Hispanic Consumers' Preferences and Willingness-to-Pay for Grass-Fed Beef in Virginia

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Dissertation submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Agricultural and Applied Economics

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December 9, 2009

Blacksburg, Virginia

Keywords: Experimental Economics, Grass-Fed Beef, Hispanic Market, Visual and Taste Preferences, Willingness-to-Pay

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ABSTRACT

The primary objective of this dissertation is to determine Hispanic consumers' preferences and willingness-to-pay (WTP) for grass-fed beef. Two hundred and thirty-one Hispanic consumers in four experiment sites in Virginia (Galax, Roanoke, Richmond, and Blacksburg) participated in an experimental economics laboratory procedure. Taste tests and visual evaluations were conducted to understand Hispanic consumers' sensory preferences for grass-fed beef in comparison to conventional grain-fed beef. A contingent valuation method, Multiple Price Lists (MPL) was used to measure Hispanic consumers' WTP for grass-fed beef. In the study, MPL was put into a non-hypothetical environment due to real products, real money, and actual transactions involved.

A bivariate Probit model was estimated to determine Hispanic consumers' visual and taste preferences for grass-fed beef and to explore the relationship between their expected and experienced quality of grass-fed beef. A two-step decision process examined Hispanic consumers' WTP and investigated the factors influencing their valuations on grass-fed beef. Approximately 50% of Hispanic consumers sampled preferred grass-fed to conventional grain-fed beef steak and the vast majority of grass-fed preferring consumers were willing to pay a price premium for it. Hispanic consumers were able to distinguish the appearance and taste between grass-fed and conventional grain-fed beef steaks. A positive correlation between visual and taste preferences for grass-fed beef was captured.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere appreciation to my dissertation committee members: Dr. Denise Mainville, Dr. Wen You, Dr. Daniel Taylor, Dr. Everett Peterson, Dr. Gordon Groover, and Dr. Rodolfo Nayga, Jr. I am indebted to each of these individuals for their guidance and expertise. I would particularly like to thank Dr. Mainville and Dr. You, my committee co-chairs, for their many insightful ideas, continuous guidance, patience, and support throughout my entire graduate study. I owe many thanks to Dr. Nayga at University of Arkansas for his conductive comments and suggestions on experiment design and modeling. Dr. Taylor, Dr. Peterson, and Dr. Groover are also greatly acknowledged for their inspirations, advice, and encouragement.

I would like to thank the Department of Agricultural and Applied Economics at Virginia Tech for providing me with the financial support necessary to complete my graduate education. The understanding and support I received from Dr. Kevin Boyle and Dr. Brad Mills will never be forgotten.

I acknowledge Nancy Lopez, Leah Harris, Nancy Becerra, Bill (Hong) Xue, Ashleigh Waddle, and Brandy Foster. Laboratory pretests and actual experiments would not have been possible without their help and efforts. A special word of thanks is due to Jason Evans at West Virginia University and Jason Maupin, who were willing to share with me their experience in economics experiments and provided me with their precious suggestions. My thanks also go to Anna Harris, Annie (Ge) Zhang, Haiyan Zhao, Feng Jiang, Joan Zapita, Zalalem Chala, Jared Burner, Amanda Sceiford**,** Todd Metcalfe, Wen Zhang, and many others for contributing their time to participate in our pretests.

I would like to extend my appreciation to the faculty and staff in AAEC and, in particular, Sharon Cox, Marilyn Echols, and Shirley Baber for their tremendous help and assistance to our experiments. I value the friendship from my friends and fellow graduate students in AAEC. They made the time I spent at Virginia Tech enjoyable and memorable.

My special gratitude goes to Dr. Joao Macieira for his valuable suggestions and advice on econometric analysis of my dissertation. His constant support and warm encouragement gave me strength to overcome the difficulties and challenges in this journey.

Last but not the least, I am deeply grateful to my parents, Yi Zhou and Jingqiang Luo, and my sister, Rong Zhou, for their unwavering love, trusts, and understanding. This dissertation is dedicated to them.

