utility. All of the classes also reported negative estimates for the smallest area steaks (10 in^2) relative to the average area (14 in^2) though not all estimates were statistically significant at conventional levels.

It is also interesting to note that none of the classes selected present "clashing" attribute levels as was found in the conditional logit model results. The conditional logit model results suggested that consumers preferred the largest and thickest steaks at cheap prices (i.e., bigger is better). However, the separate classes of the latent class model show that consumers actually make tradeoffs between thickness and area as none of the classes preferred both the largest and thickest steaks at statistically significant levels.

Table 5 reports the willingness to pay estimates for the two largest classes which had a statistically significant estimate for the price per package. Respondents in class one were willing to pay $9.35 less per package for a 0.5 inch thick steak relative to a 1 inch steak. Similarly, respondents in class two discounted a 0.5 inch steak $20.20 relative to a 1 inch steak per package. Class one respondents were willing to pay $7.51 more for a ribeye steak per package relative to a sirloin and were willing to pay $14.81 more per package for a 1.5 inch steak relative to a 1 inch steak. The negative willingness to pay estimates for moving from the smallest area and thickest steaks (i.e., 40 years ago) to the largest area and thinnest steaks (i.e., today) indicate that respondents preferred the smallest area and thickest steaks. Respondents in class two discounted a large and thin steak by $9.47 relative to a small and thick steak. Likewise,

respondents in class one discounted a large and thin steak by $10.47 relative to a small and thick steak, though not statistically significant at the five percent level.

Table 6 reports the estimated welfare changes by moving from a scenario where the choice set include small area and thick steaks (40 years ago scenario) to a scenario where the choice set includes large area and thin steaks (today scenario). Estimated welfare changes were calculated for the conditional logit model as well as the two classes from the latent class model which had statistically significant estimates for price per package. The welfare change estimate from the conditional logit model implies that moving from the scenario representing 40 years ago to today's scenario decreased welfare by $5.37 per choice, an amount that is statistically significant at the five percent level. When multiplied by the number of steak purchases in the U.S. each year, estimates from latent classes one and two suggest decreases in total welfare of $5.8 billion and $2.8 billion[2], respectively, by moving toward a choice set with large area and thin steaks, though the estimate for class one is not statistically significant at the 5 percent level. Class two respondents were less negatively affected because respondents in this class exhibited the strongest preference for the largest steak areas out of the classes estimated.

[2] We conservatively estimate the number of steak purchases per year by multiplying the average number of annual steak purchases at grocery stores indicated by the survey respondents by the number of households in the U.S. (USCB, 2016). This number is then multiplied by the proportion in each latent class and then multiplied by the estimated welfare change for each class. These estimates are conservative because we only consider steaks purchased at grocery stores. On average, respondents to our survey indicated 24 steak purchases per year at grocery stores while another study indicated that at-home consumption per capita is approximately 17 ribeye steaks and 19 sirloin steaks per year (McCarty and Neuman, 2013). Further, the estimated welfare change also includes steak purchases that were considered but not actually made. These non-purchases are omitted from the total welfare loss calculation as no data are available.

Conclusions

Our results imply that consumers are heterogeneous in preferences for steak size but are generally in unison in their dislike for the thinnest cuts of steaks. Our results also reveal the importance of accounting for heterogeneity. While the conditional logit model reports that consumers prefer the largest levels of the steak attributes (i.e., bigger is always better), the latent class model reports statistically significant differences between segments of the respondents, and consumers face tradeoffs between steak area and thickness. Though latent classes differed on which attributes were most important, all classes showed a negative impact from the thinnest steak options. The statistically significant coefficients for steak thickness imply that consumers responded to a difference in thickness even in the absence of a side profile of the steaks was not shown – thickness mattered even though they could not actually see the steak thickness. Furthermore, consumers tended to value thickness slightly more than surface area as the marginal utility estimates for thickness were greater than those for surface area in most classes.

The decrease in consumer welfare by moving from a choice set containing small area and thick steaks to a choice set that includes large area and thin steaks implies that the changes in carcass size have led to a decrease in consumer utility from today's steak choices relative to the steak choices of a few decades ago. The aggregate welfare loss from the increase in carcass weight with respect to ribeye and sirloin steaks was $8.6 billion for the two largest classes. Of course, steaks are only one piece of the carcass and the increase in carcass size may have increased welfare with respect to other beef cuts (e.g., more ground beef per carcass). However, steaks represent an important portion of the total carcass value and it is possible that the increasing size of other cuts have also created less desirable end products for consumers.

