

Seasonality Effect on US Household Demand for Different Beef Cuts

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Abstract

Australia is one the largest exporters of beef and beef products to the United States (Haley & Jones, 2017). A better understanding of the American demand for beef is important since Australia is facing strong competition from Canada and New Zealand in the beef market. We applied a discrete choice experiment to investigate 946 American consumer preferences and willingness-to-pay (WTP) for different beef products. Consumers were presented with a novel experiment in which they indicated “how many” they would purchase for ground, diced, roast, and six cuts of steaks (sirloin, tenderloin, flank, flap, New York and cowboy/rib-eye).

The results from a scaled adjusted ordered logit model showed that after price, cues related to safety option purchases such as certified logo, type of packaging, antibiotic free and organic products play a stronger influential role on American consumers’ decision making (especially in summer where the opportunities for foodborne bacteria to thrive in warm weather is higher) compared to other beef attributes.

Furthermore, on average US consumers purchase diced and roast products more often in winter “as a slow cooked season” than in summer whereas New York strip and flank steak are more popular in summer as “the grilling season” than in winter.

Finally, this study provides managerial and policy implication and recommendations to help Australian exporters to better understand US consumer preferences for beef through an understanding of seasonal effects on demand for this good.

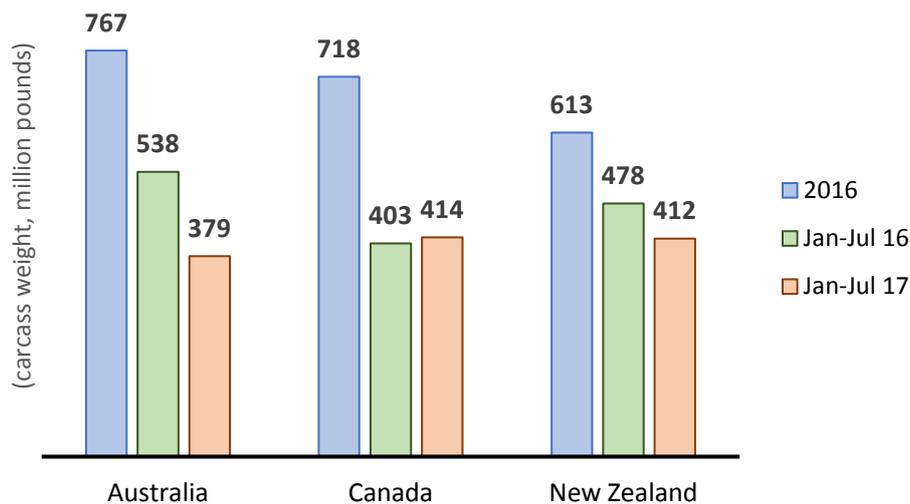
Keywords

Discrete Choice Experiments, Product Appearance, Labelling Information, Information Cues, Beef Preference, Ordered logit, Seasonality effect

1. INTRODUCTION

The United States (US) is an important importer of Australian meat. In terms of value in 2016, 24% of Australian exports of beef were shipped to the United States and had a value of AUS\$1.7 billion. This value is the second largest after Japan with 26% of Australian exports of beef valued at AUS\$1.8 billion (Meat & Livestock Australia, 2017). A better understanding of American demand for beef is important as Australia faces strong competition from Canada and New Zealand in the US beef market. In 2016 it was reported that Australia was ranked number one in exporting beef and veal to the United States. However, in the first-half 2017 Australia has relatively exported less beef than its competitors and the exported carcass weight has declined by 34% in comparison with the first half of 2016. Thus, it is prudent to have a better understanding of American consumers' preferences if Australia is to continue to expand exporting beef to this important market. This paper contributes to our understanding of how American consumers value judgements for beef products are formed by studying consumers' decision making over intrinsic and extrinsic information cues on several beef products for winter and summer hypothetical scenarios.

Figure 1: U.S. beef and veal export – carcass weight (million pounds)



Source: Economic Research Service, U.S. Dept. of Agriculture.

Beef demand in its simplest form is the price-quantity relationship of beef, which is influenced by prices of competing proteins and evolving consumer preferences. Consumer preferences for convenience, health benefits and taste influence the demand for specific products. Preference for different cuts of beef is not only based on perceived intrinsic and extrinsic cues, such as label information and appearance of a product, but also the context in which it is eaten. One context that has been recognized as important by the econometricians is modelling the seasonality effect on customer demand for goods and services (Lusk, Marsh, Schroeder, & Fox, 2001; Moskowitz & Beckley, 2009). According to Ghadirian et al. (1999) the key area of food habits in which seasonality plays a role comes from eating disorders, where seasonality is recognized as one of the external contributors. Although studies have looked at the importance of seasonality as a factor in beef purchasing habit such as seasonality effect on beef price (Capps, Farris, Byrne, Namken, & Lambert, 1994) quality graded cues (Farris & HOLLOWAY, 1990; Hogan Jr & Ward, 2003; Lusk et al., 2001), hedging wholesale beef cuts (Namken, Farris, & Capps Jr, 1994; Schroeder & Yang, 2001); there does not seem to be a

systematic analysis of seasonal effect on what specifically drives the purchasing behaviour and preference for different beef cuts. Moreover, whilst research has extensively addressed the effects of retail atmospherics such as scents, displays and sounds on consumer behaviour (Turley & Milliman, 2000) the effect of packaging design on consumer behaviour has only recently started to receive substantial attention (van Ooijen, Fransen, Verlegh, & Smit, 2017). To the author's knowledge, little scientific evidence exists regarding consumer preferences for intrinsic and extrinsic cues on packages of different beef cuts in United States. From a marketing perspective, the variety of information cues that can be used to target the final consumer raises the question: 'which information cues do consumers prefer over the others? Does season affect the importance of these information cues? And does demand for different cuts vary by season?' These questions are relevant for producers, processors and retailers in the beef industry for new product development which has a too-high fail rate (Dijksterhuis, 2016).

The objective of this study is to determine the relative value American consumers place on intrinsic and extrinsic attributes of different beef products using a novel discrete choice experiment as well as observing any seasonality effects. Attributes considered for this study included product appearance, such as packaging type, meat colour, fat colour and fat content (measured as fat marbling, fat rim and their combination) as well as a set of information that appears on the label of the product, which includes origin, price, brand, weight, traceability, type of feed, organic status, angus claim, pasture raised, non-GMO, natural, certified logo and expiry date.

From an empirical point of view this study contributes to the current literature by providing significant empirical findings that product developers can benefit from when improving existing products and developing new products. In addition, it identifies the main drivers of consumer choice when purchasing beef products in the United States. Furthermore, the findings will inform different functional departments within the food industry to effectively meet consumer needs (De Pelsmaeker, Dewettinck, & Gellynck, 2013; Fiszman, 2012; Jacobsen et al., 2014). From a study design perspective, this study is innovative in the elicitation of the discrete choice experiment, by replacing the typical "pick a product" mechanism used in traditional choice experiment surveys by further exploring the quantity aspect i.e., "how many" (including zero) products you will purchase arrangement. Furthermore, from a methodological point of view, this study applies an econometric model that specifically accounts for the underlying ordered structure of the purchasing behaviour to gain an understanding of the preferences beyond current studies utilising discrete choice experiments (DCEs).

2. LITERATURE ON BEEF LABELLING AND CONSUMERS VALUE

In the U.S., labelling of meat and poultry products intended for interstate commerce is closely regulated by the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA). The FSIS has strict rules regarding the content and appearance of meat or poultry product labels. These strict labelling requirements protect consumers by providing them with the knowledge needed to make informed purchasing decisions. Beef labelling gained momentum following the discovery of the bovine spongiform encephalopathy (BSE) disease in the U.S. in 1996, that led to widespread discussion in the popular media about the possibility of bioterrorism related to food safety and trade policy. Following the discovery of BSE, it was argued that mandatory country of origin labelling (COOL) would increase consumer demand for beef by allowing both domestic and international consumers to discriminate between BSE and BSE-free regions (Ikenson, 2004; Jin, Skripnitchenko, & Koo, 2004; Umberger, 2005). There are up to eight specific requirements for each product label: (1) product name, (2) inspection legend and establishment number, (3) handling

statement, (4) net weight statement, (5) ingredients statement, (6) address line, (7) nutrition facts, and (8) safe handling instructions (US Department of Agriculture & Service, 2005).

Bearing in mind the limited space available on the front side of the package, Australian producers, processors and retailers need to know which information cues - in addition to the mandatory ones - should be presented on the package to better target the final consumers. – This information provides them with precisely how American consumers' value judgements for beef products are formed.

The literature has revealed that when consumers form a value judgement as to their quality perceptions, it becomes necessary to break the concept of quality down into two major groups of factors (Asioli et al., 2017; Steenkamp, 1997). The first group are intrinsic attributes that permit objective measurement of quality. These qualities imbue the product with its functionality and relate to its physical aspect. According to Olson and Jacoby (1972), intrinsic attributes are specific to each product, disappear when it is consumed and cannot be altered without changing the nature of the product itself. Relevant intrinsic cues that unequivocally define a given category of beef includes sensory (i.e. colour, visible fat, cut of the meat) and nutritional attributes (Acebrón & Dopico, 2000). Extrinsic attributes, as the second group, are aspects that are related to the product but are not physically a part of it and can be changed without altering the physical product characteristic. Examples of extrinsic attributes that can significantly influence consumers in their choices are brand, price, package-layout and health claims (Jaeger, 2006; Lähteenmäki, 2013).