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CHAPTER I

INTRODUCTION

1.1. Introduction

The U.S. beef industry has experienced continuous decline in demand since the late 1970s (Purcell 1998, Davis and Lin 2005, Schroeder and Mark 2000, USDA 2004b). Numerous studies have explored the potential causes of this decline and pointed to structural changes in food demand and consumption patterns in recent decades as contributing to the dramatic decline of beef demand. (e.g. Barkema 1993; Choi and Sosin 1990; Kinnucan et al 1997; Moon and Ward 1999; Schroeder and Mark 2000). In particular, consumers' increasing concerns about health and nutrition have led them to reduce their intake of fat and calories as these are perceived to be closely associated with high cholesterol and heart diseases, causing a shift from consumption of red meat to poultry and fish (Barkema 1993; Kinnucn et al. 1997; Moon and Ward 1999). More recently, incidences of food contamination, mad cow disease, and the widespread media coverage of the usage of growth hormones, antibiotics, food additives, and farm chemicals in food production process have drawn consumers' attention and concerns about food safety (Flake and Patterson 1999; Kuchler and Tegene 2006; Misra, Grotegut, and Clem 1997). The public is also conscious about the effects of beef production on environment and animal welfare (Wandel and Bugge 1997). These factors are driving consumers to search for healthier, more nutritious, safer, and environmentally beneficial beef products.

For the past 50 years, U.S. beef production has been based on concentrated animal feeding operations (CAFOs) in which cattle are raised in confinement such as feedlots and fattened on high-energy, low-fiber concentrates (EPA 2008; McCluskey et al. 2005). On one hand, concentrated grain feeding and feedlot operation considerably improves beef quantity

and quality consistency (EPA 2008); on the other hand, the public is increasingly concerned with various aspects of conventional grain-fed beef production. CAFOs are associated with air and water pollution and threat to human health and the ecosystem (EPA 2008). Due to fast growth rate and concentrated diets, grain-fed beef has relatively high level of cholesterol and saturated fat (Duckett et al. 1993; Rule et al. 2002). Foodborne diseases and harmful bacteria such as *E. coli* O157:H7 are frequently found in grain-fed beef (Russell, Diez-Gonzalez, and Jarvis 2000). In order to promote cattle growth and reduce the incidence of diseases, growth hormones and sub-therapeutic antibiotics are widely used in feedlot operations and their residues left in beef products risk human's health (Casewell et al. 2003). As a result, there is increasing interest in alternative beef products that are produced using non-conventional practices that might meet consumers' increasing demand for healthy, nutritious, safe, and environmentally benign products.

Grass-fed beef is from cattle that graze freely on pasture rather than being restricted in feedlots and are fed native grass, forage, and/or silage throughout their lives (USDA 2007). Compared with conventional grain-fed beef, grass-fed beef has lower fat, cholesterol, and calories, and higher level of Vitamin E, Omega-3 fatty acids, and Conjugated Linoleic Acid (Dhiman et al 1999; Duckett et al. 1993; Rule et al. 2002; Yang et al. 2002). Grass-fed beef is produced without sub-therapeutic antibiotics, growth hormones, pesticides, or animal by-product rations that are usually associated with conventional beef production (Clancy 2006; Casewell et al. 2003). The incidences of foodborne infection such as *E. coli* O157:H7 rarely occur to grass-fed beef (Russell, Diez-Gonzalez, and Jarvis 2000). Grass-fed production is also promoted by some consumers as environmentally friendly since it lowers fertilizer use, protects topsoil from erosion, and reduces greenhouse gases (EPA 2008; Robinson 2004). Therefore, grass-fed beef seems to provide consumers with the healthy, nutritious, safe, and environmentally beneficial attributes they seek. In face of the increasing

public concerns about health and environmental preservation, grass-fed beef is gaining increasing interest in U.S. beef market (Lozier, Rayburn, and Shaw 2003).

Consumers' taste and preferences for beef are affected by its sensory attributes (Miller 2007). Because of the different production practices and dietary intake of cattle, grass-fed beef presents distinct visual and taste attributes from those of conventional grain-fed beef. In general, grass-fed beef has yellower fat and darker meat compared to the white fat and cherry-red meat of conventional grain-fed beef. Consumers generally find grass-fed beef less tender, drier, and more intense than conventional grain-fed beef (Bowing et al 1977; Crouse, Cross, and Seideman1984). Unfortunately, favorable health and nutrition attributes of beef do not always lead to a desirable sensory experience for consumers. Sometimes, there are tradeoffs between the two types of attributes. Despite the health, nutrition, and environmental benefits of grass-fed beef, its distinct sensory attributes appear to be unfavorable to many U.S. mainstream consumers who primarily consume conventional grain-fed beef and are accustomed to its sensory quality, which, to some extent, limits the market of grass-fed beef among mainstream consumers (Kerth et al. 2004; Sitz et al. 2005; Umberger et al. 2002).