The results provide evidence of a tradeoff that is occurring when consumers visit the meat section in grocery stores. Many grocery stores are offering thin cut steaks to combat larger steak surface areas due to larger carcass sizes in a desire to meet a target package price. The largest ribeyes are most likely to be cut thin while the smaller ones might be cut thicker, especially in stores selling pre-packaged steaks. The results shed light on how the increase in carcass size could be affecting consumers' decisions. Our results show that most consumers do not like the thin-cut steaks, nor do they like paying higher prices. Thus, marketing the largest surface area steaks is difficult because consumers do not want them to be cut thin but also do not want to pay for the higher package cost associated with the increased package weight.

One alternative, not considered in this analysis, is to maintain steak thickness but split steaks into two or more pieces. High-end steak restaurants seem very reluctant to market split steaks for traditionally whole muscle cuts (e.g., ribeye and filet mignon). However, there seems to be more of a tendency for steak splitting among mid-level restaurants and in food service (i.e., catering situations). The fact that this is happening is consistent with the results of the paper that steak thickness is preferred over surface area. However, the overall demand implication of marketing split steaks is unknown.

Our results offer implications to the beef industry regarding steaks. Increasing carcass sizes create steaks that are less desirable to most consumers. The majority of steak consumers dislike thin-cut steaks. Thus, if a retailer must decrease the thickness of a larger area steak in order to meet the same target package price once met with a small and thick steak, the end result is likely a less desirable steak for most consumers. If the welfare lost by larger steaks is not somehow offset by gains in other areas of the carcass, then the continuing industry trend toward larger cattle might be detrimental. Determining whether or not cattle are being slaughtered too

large is beyond the scope of this article because there are many factors to consider including the value of other cuts of the carcass and the production cost of the animal. However, we can argue that the most valuable cuts of the carcass have likely not become more attractive for the consumer. Because consumers are unwilling to sacrifice thickness in order to reduce package price, an increase in the area of cuts such as the ribeye and sirloin likely leads to a direct increase in the package price for the steaks which most consumers prefer.

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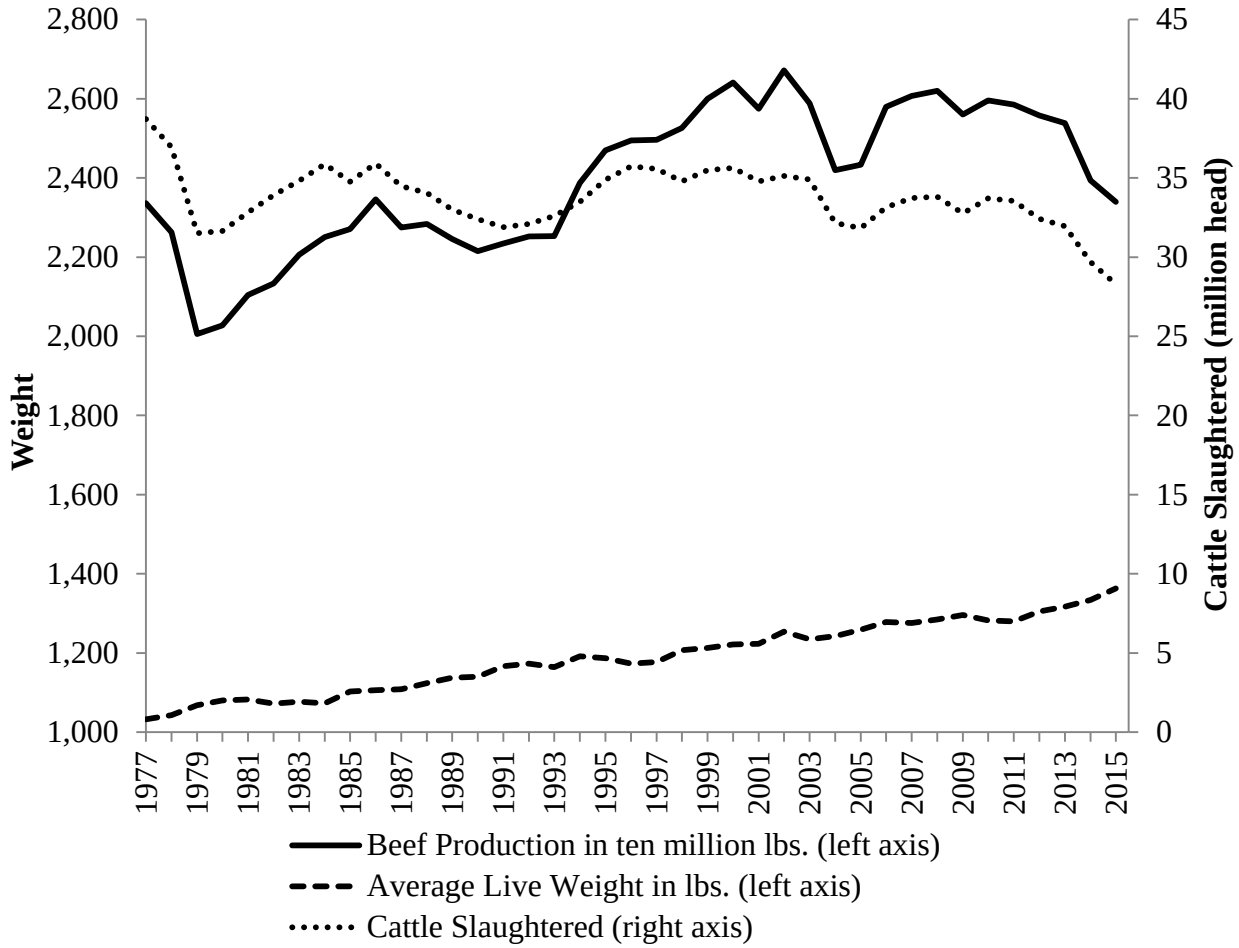