Visual impressions based on perceived intrinsic and extrinsic cues, such as label information and appearance of a product, are important inputs that may generate beef quality expectations. Numerous studies have been conducted looking at the importance of intrinsic and extrinsic cue for beef products using different models to understand consumer expectations (Acebrón & Dopico, 2000; Caputo, Scarpa, & Nayga, 2017; Chung, Boyer, & Han, 2009; De Pelsmaecker et al., 2013; Endrizzi et al., 2015; Grunert, 2015; Hoppert, Mai, Zahn, Hoffmann, & Rohm, 2012; Loebnitz, Schuitema, & Grunert, 2015; Reicks, 2006; Sánchez, Beriain, & Carr, 2012; Sasaki & Mitsumoto, 2004; Van Wezemael, Caputo, Nayga, Chrysochoidis, & Verbeke, 2014; Verbeke & Ward, 2006; Xue, Mainville, You, & Nayga Jr, 2009). Research that combines both intrinsic (sensory) and extrinsic factors makes it possible to obtain more complete and realistic information about consumer behaviour in real life buying and eating situations (Köster, 2009). Fat content has an impact on consumer visual attention and choice of beef products, with consumers paying more attention and choosing more often beef with lower fat content (Acebrón & Dopico, 2000; Banović, Chrysochou, Grunert, Rosa, & Gamito, 2016; Realini et al., 2014; Van Wezemael et al., 2014). On other hand, it has been shown that beef marbling is an important positive expectation generator in several markets because there are consumers who relate marbling with eating quality (Egan, Ferguson, & Thompson, 2001). Conversely, in some European markets, consumers tend to reject beef with high levels of marbling (Morales, Aguiar, Subiabre, & Realini, 2013; Scozzafava, Corsi, Casini, Contini, & Loose, 2016). Furthermore, food packaging has been repeatedly found to be a strong driver for consumers' food choice and packaging characteristics lead to significant market price differences (Carpenter, Cornforth, & Whittier, 2001; Loose & Szolnoki, 2012). Recent studies have been conducted focused on the effect of animal welfare information on beef (Caputo et al., 2017; Lewis, Grebitus, Colson, & Hu, 2017; Ortega, Hong, Wang, & Wu, 2016; Risius & Hamm, 2017) while other studies have related origin and production system (organic vs conventional) to beef expectation (Colella & Ortega, 2017; Lagerkvist, Berthelsen, Sundström, & Johansson, 2014; Lagerkvist & Hess, 2014; Ortega et al., 2016; Peterson & Burbidge, 2012; Risius & Hamm, 2017; Zanolli et al., 2013).

Many research has been conducted to elicit American consumers preference for intrinsic and extrinsic beef attributes, however to facilitate the choice experiment (CE) methodology Table 1 specifically

provides a detailed description of papers that have applied CE to the beef context only in the United States.

The literature reveals that beef quality traits such as colour, freshness and marbling of beef can influence American consumer purchasing decisions. Carpenter et al. (2001) conducted a study to determine American consumers' preferences for beef colours and for fresh beef packaging systems and to investigate whether their preferences influenced taste scores of beef steaks and patties. They conducted visual and taste evaluations among U.S. academics as well as students and found that their respondents preference for beef colour were rated respectively red, purple and brown and for packaging, overwrap with polyvinyl chloride was the most preferred followed by vacuum skin pack and then modified atmosphere packaging. Similar findings with regards to beef colour was concluded in Grebitus, Jensen, & Roosen (2013) study. Moreover, Italian (Zanoli et al., 2013) and Spanish (Realini et al., 2014) consumers also have similar preferences relating to meat colour as the American consumers.

Loureiro and Umberger (2007) studied American consumer's preference for food safety, COOL and traceability information. They conducted a choice experiment in order to analyse the relative preferences and willingness-to-pay (WTP) for meat attributes related to food safety in labelled rib-eye beef steaks for consumers. Their findings suggested that American residents were more readily willing to purchase meat products with food safety related labels and those labels also supported producers/retailers to obtain a significant price premium, including in relation to other types of labelling attributes such as product traceability information labels. While the price premium was higher for COOL labelling over traceability, they did conclude that consumers actually did value both attributes. Lim, Hu, Maynard, & Goddard (2012) conducted a choice experiment to elicit consumer willingness to pay (WTP) for BSE-tested and traceable beef. They concluded that consumers are willing to pay a premium for traceable and BSE-tested beef. Furthermore, concerns about BSE, influence of food manufacturer/ retailers over food safety, risk perception and risk attitude were factors that influence consumers' WTP for traceable and BSE-tested beef. Furthermore, Abidoye, Bulut, Lawrence, Mennecke, and Townsend (2011) studied American consumers preferences for quality attributes on beef products. They found that consumers had a high preference for traceability, grass-fed beef and U.S. country of origin attributes. More recently, (Lim & Hu, 2013) investigated the extent to which U.S. consumers are more receptive to imported steak and their perceptions of food safety level of beef from Canada and the United States. They conducted a choice experiment using an online survey. Apart from the difference in willingness to purchase (WTP) between domestic-labelled beef and imported beef, some other attributes that were considered related to assurance of meat tenderness, the perceived risk of food borne diseases, tenderness, feed types and organic practice. Their findings shows that U.S. consumers are willing to pay significantly less for imported steaks. Other beef attributes such as traceable, BSE and tenderness are respectively important to U.S. consumers.

Tonsor, Schroeder, and Lusk (2013) conducted an experiment using a split sample design for an online survey in order to investigate U.S. consumer preferences for origin information labels on beef products. They found that consumers are willing to pay premiums for products carrying origin labels. More specifically, they realized that products with labels showing "Product of North America" or "Product of United States" were more preferred to labels showing "Product of Canada, Mexico and US".

Loureiro and Umberger (2003) surveyed a sample of Colorado consumers and reported that consumers were willing to pay large premiums to obtain "Certified US" beef. Furthermore, they affirmed that high food safety perceptions associated with U.S. beef were one of the primary driving forces for the premiums. In another COOL study by Umberger, Feuz, Calkins, & Sitz (2003), experimental methods were used to determine Chicago and Denver consumers' preferences for steak after visually evaluating and bidding on two steaks, which differed only in package labels. They also

found that a majority of their respondents were willing to pay average premiums of about 20 percent for the US-labelled steak.

Lusk, Roosen, and Fox (2003) compared the preferences of European and US consumers, investigating consumer preferences and WTP for beef rib-eye steaks without growth hormones in France, Germany, United Kingdom and United States. Their findings indicate that European consumers preferred beef from animals that have not been fed with genetically modified corns more than U.S. consumers. More specifically, they also noted that French consumers valued beef with no added growth hormones more than U.S. consumers.

Table 1: Research articles used choice experiments to study consumer preference for intrinsic and extrinsic attributes for beef products in United States.

Year	Country	Author	Estimation Model	Main Findings
2001	United States	Carpenter, Cornforth, and Whittier (2001)	Fishers least significant difference procedure	Consumer preference for beef colour were rated respectively red, purple and brown and for packaging, overwrap with polyvinyl chloride was the most preferred followed by vacuum skin pack and then modified atmosphere packaging. It was also concluded that consumer preferences for beef colour and packaging influenced likelihood to purchase, but did not bias eating satisfaction. On average, consumers were willing to pay a 30.6% premium for corn-fed beef. Sixty-two percent of the participants were willing to pay an average premium of \$1.61 more per pound for the corn-fed beef, 23% of the consumers were willing to pay a premium of \$1.36 more per pound for the grass-fed beef, only 15% of the consumers were indifferent.
2002	United States	Umberger, Feuz, Calkins, & Killinger-Mann(2002)	Multinomial logit model	French consumers place a higher value on beef from cattle that have not been administered added growth hormones than U.S. consumers. European consumers place a much higher value on beef from cattle that have not been fed genetically modified corn than U.S. consumers.
2003	France, Germany, United Kingdom, and the United States	Lusk, Roosen, and Fox (2003)	Random parameters logit model	Econometric results indicate that surveyed consumers are willing to pay an average of \$184 per household annually for a mandatory country-of-origin labelling program. Respondents were also willing to pay an average of \$1.53 and \$0.70 per pound more for steak and hamburger labelled as "U.S. Certified Steak" and "U.S. Certified Hamburger," which is equivalent to an increase of 38% and 58%, respectively, over the initial given price.
2003	United States	Loureiro and Umberger (2003)	Multinomial logit model	Survey results indicate that the majority of consumers (73%) were willing to pay an 11% and 24% premium for COOL of steak and hamburger, respectively. In the auction, consumers were willing to pay a 19% premium for steak labelled "Guaranteed USA: Born and Raised in the US." Food safety concerns, a preference for labelling source and origin information, a strong desire to support U.S. producers, and beliefs that U.S. beef was of higher quality, were the most common reasons consumers preferred COOL.
2003	United States	Umberger, Feuz, Calkins, & Killinger-Mann(2003)	Multinomial logit model	Japanese and Mexican consumers have WTP preferences that are nonlinear in the level of food safety risk reduction. Conversely, U.S. and Canadian consumers appear to possess linear preferences.
2007	United States, Canada, Japan, and Mexico	Tonsor, Schroeder, Pennings, & Mintert (2007)	Mixed logit models	

Table 1: (continued)

Year	Country	Author	Estimation Model	Main Findings
2009	United States	Gao & Schroeder (2009)	Mixed logit model	<p>It was concluded that for different types of consumer's WTP for beef steak attributes varies significantly and their responses to new attribute information are different. Over all, there was no significant difference between the responses to new information between consumer groups. However, in the case where cue attributes existed, consumers with small family size, less children, lower income, are single and younger, respond significantly intensive to the new information than other consumers.</p> <p>Finding shows that palatability attributes play a central role in determining consumers' preferences and WTP. Furthermore, consumers' nutrition knowledge, beef consumption behaviour, health condition, living alone status and household size have significant impacts on their WTP for grass-fed beef.</p>
2010	United States	Xue, Mainville, You, & Nayga (2010)	Probit model	<p>U.S. consumers have strong valuation for traceability, grass-fed, and U.S. origin attributes in a standard rib-eye steak.</p>
2011	United States	Abidoye, Bulut, Lawrence, Mennecke, and Townsend (2011)	Conditional and random parameters logit model	<p>Results showed that consumers are willing to pay a premium for traceable and BSE-tested beef. Furthermore, concerns about BSE, influence of food manufacturer/ retailers over food safety, risk perception and risk attitude were factors that influence consumers' WTP for traceable and BSE-tested beef.</p>
2012	United States	Lim, Hu, Maynard, & Goddard (2012)	Mixed logit model and Conditional logit model	<p>Consumers prefer cherry red ground beef with a 14 day shelf life. Americans are willing to pay higher prices for longer shelf life than Germans. Germans show a significantly higher WTP for cherry red ground beef than US Americans.</p>
2013	United States and Germany	Grebitus, Jensen, & Roosen (2013)	Mixed logit models	<p>U.S. consumers are willing to pay significantly less for imported steaks. Other beef attributes such as traceable, BSE and tenderness are respectively important to U.S. consumers.</p>
2013	United States	Lim and Hu (2013)	Error component logit model	<p>U.S. consumers are willing to pay premiums for products carrying origin labels such as "Product of North America" or "Product of United States".</p>
2013	United States	Tonsor, Schroeder, and Lusk (2013)	Interval-censored model	<p>Results suggest that the way a subject processes food attributes depends not only on the design dimensions but also on food attributes' functional roles. When complexity of designs increases, models that account for different sources of heterogeneity have better fit to the data. In terms of beef attribute Americans have ranked US Certified, Tender and Lean respectively as the most important attributes when purchasing beef.</p>
2017	United States	Caputo et al. (2017)	Error Component Model	
2007	United States	Loureiro and Umberger (2007)	Conditional multinomial logit model	<p>U.S. consumers value certification of USDA food safety inspection more than any of the other choice set attributes, including country-of-origin labelling, traceability and tenderness.</p>
2009	Canada, Japan, Mexico, and the United States	Tonsor, Schroeder, Pennings, & Mintert (2009)	Mixed logit model	<p>Consumers in Canada, Japan, Mexico, and the United States have willingness to pay preferences that are nonlinear in the level of food safety risk reduction. In particular, consumers in Japan and Mexico have preferences that are convex and consumers in Canada and the United States have preferences concave in the level of food safety enhancement.</p>
2009	United States	Umberger, Thilmany McFadden, & Smith (2009)	Probit model	<p>The results indicate that the probability a consumer will pay more or less of a premium depends on purchase behaviour and shopping location, stated importance of production attributes, awareness and interest in private and civic agricultural issues, in addition to some typical demographic variables such as income.</p>