Unlike the U.S., many Latin American countries have pasture-based beef production systems. For example, Argentina and Brazil are two of the world's largest grass-fed beef exporters (USDA 2001). Inexpensive pastureland and a year-round grass supply provide advantages to pursue grass-fed production in many Latin American countries such as Mexico, Venezuela, Uruguay, and Paraguay (Myers 1980; Place 2001; USDA 1997). People from the countries that rely on grass-feeding are likely to be accustomed to the sensory attributes of grass-fed beef. Thus, while the unique visual appearance and taste of grass-fed beef seem to limit the market for grass-fed beef among U.S. mainstream consumers, it appears reasonable to hypothesize that people from Latin American countries that rely on grass-feeding practices have potential preferences for grass-fed beef to conventionally produced beef. Furthermore,

the U.S. Hispanic population has been rapidly growing for decades and is currently the largest ethnic minority in the U.S. At the same time, the fast-growing Hispanic population represents an increasingly important purchase power in U.S. food market (Humphreys 2006). Hispanic consumers are known to be heavy beef eaters and meat accounts for a greater portion of their annual food expenditure than other ethnicities (BLS/CEX 2005a). With significant consumption of beef and potential preferences for grass-fed beef, the fast-growing Hispanic population may constitute a potential promising market for grass-fed beef. Existing studies and research on the demand for grass-fed beef, however, are mostly focused on mainstream consumers (e.g. Umberger 2001; Umberger et al. 2002; Evans 2007; Sitz et al. 2005). No known study has been done to assess the potential Hispanic market for grass-fed beef.

1.2. Research Objectives

This study aims to address the aforementioned research gap to measure and understand Hispanic consumers' preferences and willingness-to-pay (WTP) for grass-fed beef and explore the market potential for grass-fed beef among Hispanic consumers. In order to accomplish this main research objective, four specific objectives are addressed:

1) Assess Hispanic/Latino consumers' visual and taste acceptances for grass-fed beef in comparison with conventional grain-fed beef through direct sensory evaluations; capture the marginal effects of sensory attributes on Hispanic/Latino consumers' visual and taste acceptances for grass-fed beef.
2) Evaluate Hispanic/Latino consumers' overall preferences for grass-fed beef and examine the consistency and relationship between visual, taste, and overall preferences.
3) Determine Hispanic consumers' WTP for grass-fed beef using experimental

economics methods; identify consumers' socio-demographic and behavioral characteristics and other relevant factors that affect their valuations on grass-fed beef.

4) Discuss the growth perspectives of the grass-fed beef market among U.S. fast-growing Hispanic population; develop practical marketing strategies to promote the development of Hispanic market of grass-fed beef.

1.3. Methods and Data

In order to fulfill the research objectives, laboratory experimental economics methods, including a written survey, sensory evaluations, and economics experiments, were used in this study. A written survey was used to collect data about Hispanic consumers' socio-demographic characteristics and beef consumption behavior. Sensory evaluations obtained Hispanic consumers' perceptions of the visual and taste attributes of grass-fed beef, and economics experiments were conducted to elicit Hispanic consumers' valuations for grass-fed beef. Data collected through these instruments made it possible to understand Hispanic consumers' sensory preferences and WTP for grass-fed beef and thus explore the market potential of grass-fed beef in the Hispanic population. A total of 231 valid observations were collected in four experiment sites in Virginia.

1.4. Outline of Dissertation

The dissertation proceeds as follows. Chapter II will discuss the background of this dissertation. Chapter III outlines the theoretical framework for evaluating consumers' preferences and WTP for grass-fed beef. Chapter IV describes methods and data. The empirical/estimation models for preferences and WTP are discussed in Chapter V. Estimation results are presented in Chapter VI. Chapter VII discusses the results and their implications

for developing marketing strategies to promote the Hispanic market for grass-fed beef. Conclusions are presented in Chapter VIII, which summarizes the main findings of the study and discusses its limitations and future research regarding Hispanic consumers' preferences and WTP for grass-fed beef.

CHAPTER II

BACKGROUND

2.1. Consumers Seeking New Attributes

In the past three decades, U.S. food consumption and demand have changed fundamentally (Barkema 1993). Consumers are becoming increasingly conscious about health and nutrition and the concerns work as an important driving force in changing food consumption patterns in the U.S. (Barkema 1993; Choi and Sosin 1990; Kinnucan et al. 1997). Considerable studies have examined the relationship between health and nutrition concerns and the structural changes in food demand and have documented that consumers are prone to reduce the intakes of saturated fat, cholesterol, and sodium and cut down the consumption of food that is perceived to be fat-rich (e.g. Barkema 1993; Capps and Schmitz 1991; Moon and Ward 1999). With respect to meat consumption in particular, Moon and Ward (1999) developed an index of health attitudes and found that concerns about the intake of fats and cholesterol lead to a decreasing demand for red meat such as beef and pork but an increasing demand for fish and white meat such as chicken. Likewise, Kinnucn et al (1997) assert that cholesterol-related information exerts negative influences on beef consumption but positively affects demand for poultry. They also found that health information elasticities are greater than price elasticities, and a small percentage of change in health information results in a disproportionately large change in meat demand. These studies indicate that the structural change in U.S. beef industry is leading to consumers' shifting from red meat, especially beef, to white meat and/or fish. As a matter of fact, U.S. beef industry has suffered a continuous decline in demand since late 1970's (Schroeder and Mark 2000; USDA 2004b). In addition to consumers' varying income and preferences, health and nutrition concerns have been partly attributed to the decrease in beef demand (Schroeder and Mark 2000). Consumers typically