Figure 1. Annual average cattle slaughter and average live cattle weight from 1977 to 2014 (USDA, NASS 2016).

Figure 2. Sample choice experiment survey question.

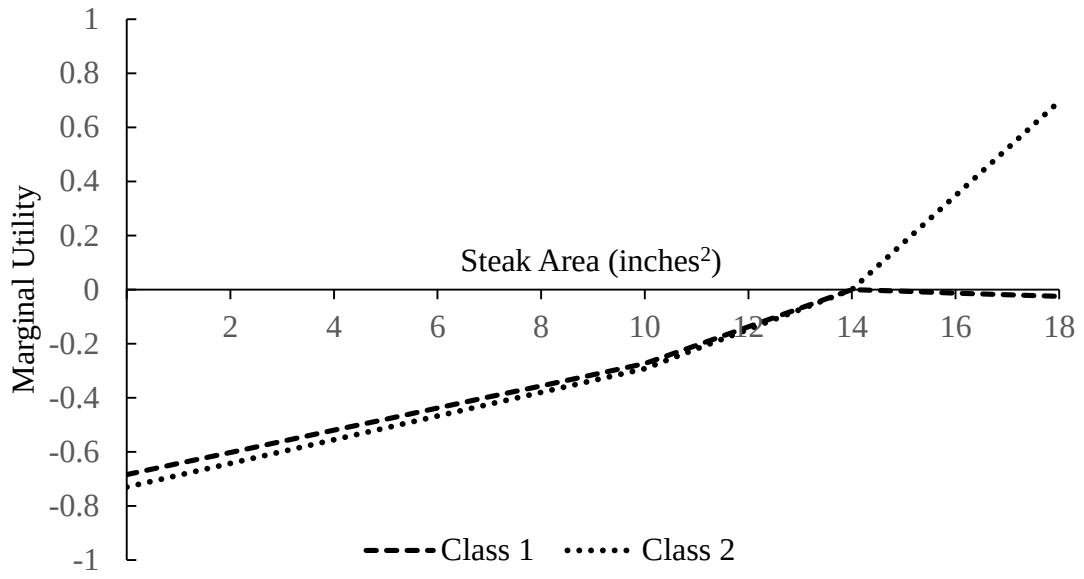

Figure 3. Marginal utility estimates over steak area (in^2) for latent classes one and two.