3. METHOD

One set of approaches for enhancing understanding of consumer behaviour involves analyses of consumer choices. These choice studies primarily rely on modelling consumer behaviour using either a random utility theory framework (McFadden, 1974) or Lancaster's (1966) consumer utility maximization model. Discrete Choice Experiments (DCE) (Louviere & Hensher, 1982; Louviere, Hensher, & Swait, 2000), based on the random utility theory, now have a mature microeconomic foundation that allows for measurement of the relative importance of various attributes in consumer behaviour through participants' repeated selection of goods with different combinations of attributes, thus assessing the participants' preferences for the attributes by analysis (Hanemann & Kanninen, 1998). While relationships between individual consumer attitudes, preferences and actual purchasing behaviours are complex (McEachern, Seaman, Padel, & Foster, 2005), DCEs and their use of consumer panels opens up the possibility of exploring multiple attributes influencing purchasing decisions across populations of consumers.

There are several reasons for the increased interest in discrete choice experiments in addition to those mentioned above. It reduces some of the potential biases of contingent valuation methods, more information is elicited from each respondent and the possibility of testing for internal consistency (W. Adamowicz, Boxall, Williams, & Louviere, 1998; Hanley et al., 1998). DCEs can create decision scenarios very similar to the real-world decision making situation where the decision maker behaviour can be examined (Mark & Swait, 2004). DCEs do a better job than contingent valuation in measuring the marginal value of changes in the characteristics of the goods (Hanley et al., 1998). This is often a more useful focus from a management/policy perspective than focussing on either the gain or loss of the good, or on a discrete change in its attributes. However, welfare value estimates obtained with DCEs are sensitive to study design (Hanley, Mourato, & Wright, 2001). For example the choice of attributes, the levels chosen to represent them, and the way in which choices are relayed to respondents (for example, through the use of photograph pairs) may all impact on the values of estimates of consumers' surplus and marginal utilities (Hanley et al., 2001).

Another concern with DCE is the choice complexity. Swait and Adamowicz (1996) found an inverted V-shaped relationship between choice complexity and variance of underlying utility amounts; whilst Mazotta and Opaluch (1995) found that increased complexity leads to increased random errors. Bradley and Daly (1994) have found that respondents become fatigued the more choices they are presented with, whilst Hanley et al. (2002) found that value estimates for outdoor recreation changed significantly when respondents were given eight rather than four choice pairs. Ben-Akiva and Morikawa (1990) and Ardeshiri (2014) found evidence of inconsistent responses that increase as the number of rankings increase. This implies that, whilst the researcher might want to include many attributes, and also interactions between these attributes, unless very large samples are collected, respondents will be faced with daunting choice tasks. This may lead them into relying on shortcuts to provide answers, rather than solving the underlying utility-maximisation problem. Finally, Lancaster and Swait (2014) argue that it is essential that the analyst chooses a representative process validity when analysing a DCE. Lancaster and Swait explain further that by *process validity* they mean that the decision process described by a mathematical and/or statistical model should be plausible/valid at the desired level of representation because it bears a semblance to the actual decision process(es). For example, if decision makers are actually using threshold-based satisficing as their decision rule, while the mathematical representation of the process employs instead utility maximisation, then we would understand that the process validity of the model is lower than if it were to represent the actual decision rule.

3.1 EXPERIMENT DESIGN AND MATERIALS

Consumers' preferences were achieved using a novel choice modelling framework. Individuals could select how many of each (including none) given beef product would they most likely purchase. For this study we investigated these attributes on ground, diced, roast, sirloin, tenderloin, flank, flap, New York strip and cowboy (rib eye)¹ using a discrete choice experiment. Each individual was assigned to a winter or summer scenario and given four sets to complete. In each set four random alternatives () that contained the relevant attributes and levels were present. In a given choice set alternatives were allowed to be repeated. Based on the season that was assigned to the individual, a current weather widget appeared next to the task to remind the individual about the hypothetical season and help them to assume that they are shopping under similar circumstances to their grocery shopping in winter/summer time.

Figure 2: The use of weather widget to create hypothetical season.



Representing **winter** scenario



Representing **summer** scenario

For the experimental design we applied an orthogonal “main effects” experimental design (Louviere et al., 2000) to a diverse list of attributes such as fat colour, meat colour, marbling (ground and diced beefs were excluded) types of packaging, origin/brand², claim attributes, weight and price (please see Table 2 for the full list of attributes and levels). Ngene software was used to generate the design for this study. The final design had a D-error of 0.0136 and included 200 choice tasks in 50 blocks providing each participant with 4 repeated choice occasions. We replaced the typical “pick a product” mechanism used in traditional choice experiment surveys with an ordered logit structure and asked individuals to respond to “how many” (including zero) products they would purchase. Figure 3 presents a snapshot of the DCE task used for this study.

¹ The selection of the beef cuts was developed in consultation with the industry partner involved in the ARC grant associated with this research.

² For the design of this study country of origin and brands have been constrained and are coincident.

Figure 3: Sample choice experiment task.

Sirloin Steak		Flap		Sirloin Steak		Ground	
Brand		Brand		Brand		Brand	
Country of Origin New Zealand		Country of Origin Australia		Country of Origin USA		Country of Origin USA	
Feed Grain-fed		Feed Grass-fed		Feed Grain-fed		Feed Grass-fed	
Certification No Certification		Certification		Certification		Certification	
Claims Angus Pasture raised/not confined Non-GMO		Claims Traceable back to farm No added antibiotic No added hormones Angus Natural		Claims No added antibiotic No added hormones Angus Pasture raised/not confined Non-GMO		Claims No added hormones Organic Angus Pasture raised/not confined	
Use-by date	3 days to expiry	Use-by date	14 days to expiry	Use-by date	7 days to expiry	Use-by date	14 days to expiry
\$/lb	\$20.00	\$/lb	\$20.00	\$/lb	\$26.00	\$/lb	\$18.00
Net weight	8(oz)	Net weight	12(oz)	Net weight	12(oz)	Net weight	16(oz)
Total Price	\$10.00	Total Price	\$15.00	Total Price	\$19.50	Total Price	\$18.00
Please indicate the quantity of packages that you would purchase for each product. If none, please enter the number zero (0).							
<input type="text"/>		<input type="text"/>		<input type="text"/>		<input type="text"/>	

3.2 PARTICIPANTS

In April 2017 an online survey focused on labelling preferences for beef products was completed by 946 American residents located at the north eastern states including Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont. From the 946 respondents 468 were allocated a summer scenario and 478 were assigned to the winter scenario. Summary data of selected demographic attributes of survey respondents are provided in Table 3. The survey was conducted amongst US residents aged 18 years and above, who had primary or shared responsibility for grocery shopping for their household as well as for their household’s meat purchases. No gender-based weighting was applied, as we wanted to speak to qualified meat purchasers (the sample was 477 female, 469 male). Participants were from different types of households with the majority as “Couple family with children” with an average household size of 3.2. The modal age group was the 25-34 years with 28.1% of the sampled population. More than 33% of the sampled population indicated that their household income is \$75,000 to \$100,000 per annum. More than 87% of the respondents were earning income. They were either working full-time (58.8%), part-time (15.1%) or retired (13.9%). Only 30% respondents indicated that they have graduated college or attended some school. The majority of respondents (39%) purchase beef once a week whereas 24% purchase it twice a week or more, 21% purchase beef 2 or 3 times a month and 16% purchase beef once a month or less.

Table 2. Attributes and levels in the choice experiment

Attribute	Levels			
Fat Colour*	1-White (0)		2-Light yellow (4)	
				
Meat Colour*	1-Pink (1A)		2-Red (3)	
				
Marbling*	1-Not marbled (0)		2-Somewhat marbled (4)	
				
Type of Packaging	<p>1-Tray Packed (TP) Tray packed meat is when the meat is packed into an open container or tray, and covered with a film. This is mainly used in smaller primal cuts or portioned meat.</p> <p>2-Vacuum Packed (VP) Vacuum Packed involves the removal of air and oxygen from the packaging. This creates a vacuum and assists in the preservation of meat and improvement in meat quality due to the lack of oxygen around the meat that promotes bacterial growth.</p> <p>3- Fresh from the butcher.</p>			 
Brand³	1-Brand 1 5-Brand 5	2- Brand 2 6- Brand 6	3- Brand 3 7- Brand 7	4- Brand 4 8- Brand 8
Claim attributes	1-Grass fed 4- No added Antibiotic 7- No added Hormone 10- Natural	2-Grain fed 5-Organic 8- Pasture Raised/ Not confined	3-Traceable back to the farm 6-Angus 9- Non-GMO	
Best before	1-One day to expiry 4-Fourteen days to expiry	2-Three days to expiry	3-Seven days to expiry	
Weight	<i>Ground, diced & Flap:</i> <i>Roast:</i> <i>Sirloin:</i> <i>New York Strip & Flank:</i> <i>Tenderloin:</i> <i>Cowboy:</i>	12(OZ), 16(OZ) 3(Lb), 5(Lb) 8(OZ),12(OZ) 6(OZ),12(OZ) 4(OZ),9(OZ) 1(Lb), 1.5(Lb)		
Price (\$US/per lb)	<i>Ground, diced & Flap:</i> <i>Roast:</i> <i>Sirloin, Flap & Cowboy:</i> <i>New York Strip:</i> <i>Tenderloin:</i>	\$6, \$12, \$18, \$24 \$8, \$14, \$20, \$26 \$14, \$20, \$26, \$32 \$12, \$18, \$24, \$30 \$30, \$42, \$54, \$66		

*Note that we used the handbook of Australian meat standards to present the levels for these attributes. The number between the parentheses refers to the reference standard score. Please see the following link for more information. <https://www.ausmeat.com.au/custom-content/cdrom/Handbook-7th-edition/English/DA71F4DE-F68A-11DA-AA4B-000A95D14B6E.html>

³ Brands have been de-identified for confidentiality reason. Brands 1 & 7 are from Australia only, brands 2, 4 & 6 are from United States only and other brands are sourced from a mixture of countries.