perceive red meat such as beef and pork to have higher levels of fat and calories than poultry and fish (Schroeder and Mark 2000). The health information that links fat and cholesterol consumption to heart disease might negatively impact beef demand (Davis and Lin 2005; Schroeder and Mark 2000). McCluskey et al. (2005) conducted a survey and found that 37 % of survey respondents consider fat and calories to be the most important attributes of beef that affect their purchase decisions and are willing to pay an average price premium of $5.65 for low-fat and low-calorie beef steaks.

Food safety is another important issue associated with beef demand (Flake and Patterson 1999; Schroeder and Mark 2000). According to Centers for Disease Control and Prevention (CDC) (2000), an estimate of 76 million illnesses, 325,000 hospitalizations and 5,200 deaths each year can be attributed to contaminated food consumption. There are increasing beef recall events happening due to foodborne illness in recent years (e.g. USDA 2008). According to Food Safety and Inspection Service (FSIS) of the U.S Department of Agriculture (USDA 2008), beef recalls averaged 2.1 per quarter from 1982 to 1998. A notable case was the outbreak of Escherichia.*coli* (i.e. E. *coli*) O157:H7 infection in 1993 that resulted in the deaths of three children who ate contaminated Hamburgers (Flake and Patterson 1999). Likewise, according to Rangel et al. (2005), an estimated 74,380 incidences of E. *coli* infections and 61 deaths occur in the U.S. each year and most of the cases have been associated with eating undercooked, contaminated ground beef. In 2008, Dutch Prime Foods, Inc. in New Jersey recalled approximately 345 pounds of ground beef products that might be contaminated with *E. coli* O157:H7 (USDA 2008). Beef recalls due to other common foodborne infections, such as *Campylobacter Jejuni, Salmonella, Listeria Monocytogenes*, and *Yersinia Enterocolitica*, are also reported by FSIS of USDA (2008). These beef recall incidences have drawn consumers' attention and concerns about food safety. Recent studies have reported a negative relationship between beef demand and FSIS recall events. For

example, Schroder, Marsh, and Mintert (2000) estimated a meat demand model and found that every 10% increase in beef recall events result in 0.2% decline in beef demand. Likewise, based on data from USDA Livestock and Poultry Situation and Outlook Report, Flake and Patterson (1999) reported that increasing beef recall events and food-related safety concerns reduce beef consumption by 0.01%.

The U.S. beef industry has also been affected by Bovine Spongiform Encephalopathy (BSE), also called Mad Cow Disease, for nearly two decades (Coffey et al. 2005). In late 2003, USDA announced the first diagnosed case of BSE in the U.S. (Kuchler and Tegene 2006). Such outbreaks of BSE may hurt the U.S beef industry to some extent and impact beef consumption. Coffey et al. (2005) conducted mail surveys to investigate consumers' reactions to BSE incidences. Fifty-four percent of respondents reported no change in their consumption of beef in face of the first case of BSE; however, this percent decreased to 30% when additional cases of BSE occurred while nearly 70% of respondents chose to reduce or stop eating beef. According to a survey by Jin, Skripnitchenko, and Koo (2004), it is anticipated that BSE emergence and its additional cases are likely to contribute to up to 20% reduction in beef consumption in the U.S. Their survey also indicates that a 10% decrease in domestic beef consumption and 75% decline in beef exports due to BSE could lead prices for slaughter and feeder cattle to decrease by 13% and 16%, respectively.

Consumers are more and more concerned about the widespread use of antibiotics, food additives, growth hormone, and pesticide/residues and farm chemicals in the process of food production (e.g. Byrne, Bacon, and Toensmeyer 1994; Huang 1996; Misra, Grotegut, and Clem 1997). Misra, Grotegut, and Clem (1997) conducted a mail survey among 2000 households in Texas and found that 58% of respondents show extreme concerns about pST (a kind of growth hormone) and more than half of them perceive pesticide/residues and farm chemicals, food additives, and antibiotics to be food safety threats. Seventy-nine percent of

respondents are unwilling or uncertain about buying pST-treated pork due to their extreme concerns about the influences of pST on health. Similarly, based on the data from a mail survey in Georgia in 1989, Huang (1996) investigated consumers' risk perception toward food quality and safety with respect to the use of chemicals on fresh produce and found that pesticide use, chemical food additives and preservatives, and food poisoning are ranked as the top three food safety issues; along with the concerns about chemical residues, consumers are likely to prefer organically grown to conventionally grown fresh produce.