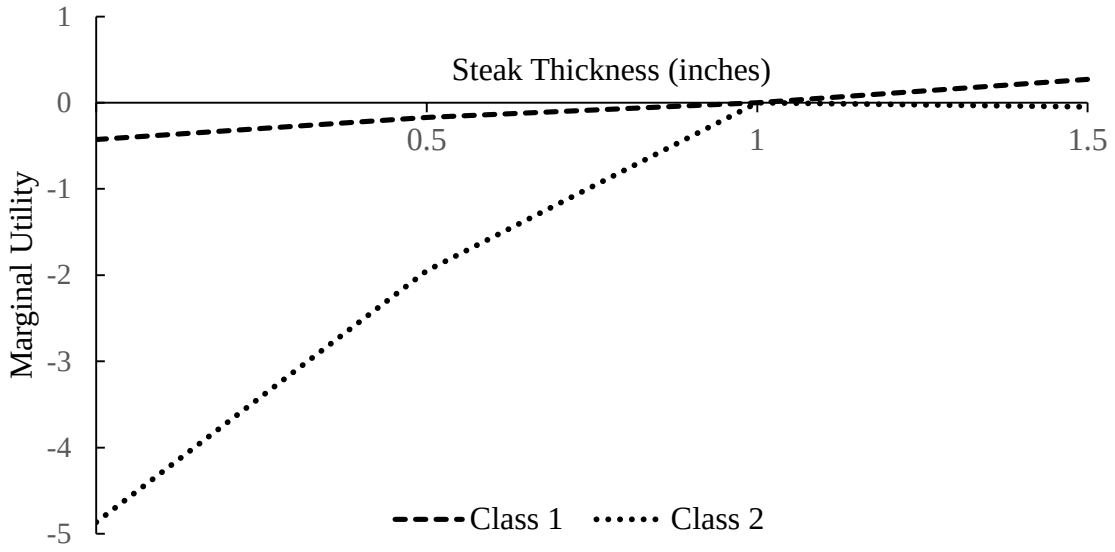

Figure 4. Marginal utility estimates over steak thickness (inches) for latent classes one and two.

Table 1. Attributes and Levels

Attribute	Levels
Thickness	0.5 inches
	1 inch
	1.5 inches
Ribeye steak area	10 in^2
	14 in^2
	18 in^2
Top sirloin steak area	20% decrease from average
	Average[a]
	20% increase from average
Ribeye steak price	$5.00 per package
	$10.00 per package
	$15.00 per package
Top sirloin steak price	$2.00 per package
	$6.00 per package
	$10.00 per package

[a] Because the top sirloin steak is not a uniform cut like the ribeye, the average steak size was visually estimated by the researchers. This average was then adjusted proportionally to the ribeye steak attribute levels.

Table 2. Conditional Logit Marginal Utility Estimates for Steak Attribute Levels and Price

Variable	Estimate	Std. Error
10 inch area vs. 14 inch	-0.197**	0.038
18 inch area vs. 14 inch	0.098**	0.037
0.5 inch thick vs. 1 inch	-0.521**	0.038
1.5 inch thick vs. 1 inch	0.130**	0.037
None vs. sirloin	-2.182**	0.055
Ribeye vs. sirloin	-0.249**	0.028
Price per package	-0.028**	0.004

Note: n=9,243 and AIC=16,406. Double asterisk (**) and single asterisk (*) denote significance at the 1%, and 5% percent levels, respectively.

Table 3. Willingness to Pay Estimates for Changes in Steak Attribute Levels ($/package)

Variable	Estimate	95% CI Lower	95% CI Upper
10 inch area vs. 14 inch	-7.07	-11.17	-4.20
18 inch area vs. 14 inch	3.51	0.87	6.95
0.5 inch thick vs. 1 inch	-18.68	-27.47	-13.54
1.5 inch thick vs. 1 inch	4.67	2.01	8.28
Ribeye vs. sirloin	-8.93	-14.65	-5.68

Note: Confidence intervals determined by the Krinsky and Robb (1986) method

Table 4. Latent Class Model Marginal Utility Estimates for Attribute Levels and Price