Table 3. Demographic variables and summary statistics of choice experiment participants

Variable	Definition	Statistics
<i>Gender</i>		
	Male	50.4%
	Female	49.6%
	Total participants	946
<i>Age</i>		
	Modal age group	25-34 years (28.1%)
<i>State of origin</i>		
	New York	72%
	Other	28%
<i>Household type</i>		
	Couple family with no children	16%
	Couple family with children	33.2%
	One parent family	6.7%
	Single person household	15.6%
<i>Household size</i>		
	Average household size	3.2
<i>Household income</i>		
	Modal income bracket	\$75,000 to \$100,000 (33.2%)
<i>Employment</i>		
	Full-time	58.8%
	Part-time	15.1%
	Retired	13.9%
	Un-employed	12.2%
<i>Education</i>		
	Graduate degree	30%
	Bachelor's degree	32%
	Associate's degree	8%
	College graduate or less	30%
<i>Dwelling status</i>		
	Owned	71.6%
	Renting	28.4%
<i>Beef consumption frequency</i>		
	2+ per week	24%
	Once a week	39%
	2 or 3 a month	21%
	Once a month	16%

3.3 DATA ANALYSIS

As mentioned previously, for this study we are interested in observing the seasonality effect on American household demand for different beef cuts. A hypothetical scenario representing summer and winter was designed to investigate any differences in beef purchasing behaviour for “the grilling season” versus “the slow cook season”. Furthermore we designed the experiment allowing respondents to answer how many of each (including none) given beef product they are willing to purchase, which is different to the “picked products” mechanism used in traditional choice experiment surveys. Participants response to the “how many” ranged from zero to ten quantities.

Attributes in DCE with qualitative levels have typically been handled in the food economics literature by a number of dummy coded variables. For this study we have used effects coding which is an alternative to dummy coding, wherein the effects are uncorrelated with the intercept (Louviere et al.,

2000). When effects coding is applied the constant term can only reflect the utility associated with the fixed comparator and misinterpretation is not possible (Bech & Gyrd-Hansen, 2005).

For any individual, we might reasonably hypothesize that there is a continuously varying strength of preference for beef purchasing that would underline the “how many” they submit. For convenience and consistency with what follows, we will label that strength of preference “utility,” V . Given that there are no natural units of measurement, we can describe utility as having the following range:

$$-\infty < V_{im} \leq \infty$$

where i indicates the individual and m indicates the beef product. Individuals are invited to choose “how many” of the product they want on an integer scale from 0 to 10. Logically, then, the translation from underlying utility to a rating could be viewed as a *censoring* of the underlying utility,

$$\begin{aligned} y_{im} &= 0 \text{ if } -\infty < V_{im} \leq \tau_{m1} \\ y_{im} &= 1 \text{ if } \tau_{m1} < V_{im} \leq \tau_{m2} \\ &\vdots \\ y_{im} &= j \text{ if } \tau_{mj} < V_{im} \leq \infty \end{aligned} \quad (1)$$

The thresholds, τ_{mj} , are specific to the beef cut and number ($J-1$) where J is the number of possible ratings (here, eleven) $J-1$ values are needed to divide the range of utility into J cells. Moreover, to preserve the positive signs of all of the probabilities, it is required $\tau_j > \tau_{j-1}$. The thresholds are an important element of the model; they divide the range of utility into cells that are then identified with the observed ratings. One of the admittedly unrealistic assumptions in many applications is that these threshold values are the same for all individuals. Importantly, difference on a rating scale (e.g., 0 compared to 1, 1 compared to 2) are not equal on a utility scale; hence we have a strictly nonlinear transformation captured by the thresholds, which are estimable parameters in an ordered choice model.

The model as suggested thus far provides a crude description of the mechanism underlying an observed choice. But it is simple to see how it might be improved. Any individual brings their own set of *preferences* for the beef attributes to the utility function, such as meat colour, fat colour, packaging, etc. which we denote $x_{i1}, x_{i2}, \dots, x_{iK}$. They also bring their own covariates (sociodemographic variables) $z_{i1}, z_{i2}, \dots, z_{iK}$ to allow for covariate specific heterogeneity. And finally an aggregate of unmeasured and unmeasurable (by the statistician) idiosyncrasies, denoted ε_{im} . How these features enter the utility function is uncertain, but it is conventional to use a linear function, which produces a familiar random utility function,

$$U_{im} = ASC_i + \beta_i x_{ik} + \gamma_i z_{ik} + \varepsilon_{im} \quad (2)$$

Estimation of the parameters is a straightforward problem in maximum likelihood estimation (Greene & Hensher, 2010). Initially two separate ordered logit were estimated for summer and winter scenarios. Coefficients from the two models were then plotted to determine whether the preferences expressed through the two methods were similar (proportional) (Hensher, Louviere, & Swait, 1998; Huynh, Coast, Rose, Kinghorn, & Flynn, 2017; Swait & Bernardino, 2000). This provides an initial indication as to whether pooling of data is likely to be possible, that is, that respondents are using similar cognitive processes when completing each task, albeit with a change in the decision context. Formal testing for the pooling of the data was conducted. This followed the Swait and Louviere (1993) approach to pooling different sources of data. A Chow test for pooling data (Swait & Louviere, 1993) was used. The test statistic compares the sum of the log likelihood from the ordered logit models for each season to a log likelihood function from ordered logit models that adjusts for scale differences across the data sources (Swait, 2006). The hypothesis was homogeneity in preferences across the

seasons, whilst allowing for variance scale differences across these two datasets. Passing this test at the 1% significance level indicated that it would be appropriate to combine the datasets as long as the different variance scales were accounted for. The combined data were analysed using a seasonality scale⁴ adjusted ordered logit model using Python Biogeme 2.4. (Bierlaire, 2016). The final utility function to be estimated for decision maker n is:

$$U_{im} = \exp(\mu_{c_b s_j}) [ASC_i + \beta_i x_{ik} + \gamma_i z_{ik} + \varepsilon_{im}] \quad (3)$$

Where $\mu_{c_b s_j}$ represent the scale value for cut b and season j . Attributes were measured for beef specific alternatives as well as season specific parameters, however some attributes were allowed to be estimated as generic across all or a range of beef products. Using Louviere et al. (2000) log likelihood ratio test all coefficients that were not significant at the 90% level of accuracy have been removed. All coefficients presented are statistically significant at conventional critical levels, and the relationship with the utility function is as expected.

4. RESULTS

Estimation resulted from a scaled adjusted ordered logit model are presented in several tables. Tables 4 and 5 presents seasonal parameter estimates for specific beef cuts. Table 6 presents the covariate estimates and table 7 presents threshold properties estimates.

The majority of the scale parameters are not statistically different from one. Only summer scales for ground, diced and roast are different from one at the 95% confidence level. This is to be expected as we had introduce season specific parameters in the utility function.

With regards to attributes related to product appearance (i.e. fat colour, meat colour, marbling and package type) American consumers showed similar taste for beef colour, fat colour and marbling in both seasons. A generic parameter was used to measure beef and fat colour preferences across all beef cuts and both seasons. US consumers prefer “white” fat colour in comparison to “light yellow” and a “red” beef colour over “pink” and willing to pay respectively \$3.14 and \$2.18 if the beef cuts have a white fat colour and a read beef colour. An alternative specific parameter was used to represent marbling taste across all beef cuts, however the beef specific parameters were the same across both season (marbling did not applied to ground and diced beef). No differences were observed for “no marbling” and “somewhat marbled” levels for tenderloin, flank and New York steak. US consumers preferred “no marbling” for roast, sirloin and flap over “somewhat marbled” and are relatively WTP \$10.18, \$16.46 and \$3.89. Though “somewhat marbled” is more preferred when it comes to the cowboy cut and US consumers are WTP \$17.92 for a “somewhat marbled” cowboy cut.

An alternative specific parameter representing both beef cuts and season were used to present heterogeneity in preference for packaging type. Except for cowboy cut, all beef cuts and for both seasons “tray packed” was seen as less preferred relative to “vacuumed pack” and sold “fresh”. Nonetheless the magnitudes differ when comparing both seasons. For example in the case of “tray packed”, US consumers show a stronger negative preference for diced, tenderloin and flank beef in summer relative to winter. This negativity in preferences is less for sirloin steaks. “Tray packed” is more preferred for cowboy cut in both seasons. In general, American place a higher value for ground and diced beef if they are sold as “fresh”, Roast, sirloin, flank and New York steak as “vacuumed packed” and cowboy steak as “tray packed” in both seasons. Tenderloin is preferred as “vacuumed

⁴ In this study eighteen scales (holding one constant at one) represented the nine studies cuts in two different seasons.

packed” in winter and “fresh” in summer. Finally, for flap cut no difference in packaging types were found in winter although in summer US consumers preferred “fresh”. For willingness to pay estimates please refer to tables 8 and 9. These results are in line and contribute (by observing preference for different beef cuts) to results from Carpenter et al. (2001) where they observed U.S. consumers preferred vacuum skin packaging.