Concerns about health, nutrition, food safety, and environmental preservation are driving consumers to search for healthier, more nutritious, safer, and environmentally benign food products that meet their needs in these regards. Lusk, Roosen, and Fox (2003) examined the demand for genetically modified (GM) corn-fed beef and growth hormone-free beef by consumers from France, Germany, UK, and the U.S. Their findings indicate that European consumers are willing to pay much more for beef that are not fed GM corn than U.S. consumers, and that French consumers are also willing to pay a price premium for growth hormone-free beef products. Based on mail survey data in Colorado, Eastern Utah, and North New Mexico, Grannis, Hooker, and Thilmany (2000) analyzed consumers' preferences and WTP for natural beef. For 1400 valid responses, non-hormone, antibiotic-free, grass-fed, and environmental- and animal-friendly attributes are ranked as the important elements in their purchase decisions. Thirty-eight percent of consumers are willing to pay 10% price premium and 14% are willing to pay a 20% price premium for "natural" steaks whereas 67% of consumers place a 12% price premium and 29% of consumers place a 23% price premium for natural ground beef. Huang (1996) found that people who are conscious about nutrition, food safety, and environmental quality are more likely to become the potential consumers of organic produce because they perceive organically grown produce to be a safer, more nutritious, and environmentally friendly alternative to conventionally grown produce. Wandel

and Bugge (1997) conducted personal interviews with a representative sample of Norway population to examine the effects of environmental concerns on consumers' evaluations on food quality. Their findings reveal that 44% of respondents report buying food produced in an environmentally benign manner either sometimes or frequently, and 35% of respondents put the environmentally sound production as the first or second priority compared with other food quality attributes. Fifty-four percent of those respondents who perceive environmentally sound production to be a priority attribute are willing to pay 10% price premium and 87% of them are willing to pay at least 5% price premium for environmentally beneficial food products.

2.2. Production and Issues of Conventional Grain-Fed Beef in the U.S.

For more than 50 years, U.S. beef cattle production has been based on the concentrated animal feeding operations (CAFOs) (EPA 2008; McCluskey et al. 2005). Instead of grazing on pastureland, cattle under CAFOs are finished in confinement such as feedlots and fattened with high-energy low-fiber concentrates like grains (Clancy 2006; EPA 2008). The grain feeding and feedlot operation benefits beef producers with economies of scale; it considerably advances beef quantity and improves the efficiency of beef cattle production by decreasing the amount of time to fatten cattle to the slaughter weight (EPA 2008). To date, the United States has owned the largest fed-cattle industry and has been the largest producer of conventional grain-fed beef in the world (Mildred 2007). According to Mildred (2007), there were nearly 90,000 feedlots across the country in 2006, 3% of which had capacity of 1000 heads or more. These feedlots provided over 26 million fed cattle to marketplace and accounted for 77% of cattle commercially slaughtered that year. Nevertheless, issues and concerns have been raised regarding potential consequences of factory-like farming on human health, environment, and animal welfare. With respect to the environment, CAFOs

accumulate manure at a faster rate than the land base on which the manure is spread can accommodate, causing water pollution when the nutrients, ammonia, harmful microorganism, pathogens, and hormone and antibiotic residues runoff into surface and ground water (Clancy 2006; EPA 2008). Likewise, the grain-fed production system emits odor and greenhouse gas that cause air pollution and contribute to global warming (EPA 2008).

More than half of grain-fed cattle have been found to have acid-resistant E. coli O157:H7 in their feces while the proportion drops to 15% if they are switched to eat hay (Russell, Diez-Gonzalez, and Jarvis 2000; Russell and Rychlik 2001). According to Russell, Diez-Gonzalez, and Jarvis (2000), grain-based diets cause cattle's digestive tract abnormally acidic, which makes E. coli bacteria adaptive to a high acid environment. As a result, E. coli can survive more easily in human's stomach acid and potentially cause disease when people eat contaminated beef.