Class	Probability of Class Membership	Variable	Estimate	Std. Error
		10 inch area vs. 14 inch	-0.273**	0.064
		18 inch area vs. 14 inch	-0.024	0.070
		0.5 inch thick vs. 1 inch	-0.170*	0.068
1	0.416**	1.5 inch thick vs. 1 inch	0.269**	0.063
		None vs. sirloin	-4.082**	0.272
		Ribeye vs. sirloin	0.137*	0.068
		Price per package	-0.018*	0.007
		10 inch area vs. 14 inch	-0.292*	0.143
		18 inch area vs. 14 inch	0.696**	0.185
		0.5 inch thick vs. 1 inch	-1.947**	0.180
2	0.337**	1.5 inch thick vs. 1 inch	-0.047	0.115
		None vs. sirloin	-5.880**	0.340
		Ribeye vs. sirloin	-1.572**	0.129
		Price per package	-0.096**	0.012
		10 inch area vs. 14 inch	-0.100	0.112
		18 inch area vs. 14 inch	0.229*	0.112
		0.5 inch thick vs. 1 inch	-0.605**	0.125
3	0.147**	1.5 inch thick vs. 1 inch	0.094	0.117
		None vs. sirloin	-0.351*	0.178
		Ribeye vs. sirloin	-0.547**	0.110
		Price per package	0.011	0.013
		10 inch area vs. 14 inch	-0.805	0.689
		18 inch area vs. 14 inch	-0.194	0.455
		0.5 inch thick vs. 1 inch	-1.057	0.703
4	0.062**	1.5 inch thick vs. 1 inch	0.709	0.605
		None vs. sirloin	-2.847*	1.222
		Ribeye vs. sirloin	3.750**	0.990
		Price per package	0.010	0.064
		10 inch area vs. 14 inch	-0.141	0.386
		18 inch area vs. 14 inch	0.202	0.339
		0.5 inch thick vs. 1 inch	-0.509	0.411
5	0.038**	1.5 inch thick vs. 1 inch	-0.278	0.372
		None vs. sirloin	1.537**	0.475
		Ribeye vs. sirloin	0.133	0.499
		Price per package	-0.059	0.057

Note: n=9,243. (**) and (*) denote significance at the 1%, and 5% percent levels, respectively.

Table 5. Latent Class Model Willingness to Pay for Changes in Steak Attribute Levels ($/package)

Class	Probability of Class Membership	Variable	Estimate	95% CI Lower	95% CI Upper
1	0.416	10 inch area vs. 14 inch thick	-15.03	-67.94	-5.89
		18 inch area vs. 14 inch thick	-1.34	-15.73	7.10
		0.5 inch thick vs. 1 inch thick	-9.35	-38.05	-1.92
		1.5 inch thick vs. 1 inch thick	14.81	6.08	65.29
		Ribeye vs. sirloin	7.51	-1.24	31.52
		18 inch area and 0.5 inch thick vs. 10 inch area and 1.5 inch thick	-10.47	-44.49	1.20
2	0.337	10 inch area vs. 14 inch thick	-3.03	-6.50	0.13
		18 inch area vs. 14 inch thick	7.21	3.61	11.05
		0.5 inch thick vs. 1 inch thick	-20.20	-27.00	-15.48
		1.5 inch thick vs. 1 inch thick	-0.49	-2.87	1.91
		Ribeye vs. sirloin	-16.30	-22.43	-12.36
		18 inch area and 0.5 inch thick vs. 10 inch area and 1.5 inch thick	-9.47	-13.99	-5.63

Note: Confidence intervals determined by the Krinsky and Robb (1986) method

Table 6. Estimated Welfare Changes between Choice Sets with Small and Thick Steaks versus Sets with Large and Thin Steaks ($/package)

Model	Estimated Welfare Change	95% CI Lower	95% CI Upper
Conditional Logit Model	-5.37	-8.36	-3.52
Latent class 1	-4.95	-20.70	0.56
Latent class 2	-2.96	-4.53	-1.75

Note: The estimated welfare changes reported represent a move from the scenario with small area and thick steaks to the scenario with large area and thin steaks in dollars. Confidence intervals determined by the Krinsky and Robb (1986) method

Appendix

Table A1. Summary Statistics of Survey Respondents

Variable	Definition	Percentage of Respondents
Gender	Female	51.51%
Age	18-25 years	17.53%
	26-34 years	19.86%
	35-54 years	42.84%
	55-64 years	19.47%
	65 years or older	0.29%
Education	Some high school	2.92%
	High school diploma	19.38%
	Some college	26.29%
	Associate's degree	10.13%
	Bachelor's degree	28.14%
	Graduate degree	13.15%
Region	Midwest	20.76%
	Northeast	21.44%
	South	32.65%
	West	25.15%
Income	Less than $20,000	14.90%
	$20,000 to $59,999	38.17%
	$60,000 to $99,999	28.53%
	$100,000 to $139,999	10.32%
	$140,000 or more	8.08%
Eat steak	About once per week	34.37%
	A few times per month	32.91%
	About once per month	15.19%
	A few times per year	13.53%
	About once a year or less	3.99%
Purchase steaks at grocery store	About once per week	24.05%
	A few times per month	33.59%
	About once per month	19.28%
	A few times per year	14.22%
	About once a year or less	4.77%
	Never	4.09%

Note: n=1,027.