In relation to labelling information when it comes to seasonality differences, the largest difference in magnitude of preferences is observed in the “certified logo” attribute representing the authority which has approved and certified the beef. American’s reacted strongly to “no certification logo” in summer, compared to in winter. The highest negative willingness to pay for “no program/logo” in winter was calculated for the New York strip with a value of -\$28.42. Whereas this value was calculated at -\$87.05 when it is summer showing that US consumers are concern about the safety of the beef products and aware of the opportunities for foodborne bacteria to thrive in warm weather. Results related to product claim confirms that US consumer value judgment for each claim is homogenous for both seasons. Heterogeneity in preferences appears only in claims related to specific cuts of beef. Results demonstrate that “grass fed” is more preferred over “grain fed” and US consumers have the highest WTP for “grass fed” for the cowboy cut with a value of \$11.60. Furthermore, US consumer are willing to pay a premium for knowing that the beef product is traceable back to farm and the highest WTP is for New York strip with a value of \$15.89. Antibiotic free claim had the highest variance in WTP ranging from \$4.53 for ground beef up to \$47.52 for sirloin steak. On the contrary, Hormone free had the lowest variance in WTP ranging from \$0.69 for diced beef to \$2.27 for sirloin steak. US consumer place a positive and significant value if the beef product claims that it is “Angus” beef. Furthermore, claims such as “organic”, “non-gmo”, “pasture” and “natural” also have a positive impact on American consumers purchasing behaviour (please view Tables 8 and 9 for all the WTP calculated values). A rather interesting and controversial result from Grebitus, Jensen, & Roosen (2013) was observed for the “use-by date” attribute. US consumer have relatively a lower WTP for longer use-by date in summer than in winter. This may be due to consumer’s safety judgment and trust on the information provided on the products. US consumer are willing to pay more for bigger sizes of roast and flap in winter rather than in summer. Flank has a negative estimated coefficient for weight in both seasons demonstrating US consumer prefer flank steaks in smaller portions. As expected, the price coefficient was negative for all beef products. US consumer are more sensitive to a price increase for diced products. Tables 8 and 9 provide all the WTP calculated values.

Table 6 presents the covariate coefficient estimates. The results from this table demonstrate that covariates such as having a graduate degree, owning a dwelling, larger household size, being a male, living in New York state, purchasing beef 2 plus times a week, belonging to a couple family with no kids household and being in the lower age spectrum will increase the probability of purchasing beef products. Moreover a quadratic form of income became significant with a negative value representing that middle income US consumer will more likely purchase beef products rather than individuals belonging to both ends of the income range.

Table 4 Ordered logit parameter estimate for *winter* season

Attribute	Level	Ground	Diced	Roast	Sirloin	Tenderloin	Flank	Flap	New York	Cowboy
Scale	(μ)	1.18	1.32	1.413	1	1	1	1	1	1
ASC	ASC	0.278	0.237	-0.193	-0.178	0.341	0.957	-0.772	-0.806	0.136
Fat colour	<i>White</i>	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
	<i>Light Yellow*</i>	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022
Meat colour	<i>Pink*</i>	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015
	<i>Red</i>	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Marbling	<i>Not marbled</i>			0.065	0.068			0.041		-0.140
	<i>Somewhat marbled*</i>			-0.065	-0.068			-0.041		0.140
Packaging type	<i>Vacuum</i>									
	<i>Packed</i>		0.033	0.033	0.137	0.077	0.233		0.061	-0.037
	<i>Tray packed</i>	-0.024	-0.072	-0.041	-0.125	-0.140	-0.418		-0.072	0.090
	<i>Fresh*</i>	0.024	0.039	0.008	-0.012	0.063	0.185		0.011	-0.054
Feed type	<i>Grass</i>		0.043	0.038		0.034	0.033	0.048		0.091
	<i>Grain*</i>		-0.043	-0.038		-0.034	-0.033	-0.048		-0.091
Traceable back to farm	<i>Yes</i>	0.041	0.041	0.055	0.032		0.039	0.065	0.070	0.055
	<i>No*</i>	-0.041	-0.041	-0.055	-0.032		-0.039	-0.065	-0.070	-0.055
Antibiotic free	<i>Yes</i>	0.031	0.068	0.068	0.196		0.075	0.052		0.045
	<i>No*</i>	-0.031	-0.068	-0.068	-0.196		-0.075	-0.052		-0.045
Hormone added	<i>Yes*</i>	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009
	<i>No</i>	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Organic	<i>Yes*</i>		0.055	0.064	0.057		0.067	0.026	0.075	0.065
	<i>No</i>		-0.055	-0.064	-0.057		-0.067	-0.026	-0.075	-0.065
Angus	<i>Yes</i>	0.034	0.068	0.062	0.036	0.147			0.055	0.048
	<i>No*</i>	-0.034	-0.068	-0.062	-0.036	-0.147			-0.055	-0.048
Non-GMO	<i>Yes*</i>	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
	<i>No</i>	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029
Pasture	<i>Yes</i>			0.070	0.088	0.058	0.058	0.087	0.039	
	<i>No*</i>			-0.070	-0.088	-0.058	-0.058	-0.087	-0.039	
Natural	<i>Yes</i>					0.054		0.047	0.063	
	<i>No*</i>					-0.054		-0.047	-0.063	
Certified logo	<i>USDA Verified*</i>	0.133	0.198	0.086	0.096	0.127	0.158	0.067	0.074	0.144
	<i>Global Animal Partnership</i>	-0.04								
	<i>Self-Assurance Program</i>						-0.068		0.051	-0.045
	<i>No Program/Logo</i>	-0.094	-0.198	-0.086	-0.096	-0.127	-0.09	-0.067	-0.125	-0.099
Brands	<i>Brand 1*</i>	0.053	0.128	0.013	-0.062	-0.113	-0.039	-0.007	0.046	0.055
	<i>Brand 2</i>	-0.053	-0.155			-0.062		-0.077	-0.046	0.057
	<i>Brand 3</i>		-0.069	-0.099		0.065				
	<i>Brand 4</i>		0.124		0.062	0.110		0.084		
	<i>Brand 5</i>									-0.111
	<i>Brand 6</i>		0.052							
	<i>Brand 7</i>		-0.080				0.039			
	<i>Brand 8</i>			0.086						
Use-By date	<i>Continues</i>	0.013	0.016	0.018	0.024	0.010	0.017	0.072	0.034	0.016
Net weight	<i>Continues</i>			0.065	0.021	0.018	-0.082	0.064	0.010	
Price	<i>Continues</i>	-0.007	-0.014	-0.006	-0.004	-0.009	-0.007	-0.011	-0.004	-0.008

*Represents the base level

Table 5 Ordered logit parameter estimates for *summer* season

Attribute	Level	Ground	Diced	Roast	Sirloin	Tenderloin	Flank	Flap	New York	Cowboy
Scale	(μ)	1	1	1	1	1	1	1	1	1*
ASC	ASC	0.175	0.132	-0.284	-0.39	0.0713	0.978	-0.0582	-0.6340	0.0099
Fat colour	White	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
	Light Yellow*	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022
Meat colour	Pink*	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015
	Red	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Marbling	Not marbled			0.065	0.068			0.041		-0.140
	Somewhat marbled*			-0.065	-0.068			-0.041		0.140
Packaging type	Vacuum Packed		0.033	0.033	0.114	0.077	0.242		0.043	-0.037
	Tray packed	-0.024	-0.111	-0.041	-0.096	-0.201	-0.457	-0.056		0.090
	Fresh*	0.024	0.078	0.008	-0.018	0.124	0.215	0.056	-0.043	-0.054
Feed type	Grass		0.043	0.038		0.034	0.033	0.048		0.091
	Grain*		-0.043	-0.038		-0.034	-0.033	-0.048		-0.091
Traceable back to farm	Yes	0.041	0.041	0.055	0.032		0.039	0.065	0.070	0.055
	No*	-0.041	-0.041	-0.055	-0.032		-0.039	-0.065	-0.070	-0.055
Antibiotic free	Yes	0.031	0.068	0.068	0.196		0.075	0.052		0.045
	No*	-0.031	-0.068	-0.068	-0.196		-0.075	-0.052		-0.045
Hormone added	Yes*	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009
	No	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Organic	Yes*		0.055	0.064	0.057		0.067	0.026	0.075	0.065
	No		-0.055	-0.064	-0.057		-0.067	-0.026	-0.075	-0.065
Angus	Yes	0.034	0.068	0.062	0.036	0.147			0.055	0.048
	No*	-0.034	-0.068	-0.062	-0.036	-0.147			-0.055	-0.048
Non-GMO	Yes*	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
	No	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029	-0.029
Pasture	Yes				0.070	0.088	0.058	0.058	0.087	0.039
	No*				-0.070	-0.088	-0.058	-0.058	-0.087	-0.039
Natural	Yes					0.054			0.047	0.063
	No*					-0.054			-0.047	-0.063
Certified logo	USDA Verified*	0.282	0.27	0.223	0.21	0.254	0.258	0.265	0.332	0.255
	Global Animal Partnership	-0.04								
	Self-Assurance Program						-0.068		0.051	-0.045
	No Program/Logo	-0.242	-0.27	-0.223	-0.21	-0.254	-0.19	-0.265	-0.383	-0.21
Brands	Brand 1*	0.053	0.075	0.013	-0.062	-0.048	-0.039	0.048	0.046	0.055
	Brand 2	-0.053	-0.127			-0.062		-0.132	-0.046	0.057
	Brand 3			-0.099						
	Brand 4				0.062	0.110		0.084		
	Brand 5									-0.111
	Brand 6		0.052							
	Brand 7						0.039			
	Brand 8			0.086						
Use-By date	Continues	0.013	0.016	0.018	0.011	0.010	0.017	-0.018	0.009	0.016
Net weight	Continues			0.054	0.033	0.018	-0.091	0.023	0.010	
Price	Continues	-0.007	-0.014	-0.006	-0.004	-0.009	-0.007	-0.011	-0.004	-0.008