Additionally, the concentrated feeding system confines cattle in cramped spaces and feeds them grain-based rations that have low fiber. The practice violates the natural growth way of ruminant animals and thus causes health problems in cattle (Smith 1998). In order to promote growth and reduce disease incidences, sub-therapeutic antibiotics and growth hormones are administered to cattle and their residues left in beef products potentially risk human's health (Casewell et al. 2003). Moreover, the public has been questioning the confinement and antibiotics usage of cattle on humane ground (Clancy 2006; EPA 2008). With the outbreak of Mad Cow disease and worldwide antibiotic-resistance problem, the public has expressed more concerns about conventional grain-fed beef production and been showing increasing interest in healthier, safer, and environmentally-friendly alternatives to the conventional beef production (Thilmany, Umberger, and Ziehl 2004).

2.3. Grass-Fed Beef as an Alternative to Conventional Grain-Fed Beef Production

In contrast to conventional grain-fed beef, grass-fed beef is promoted as being produced from cattle that graze freely on pastureland rather than being restricted in feedlots. Grass-fed beef are fed native grass, forage, and/or silage throughout their lives (USDA 2007); therefore, grass-fed beef has different characteristics from conventional grain-fed beef.

2.3.1. Definition of Grass-Fed Beef

The USDA proposed a grass (forage)-fed standard in 2002 which indicated "grass, green or range pasture, or forage shall be 80% or more of primary energy source throughout the animal's life cycle" (USDA 2006). Concerns rose among grass-fed producers and consumers in that a considerable amount of non-grass/forage diets, especially grains, was allowable in the proposed standard. The proposed standard was also contentious in that it didn't rule out confined feeding of cattle as long as the percentage of grass and forage in their diets was high enough to reach the standard (Burros 2006; Pena 2006). Moreover, the proposed standard was criticized for not reflecting consumers' perceptions of grass (forage)-fed animals as having free access to pasture rather than in confinement feedlots and, by extension, the absence of growth hormones and sub-therapeutic antibiotics usually associated with feedlot production (Pena 2006).

After incorporating comments nationwide and considering feasible production practices, the USDA established the grass (forage)-fed marketing claim in Oct, 2007. The claim defines grass- and forage-fed as "Grass and forage shall be the feed source consumed for the lifetime of the ruminant animal, with the exception of milk consumed prior to weaning. The diet shall be derived solely from forage consisting of grass (annual and perennial), forbs (e.g., legumes, Brassica), browse, or cereal grain crops in the vegetative (pre-grain) state. Animals cannot be fed grain or grain byproducts and must have continuous access to pasture

during the growing season. Hay, haylage, baleage, silage, crop residue without grain, and other roughage sources may also be included as acceptable feed sources. Routine mineral and vitamin supplementation may also be included in the feeding regimen. If incidental supplementation occurs due to inadvertent exposure to non-forage feedstuffs or to ensure the animal's well being at all times during adverse environmental or physical conditions, the producer must fully document (e.g., receipts, ingredients, and tear tags) the supplementation that occurs including the amount, the frequency, and the supplements provided." (USDA 2007)

Compared with the previously proposed claim, the established grass (forage)-fed standard emphasizes a high percentage of grass (forage) in the diets of ruminant animals and their "continuous access to pasture during the growth season" by considering the weather condition and forage availability during the winter across geographic regions. In this study, grass-fed is defined according to the USDA-established grass (forage)-fed standard and grass-fed beef refers to the meat from cattle that graze on pasture and are fed grass with supplementary forage and/or silage other than grain from weaning to finish.

2.3.2. Production and Benefits of Grass-Fed Beef

From the perspective of environment preservation, grass-fed production is promoted by some consumers as environmentally benign in that well-managed cattle disperse their waste over open grassland, which decreases water and air pollution and greenhouse gas emissions typically associated with the concentration of manure in feedlot production (Clancy 2006; Robinson 2004). The scattered manure on pasture serves as natural fertilizers and helps improve soil quality and ecosystem health (Lozier, Rayburn, and Shaw 2003; Robinson, 2004). Well-managed grazing may also help reduce soil erosion caused by grain and oilseed cultivation, and water pollution attributed to the use of fertilizers and feedlots that are

typically related to grain-feeding (Rayburn 2003).

Animals' body fat content is not determined directly by their diets but rather is affected by their growth rate (Muir, Deaker, and Bown 1998). Compared to grain concentrates, grass has higher fiber and lower starch and calories (McCluskey et al. 2005, Robinson 2004). Grain-based feeding, therefore, makes cattle grow faster and thus shortens the time for cattle to reach a slaughter weight compared to grass-feeding. As indicated by Bearden (2004), grain-fed cattle typically take up to 15 months to achieve the desired slaughter weight whereas the growth period is from 18 to 24 months for pasture-fed cattle. Muir, Deaker, and Bown (1998) also indicate that grass-fed beef cattle, if fed without supplemental growth hormones, are four months older at slaughter on average than conventional grain-fed cattle. The slower growth rate leads to less fat in the body of grass-fed cattle. Rule et al. (2002) indicate that grass-fed beef has only one third as much fat as grain-fed beef, equal to the amount of fat on a skinless chicken breast or wild deer. The leaner grass-fed beef carcass also means a lower level of calories and cholesterol than conventional grain-fed beef carcasses. Grass-fed beef loin contains about 100 fewer calories for a six-ounce steak than the conventional grain-fed beef counterpart (Rule et al. 2002).