*Represents the base level

Table 6 Covariate estimates in the ordered logit model

Demographics	Description	Values
Education	<i>Graduate degree</i>	0.023
	<i>Bachelor's degree</i>	-0.047
	<i>Associate's degree*</i>	-0.024
Dwelling	<i>Owned</i>	0.033
	<i>Renting*</i>	-0.033
Household Size	<i>Continues</i>	0.014
Income	<i>Continues (Quadratic form)</i>	-0.008
Origin	<i>New York state</i>	0.035
	<i>Other states*</i>	-0.035
Frequency of purchase	<i>2+ per week</i>	0.059
	<i>Once a month*</i>	-0.059
Gender	<i>Female</i>	-0.021
	<i>Male*</i>	0.021
Age	<i>Continues</i>	-0.034
Household type	<i>Couple family with no children</i>	0.099
	<i>One parent family</i>	-0.040
	<i>Couple family with children*</i>	-0.059

*Represents the base level

Table 7 Estimation of threshold properties in the ordered logit model

Threshold's (τ)	Ground	Diced	Roast	Sirloin	Tenderloin	Flank	Flap	New York	Cowboy
Threshold 1	0	0	0	0	0	0	0	0	0
Threshold 2	1.57	1.74	1.61	1.9	3.04	1.83	1.87	1.8	1.63
Threshold 3	2.74	2.96	3.09	3.31	4.1	3.54	3.11	3.18	2.95
Threshold 4	3.61	3.88	4.01	4.21	4.94	4.84	4.13	3.94	3.81
Threshold 5	4.56	4.71	4.92	5.03	5.85	5.87	5	4.68	4.59
Threshold 6	5.28	5.49	5.99	5.77	6.24	6.79	5.48	5.39	5.42
Threshold 7	5.78	6.22	6.32	6.38	6.62	7.36	6	5.73	5.85
Threshold 8	6.35	6.98	6.8	6.99	7.07	7.91	6.54	6.49	6.58
Threshold 9	6.76	7.39	7.21	7.55	7.63	8.25	7.01	7.19	6.99
Threshold 10	7.46	8.09	7.9	8.25	8.33	9.17	7.77	8.11	7.68

Estimation Report

<i>Final log likelihood</i>	-18789.548
<i>Number of parameters</i>	257
<i>Sample size</i>	3784

Table 8 Willingness to pay estimates for *winter* season

Attribute	Level	Ground	Diced	Roast	Sirloin	Tenderloin	Flank	Flap	New York	Cowboy
Fat colour	<i>White</i>	\$3.14	\$1.61	\$3.40	\$5.26	\$2.48	\$3.14	\$2.05	\$4.93	\$2.78
	<i>Light Yellow*</i>	-\$3.14	-\$1.61	-\$3.40	-\$5.26	-\$2.48	-\$3.14	-\$2.05	-\$4.93	-\$2.78
Meat colour	<i>Pink*</i>	-\$2.18	-\$1.12	-\$2.37	-\$3.66	-\$1.73	-\$2.18	-\$1.43	-\$3.43	-\$1.93
	<i>Red</i>	\$2.18	\$1.12	\$2.37	\$3.66	\$1.73	\$2.18	\$1.43	\$3.43	\$1.93
Marbling	<i>Not marbled</i>			\$10.18	\$16.46			\$3.89		-\$17.92
	<i>Somewhat marbled*</i>			-\$10.18	-\$16.46			-\$3.89		\$17.92
Packaging type	<i>Vacuum Packed</i>		\$2.44	\$5.11	\$33.21	\$8.78	\$33.69		\$13.82	-\$4.68
	<i>Tray packed</i>	-\$3.47	-\$5.32	-\$6.36	-\$30.30	-\$16.01	-\$60.43		-\$16.41	\$11.57
	<i>Fresh*</i>	\$3.47	\$2.88	\$1.25	-\$2.91	\$7.23	\$26.75		\$2.59	-\$6.89
Feed type	<i>Grass</i>		\$3.17	\$5.89		\$3.93	\$4.71	\$4.52		\$11.60
	<i>Grain*</i>		-\$3.17	-\$5.89		-\$3.93	-\$4.71	-\$4.52		-\$11.60
Traceable back to farm	<i>Yes</i>	\$5.91	\$3.00	\$8.68	\$7.81		\$5.62	\$6.14	\$15.89	\$6.98
	<i>No*</i>	-\$5.91	-\$3.00	-\$8.68	-\$7.81		-\$5.62	-\$6.14	-\$15.89	-\$6.98
Antibiotic free	<i>Yes</i>	\$4.53	\$5.07	\$10.59	\$47.52		\$10.79	\$4.87		\$5.80
	<i>No*</i>	-\$4.53	-\$5.07	-\$10.59	-\$47.52		-\$10.79	-\$4.87		-\$5.80
Hormone added	<i>Yes*</i>	-\$1.35	-\$0.69	-\$1.47	-\$2.27	-\$1.07	-\$1.35	-\$0.88	-\$2.13	-\$1.20
	<i>No</i>	\$1.35	\$0.69	\$1.47	\$2.27	\$1.07	\$1.35	\$0.88	\$2.13	\$1.20
Organic	<i>Yes*</i>		\$4.07	\$10.09	\$13.92		\$9.74	\$2.47	\$17.02	\$8.33
	<i>No</i>		-\$4.07	-\$10.09	-\$13.92		-\$9.74	-\$2.47	-\$17.02	-\$8.33
Angus	<i>Yes</i>	\$4.87	\$5.04	\$9.65	\$8.68	\$16.81			\$12.45	\$6.16
	<i>No*</i>	-\$4.87	-\$5.04	-\$9.65	-\$8.68	-\$16.81			-\$12.45	-\$6.16
Non-GMO	<i>Yes*</i>	\$4.19	\$2.15	\$4.54	\$7.03	\$3.32	\$4.19	\$2.74	\$6.59	\$3.71
	<i>No</i>	-\$4.19	-\$2.15	-\$4.54	-\$7.03	-\$3.32	-\$4.19	-\$2.74	-\$6.59	-\$3.71
Pasture	<i>Yes</i>				\$16.90	\$10.05	\$8.34	\$5.43	\$19.66	\$4.94
	<i>No*</i>				-\$16.90	-\$10.05	-\$8.34	-\$5.43	-\$19.66	-\$4.94
Natural	<i>Yes</i>					\$6.21			\$10.70	\$8.06
	<i>No*</i>					-\$6.21			-\$10.70	-\$8.06
Certified logo	<i>USDA Verified*</i>	\$19.23	\$14.67	\$13.47	\$23.27	\$14.53	\$22.84	\$6.32	\$16.82	\$18.43
	<i>Global Animal Partnership</i>	-\$5.78								
	<i>Self-Assurance Program</i>						-\$9.83		\$11.59	-\$5.76
	<i>No Program/Logo</i>	-\$13.59	-\$14.67	-\$13.47	-\$23.27	-\$14.53	-\$13.01	-\$6.32	-\$28.41	-\$12.67
Brands	<i>Brand 1*</i>	\$7.62	\$9.46	\$1.97	-\$15.10	-\$12.94	-\$5.65	-\$0.67	\$10.55	\$6.98
	<i>Brand 2</i>	-\$7.62	-\$11.48			-\$7.10		-\$7.22	-\$10.55	\$7.23
	<i>Brand 3</i>		-\$5.13	-\$15.51		\$7.46				
	<i>Brand 4</i>		\$9.19		\$15.10	\$12.58		\$7.89		
	<i>Brand 5</i>									-\$14.21
	<i>Brand 6</i>		\$3.86							
	<i>Brand 7</i>		-\$5.90				\$5.65			
	<i>Brand 8</i>				\$13.53					
Use-By date	<i>Continues</i>	\$1.81	\$1.15	\$2.85	\$5.70	\$1.17	\$2.50	\$6.82	\$7.82	\$2.05
Net weight	<i>Continues</i>			\$10.15	\$5.05	\$2.02	-\$11.84	\$6.08	\$2.27	