With reference to nutritional and health benefits, Omega-3 fatty acids are a kind of healthy fat that protects human from high blood pressure and heart attacks (Kris-Etherton, Harris, and Appel 2002). Grass-fed beef contains two to four times more Omega-3s than grain-fed beef because the fat is formed in the chloroplasts of green leaves and algae (Duckett et al. 1993). Studies have shown that Conjugated Linoleic Acid (CLA) has cancer-fighting and disease-resisting properties (e.g. Scimeca et al. 1994). According to Dhiman et al. (1999), grass-fed beef has three to five times more CLA than conventional grain-fed beef. In addition to high levels of Omega3 and CLA, grass-fed beef has almost four times as much Vitamin E as conventional grain-fed beef (McCluskey et al. 2005; Yang et al. 2002). Grass-fed beef also

reduces consumers' exposure to antibiotics and feed additives that are usually used in feedlot production (Clancy 2006). Grass-fed beef is produced from animals that don't receive supplemental hormones before slaughter; therefore, it is viewed by consumers as a healthy alternative to conventional grain-fed beef (Clancy 2006; Robinson 2004). After the appearance of Mad Cow disease, more and more consumers are paying attention to grass-fed beef which they consider as reducing their risk in exposure to Bovine Spongiform Encephalopathy (BSE) (Thilmany, Umberger, and Ziehl 2004).

2.3.3. Sensory Attributes of Grass-Fed Beef

Even as consumers are more and more concerned about the health, nutrition, food safety, and other intangible attributes of beef, they evaluate food quality through their senses of smell, sight, taste, and feel. Therefore, their preferences and purchase decisions are inevitably affected by the sensory attributes and quality of beef products (Miller 2007). Numerous studies have documented the relationship between food sensory attributes and consumers' preferences and purchase decisions. Alfene et al. (2006) conducted choice experiments to investigate consumers' valuations for the color of salmon and found that they are willing to pay more for salmon fillets at normal or above-normal redness than paler salmon. Several studies have demonstrated that tenderness is the most important organoleptic attribute that determines the palatability of beef and affects consumers' sensory acceptance of beef products (e.g. Huffman et al. 1996; Miller et al 1995). Lusk et al. (2001) used experimental economics methods in retail stores to assess consumers' preferences and WTP for tenderness of beef steak. Their findings reveal that consumers prefer more tender steak and their preferences can be translated to a price premium. Huffman et al. (1996) indicate that flavor alone explains most of the variation (67%) in consumers' overall palatability preferences for beef prepared at home and that about 80% of the palatability variation could be attributed to

the differences in both flavor and tenderness. Leanness and color are also usually considered to be important selection criteria when purchasing beef (e.g. Forbes, Vaisey, and Diamant 1974; Jeremiah, Carpenter, and Smith 1972; Killinger et al. 2004). For example, Killinger et al. (2004) conducted consumer surveys and visual evaluations for two pairs of beef steaks that differed in marbling level and color, and found that most consumers prefer less marbled and bright-cherry-red steaks, and are willing to pay more for the steaks they prefer.

While quality and sensory attributes of beef products influence consumers' preferences and valuations, consumers typically evaluate and establish their perceptions and acceptability of beef quality based on differently at the time of purchase and consumption (Acebron and Dopico 2000). Consumers usually develop their expectations of beef quality at the time of purchase by inspecting the visual appearance of beef but obtain their eating experience when consuming by assessing the palatability attributes of beef such as flavor, tenderness and juiciness (Acebron and Dopico 2000; Becker 2000). As a result, visual and palatability attributes mainly determine consumers' perceptions of beef quality at the two stages of quality evaluation.

At the time of purchase, consumers perceive beef quality based on intrinsic and extrinsic cues since there is not actual consumption happening at this stage. The intrinsic cues are the physical characteristics that cannot be altered without changing the product per se whereas extrinsic cues are related to the product but not the physical part of it (Becker 2000; Gurunt 2000). The main intrinsic cues include color, visible fat, meat texture, freshness, and cuts while extrinsic cues encompass things like price, promotion, and brand. When consuming beef, the important quality attributes that affect consumers' eating experience are flavor, tenderness, and juiciness (Acebron and Dopico 2000; Gurunt 2000; Miller 2007). Acebron and Dopico (2000) found that consumers prefer light-colored, less fatty, and fresher meat and perceive beef with these traits to be of higher quality. Taste, tenderness, and

juiciness are significant factors in consumers' experienced quality but taste and tenderness appear to be more important than juiciness.