Table 9 Willingness to pay estimates for summer season

Attribute	Level	Ground	Diced	Roast	Sirloin	Tenderloin	Flank	Flap	New York	Cowboy
Fat colour	<i>White</i>	\$3.14	\$1.61	\$3.40	\$5.26	\$2.48	\$3.14	\$2.05	\$4.93	\$2.78
	<i>Light Yellow*</i>	-\$3.14	-\$1.61	-\$3.40	-\$5.26	-\$2.48	-\$3.14	-\$2.05	-\$4.93	-\$2.78
Meat colour	<i>Pink*</i>	-\$2.18	-\$1.12	-\$2.37	-\$3.66	-\$1.73	-\$2.18	-\$1.43	-\$3.43	-\$1.93
	<i>Red</i>	\$2.18	\$1.12	\$2.37	\$3.66	\$1.73	\$2.18	\$1.43	\$3.43	\$1.93
Marbling	<i>Not marbled</i>			\$10.18	\$16.46			\$3.89		-\$17.92
	<i>Somewhat marbled*</i>			-\$10.18	-\$16.46			-\$3.89		\$17.92
Packaging type	<i>Vacuum Packed</i>		\$2.44	\$5.11	\$27.64	\$8.78	\$34.99		\$9.75	-\$4.68
	<i>Tray packed</i>	-\$3.47	-\$8.22	-\$6.36	-\$23.20	-\$22.99	-\$66.07	-\$5.28		\$11.57
	<i>Fresh*</i>	\$3.47	\$5.79	\$1.25	-\$4.44	\$14.21	\$31.08	\$5.28	-\$9.75	-\$6.89
Feed type	<i>Grass</i>		\$3.17	\$5.89		\$3.93	\$4.71	\$4.52		\$11.60
	<i>Grain*</i>		-\$3.17	-\$5.89		-\$3.93	-\$4.71	-\$4.52		-\$11.60
Traceable back to farm	<i>Yes</i>	\$5.91	\$3.00	\$8.68	\$7.81		\$5.62	\$6.14	\$15.89	\$6.98
	<i>No*</i>	-\$5.91	-\$3.00	-\$8.68	-\$7.81		-\$5.62	-\$6.14	-\$15.89	-\$6.98
Antibiotic free	<i>Yes</i>	\$4.53	\$5.07	\$10.59	\$47.52		\$10.79	\$4.87		\$5.80
	<i>No*</i>	-\$4.53	-\$5.07	-\$10.59	-\$47.52		-\$10.79	-\$4.87		-\$5.80
Hormone added	<i>Yes*</i>	-\$1.35	-\$0.69	-\$1.47	-\$2.27	-\$1.07	-\$1.35	-\$0.88	-\$2.13	-\$1.20
	<i>No</i>	\$1.35	\$0.69	\$1.47	\$2.27	\$1.07	\$1.35	\$0.88	\$2.13	\$1.20
Organic	<i>Yes*</i>		\$4.07	\$10.09	\$13.92		\$9.74	\$2.47	\$17.02	\$8.33
	<i>No</i>		-\$4.07	-\$10.09	-\$13.92		-\$9.74	-\$2.47	-\$17.02	-\$8.33
Angus	<i>Yes</i>	\$4.87	\$5.04	\$9.65	\$8.68	\$16.81			\$12.45	\$6.16
	<i>No*</i>	-\$4.87	-\$5.04	-\$9.65	-\$8.68	-\$16.81			-\$12.45	-\$6.16
Non-GMO	<i>Yes*</i>	\$4.19	\$2.15	\$4.54	\$7.03	\$3.32	\$4.19	\$2.74	\$6.59	\$3.71
	<i>No</i>	-\$4.19	-\$2.15	-\$4.54	-\$7.03	-\$3.32	-\$4.19	-\$2.74	-\$6.59	-\$3.71
Pasture	<i>Yes</i>				\$16.90	\$10.05	\$8.34	\$5.43	\$19.66	\$4.94
	<i>No*</i>				-\$16.90	-\$10.05	-\$8.34	-\$5.43	-\$19.66	-\$4.94
Natural	<i>Yes</i>					\$6.21			\$10.70	\$8.06
	<i>No*</i>					-\$6.21			-\$10.70	-\$8.06
Certified logo	<i>USDA Verified*</i>	\$40.77	\$20.00	\$34.93	\$50.91	\$29.05	\$37.30	\$25.01	\$75.45	\$32.64
	<i>Global Animal Partnership</i>	-\$5.78								
	<i>Self-Assurance Program</i>						-\$9.83	\$0.00	\$11.59	-\$5.76
	<i>No Program/Logo</i>	-\$34.99	-\$20.00	-\$34.93	-\$50.91	-\$29.05	-\$27.47	-\$25.01	-\$87.05	-\$26.88
Brands	<i>Brand 1*</i>	\$7.62	\$5.55	\$1.97	-\$15.10	-\$5.48	-\$5.65	\$4.57	\$10.55	\$6.98
	<i>Brand 2</i>	-\$7.62	-\$9.41			-\$7.10		-\$12.46	-\$10.55	\$7.23
	<i>Brand 3</i>			-\$15.51						
	<i>Brand 4</i>				\$15.10	\$12.58		\$7.89		
	<i>Brand 5</i>									-\$14.21
	<i>Brand 6</i>		\$3.86							
	<i>Brand 7</i>						\$5.65			
	<i>Brand 8</i>			\$13.53						
Use-By date	<i>Continues</i>	\$1.81	\$1.15	\$2.85	\$2.74	\$1.17	\$2.50	-\$1.67	\$2.11	\$2.05
Net weight	<i>Continues</i>			\$8.41	\$7.95	\$2.02	-\$13.19	\$2.19	\$2.27	

5. DISCUSSION

With the growing interest in beef, which is considered a luxury purchase when compared with other types of meat consumption (Wong, Selvanathan, & Selvanathan, 2013), consumers are increasingly interested in beef attributes (Verbeke, 2000) and labels are a key player in consumer decision making processes. Changes to the attributes available in the label create an additional dimension of consumer utility which may be traded for other quality indicators. The literature has revealed that in real markets, consumers are faced with consumption choices over bundles of attributes that can be modelled in a stated preference framework and then a WTP measure can be calculated for each attribute. In other words, it confirms the adaptation of using DCEs among researchers to determine the share of preference a given attribute has in a particular market. Therefore, stated choice experiments provide a richer description of the attribute trade-offs that consumers are willing to make than do more traditionally used contingent valuation methods (Lusk & Schroeder, 2004). This research provides industry and policy-makers with additional information to better understand the relative value of beef product appearance and labelling information to American consumers in summer and winter seasons.

In the context of our results, although the empirical findings support the majority of the claims from the previous studies, some controversy has been indicated. In relation to product appearance, the finding of this study was consistent with the literature that white colour fat is preferred to light yellow fat colour and consumers are WTP a price premium of \$1.61 for diced beef and up to \$5.26 for sirloin beef. Respondents also attach higher value for red coloured meat for all beef products. These results are aligned with the work of Zanoli et al. (2013) and Carpenter et al. (2001). The highest premium for having red coloured meat is \$3.66 for sirloin steak while the lowest premium is diced beef with \$1.12.

Marbling or intramuscular fat content has been mentioned as the primary determinant of the quality grading system. Highly marbled beef, specifically steaks, typically have better taste but more fat. Our results on American consumers' taste for beef marbling is very similar to that of Lusk et al. (2003) study concluding that British and American consumers prefer the least amount or no marbling (In this study marbling attribute was not considered for mince and diced products). The highest premium for having no intramuscular fat (no marbling) was at \$16.46 for sirloin steak and the lowest was -\$17.92 for cowboy cut.

Results from this study on type of feed is aligned with Abidoye et al. (2011) who concluded that U.S. consumers have strong and positive value for a grass-fed claim, and is in contrast with Mennecke et al. (2007), where they found no valuation for grass-fed cattle.

Angus is a breed of cattle that has traditionally been associated by consumers with quality, flavour, juiciness, and tenderness because of its natural marbling (Froehlich, Carlberg, & Ward, 2009). These characteristics of Angus beef were also mentioned in a sensory assessment study by Chambaz et al. (2003). In Froehlich et al. study (2009), Canadians were WTP \$1.31 for Angus beef. In this study, US consumer also place higher value when it is claimed that the beef is Angus. The premium range starts with \$4.87 for ground beef to \$16.81 for a tenderloin steak.

In relation to an organic claim, similar results to our finding were concluded in Zanoli et al. (2013) study where they concluded Italian consumers attached higher value to organic beef. However, the findings contrasts with Lagerkvist et al. (2014) where they concluded that an organic claim is unlikely to stand as a relevant beef labelling attribute.

5.1 MANAGERIAL AND POLICY IMPLICATIONS

The policy implications of the current study is potentially wide-ranging regarding influencing consumers, businesses and the government.

The results from this study yield consumer welfare enhancing information by better understanding American consumer's utility and the information cues on beef products that actually attract consumer interest will be processed for subsequent use in their decision making. Typically, a unique bundle of beef intrinsic and extrinsic attributes maximizes the consumer's satisfaction with their purchased commodity. Thus, targeted information provision is proposed as a potential solution to market failure of products. This will make information meaningful, useful and effective and will enable consumers to navigate between products more efficiently and consequently increase their satisfaction from their shopping trip. Given the large number of food choices that consumers make each day and the diversity of products, it seems unlikely that individuals allocate substantial cognitive effort and time to each decision. Furthermore, food consumers face uncertainty and demand high quality and safe food products. However this doesn't mean that consumers are asking for the provision of evermore and too detailed information as it entails a risk of information overload, resulting in consumer indifference or loss of confidence (Verbeke, 2005).

These results are also useful for business firms' with regard to policy implementation and product differentiation strategy. Consumers may use heuristics to screen out whether or not to investigate a product category in detail (Swait, 2001). The results from this study not only informs business firms' on which intrinsic and extrinsic attributes of beef products will trigger changes in decision strategy, but also highlights the importance of seasonality effect on consumers purchasing behaviour. Furthermore, results will extend industry firms understanding of a "better product design by season" from the consumer's perspective. This information will increase the efficiency gain in an oligopolistic/monopolistic competition market where for example firm A and B produces the exact same beef cut but with different packaging design.

Finally results from this study will complement the collective efforts of governments in influencing the decision-making environment of food producers, food consumers and food marketing agents in order to further social objectives. These objectives nearly always include improved nutrition for inadequately nourished citizens and more rapid growth in domestic food production.

5.1.1. HYPOTHETICAL SCENARIO

In the following paragraphs we will show an example of how the results from this study can help business firms with their cost-benefit estimation for a newly developed product by season. For this reason we will present probability of purchase for all the nine studied cuts in both season. The product details (i.e fat colour, beef colour, claims, brands and the used-by date) have been considered to be the same among all the 9 cuts. The average value for price per pound and package size differed based on the beef cut however they were assumed to be equal in both seasons. Figures 4 and 5 presents the probability of purchasing different quantities (including none) for winter and summer. Looking at the zero purchase probability it can be perceive that in winter roast and diced have the biggest deduction in zero purchase (15% to 10% for diced and 16% to 11% for roast) followed by flap and mince with 3 and 2 percent. This results do support that winter is "the slow cooked" season however, it also shows that winter competes strongly with summer as the grilling season as almost the purchase probabilities of all the grilling products are very close to that of summer. Only New York strip has a lower probability of zero purchase in summer compared to winter (22% in summer vs 26% in winter).

Figure 4: Probability of purchase quantity for each beef products in *winter*

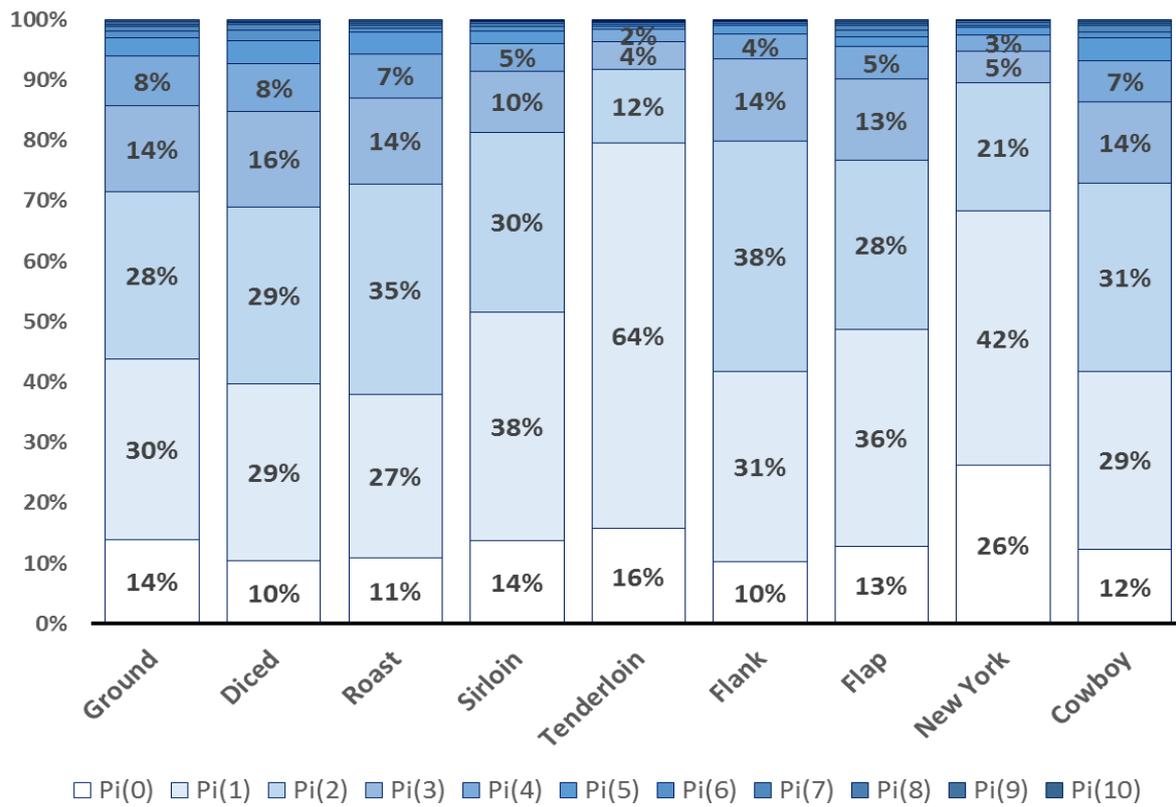


Figure 5: Probability of purchase quantity for each beef products in *summer*

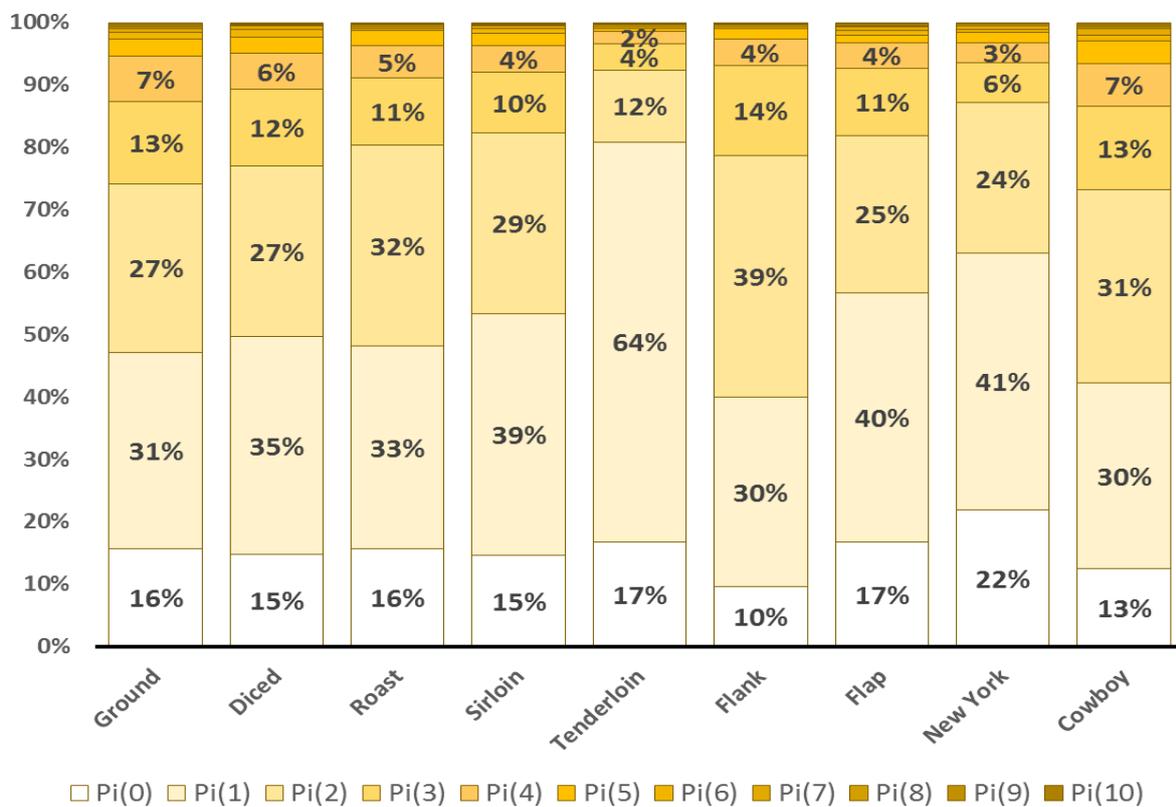
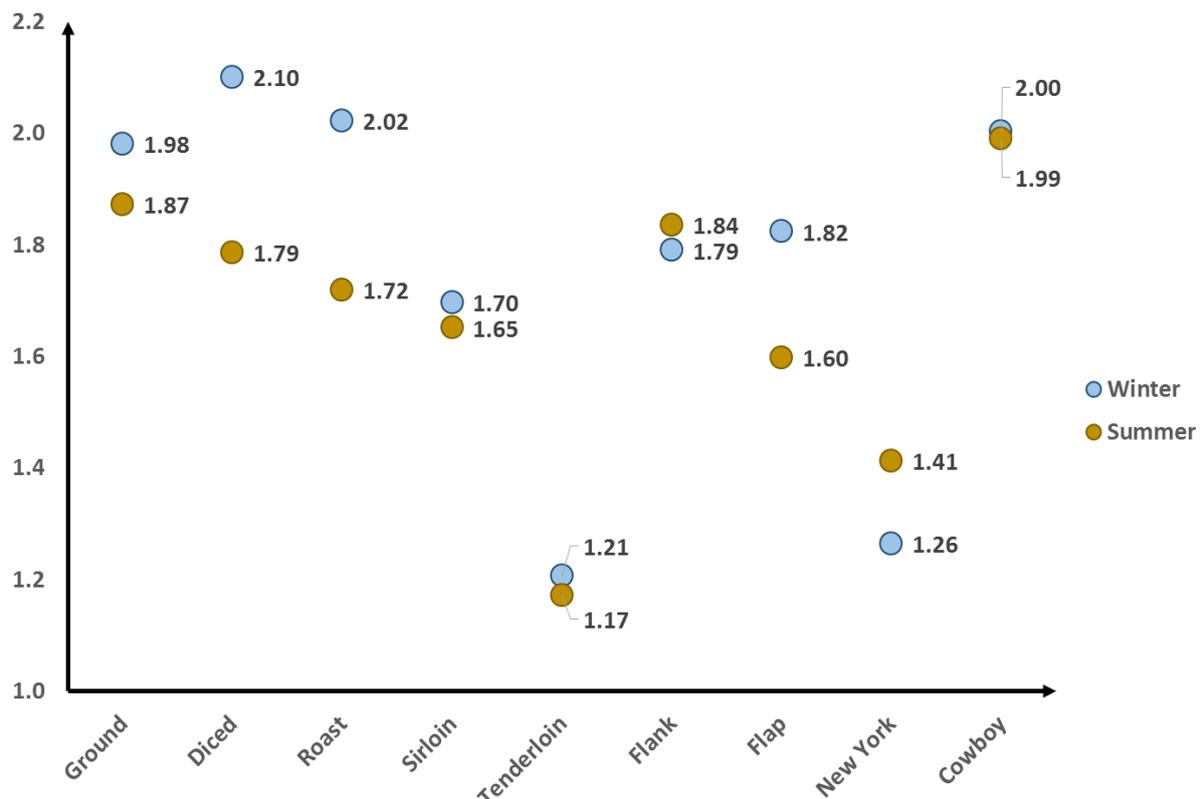


Figure 6 represents the average purchase quantity for each product and also supports the underlying comparison made earlier by only looking at the zero purchase probability. On average diced in winter has the highest purchase quantity with more than 2 quantities and as expected tenderloin as the most expensive cut has the lowest purchase quantity in summer. Although flank steak had the same probability of zero purchases (10%) nonetheless on average it is being purchased more in summer. Resulting New York strip and flank steak to be the only “grilling products” to have on average a higher purchase quantity in summer than in winter.

The above example presents a simple benefit of this study to the beef industry. By creating hypothetical products they can observe and predict the attractiveness of a new product. Furthermore, by using the product weights, market share of these new products can be estimated based in total pounds sold for each cut of beef. Moreover, purchase probability trends can be drawn for each cut to observe different probabilities for an increment in price values. These graphs can help to show the revenue gained and finding the optimal price value which maximises revenue. This is a simple, and yet powerful predictive tool for beef, producers, processors and policy makers to strengthen their decision making capabilities.

Figure 6: A comparison of the average purchase quantity for each beef products in *summer* and *winter*



6. CONCLUSION

The results obtained from the American household survey provide interesting information on the relative importance of intrinsic and extrinsic beef attributes to American consumers when selecting beef products in winter and summer.

This study highlighted how choice experiments can create hypothetical scenarios and provide insights for industry and policy-makers with additional information to better understand relative value with regards to consumers' safety, ethical and aesthetic concerns. It benefits the policy makers and stock holders to introduce more consumer-desirable products as well as estimating the economic benefits of a given policy measure by season. It presents information to decision makers about how consumers might be balancing trade-offs inherent in the decision-making process.

Extant literature from non-DCE domains reveals that consumers' value for purchasing a beef product is driven not only by the beef attributes but by sets of other variables such as the location, frequencies of eating beef (by specific cut) in restaurants, cafés, bars, etc., cultural beliefs, level of knowledge, environmental sustainability preferences, religious beliefs and so on. Thus a limitation to this study and as a further research stream it is suggested to investigate individual differences (i.e. segmentation) and identify consumers segments for better targeting consumers as well as marketing strategies for beef producers and marketers.

Finally, an alternative suggestion for future directions of research is to investigate consumers processing resources and cognitive efforts for each decision. In the area of food choices alone, consumers are estimated to make over 200 choice decisions per day (Wansink & Sobal, 2007). Adamowicz and Swait (2012) have argued that given the sheer number of decisions involved across the many facets of people's lives, it seems unlikely that individuals allocate substantial cognitive effort and time to each decision. Indeed, decisions regarding small budget items like food or consumer packaged goods would seem more likely to be relegated to some form of habitual choice behaviour.

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