As quality and sensory attributes of beef carcass are considerably affected by beef production practices and the diets that cattle are fed (Muir, Deaker, and Bown 1998; Umberger et al. 2002), grass-fed practice that combines free-roaming with low-energy grass-based diets offers grass-fed beef distinct visual appearance and palatability characteristics from conventional grain-fed beef (Muir, Deaker, and Bown 1998). With respect to visual attributes, grass-based diets have high concentration of beta-carotene, a yellow carotenoid pigment that provides essential vitamins to human (Descalzo et al. 2005; Muir, Deaker, and Bown 1998; Yan et al. 2002). As indicated by Descalzo et al. (2005), the amount of beta-carotene in a grass meal is four times as high as in grain-based feed, which causes grass-fed beef's muscle tissue to have 10 times as much beta carotene as that of grain-fed beef, turning the fat of beef carcasses yellow (Bowling et al 1977; Crouse, Cross, and Seideman1984; Muir, Deaker, and Bown 1998). Likewise, other studies report that grass-fed beef, in general, has dark rather than cherry-red meat muscles of conventional grain-fed beef when exposed to the air (Bowling et al. 1977; Crouse, Cross, and Seideman1984; Martz 2000, Shreder et al. 1980). Surface discoloration of grass-fed beef is faster than conventional grain-fed beef. The muscles of grass-fed beef typically keep bright under regular retail display for only four days while conventional grain-fed beef can have bight meat muscles for five to six days (Bowling et al. 1977; Crouse, Cross, and Seideman1984; Schroeder et al. 1980).

When it comes to palatability/taste attributes, Muir, Deaker, and Bown (1998) indicate that beef from cattle with higher growth rates prior to slaughter is typically more tender due to the concentrated proteolytic enzymes in meat tissues. As a result, grass-fed cattle have less tender carcasses due to their lower growth rate than conventional grain-fed cattle (Bowling et

al. 1977; Crouse, Cross, and Seideman1984). Furthermore, grass-fed beef is generally leaner than conventional grain-fed beef and has relatively low level of marbling, a characteristic that is closely associated with the juiciness of beef. Thus, less-marbled grass-fed beef carcasses tend to be less juicy than conventional grain-fed beef (Crouse, Cross, and Seideman1984; Melton et al. 1982). Little fat cover of grass-fed beef carcasses also causes it to cool down faster after harvest than conventional grain-fed beef and thus become drier and less tender (French et al. 2000). Flavor is another important factor that sets grass-fed beef apart from conventional grain-fed beef. Consumers sometimes perceive the flavor of grass-fed beef to be intense and grassy while they perceive the flavor of conventional grain-fed beef to be "fatty" (Bowing et al. 1977; Melton et al. 1982; Schroeder et al. 1980). Martz (2000, pp.3) asserts that "although off flavor stays at an almost undetectable level, grassy taste can be observed in most pasture-based meat."

2.4. The Potential Hispanic Market for Grass-Fed Beef

Health, nutrition, food safety, and environmental quality considerations drive consumers to search for food attributes to meet their needs. Sometimes, however, favorable health, nutrition, food safety, and environmental-related attributes are not necessarily consistent with consumers' preferences for sensory attributes. For example, beef steaks with higher USDA grade means a higher level of intramuscular fat/marbling, which may make beef juicier and taste better. The highly-marbled steak provides consumers with a favorable eating experience, but, from the view of health, it implies a higher level of saturated fat, a seemingly unhealthy attribute of beef (McCluscky et al. 2005). Huang (1996) indicates that although consumers are aware of the benefits of organically-grown fresh produce, a majority of them perceive its appearance to be inferior to conventionally grown fresh produce and are unwilling to buy it if they consider it with sensory defects. A similar inconsistency may occur

with grass-fed beef.

The U.S. has based its beef production on grain-fed and feedlot practices over the past 50 years and thus its beef markets have been dominated by conventional grain-fed beef products. Although there is an increasing interest in grass-fed beef in the U.S along with the increasing public concerns about health, nutrition, food safety, and environmental preservation (Lozier, Rayburn, and Shaw 2003), the distinct visual appearance and taste attributes of grass-fed beef seem undesirable to domestic consumers who primarily consume conventional grain-fed beef and are accustomed to its quality and taste attributes (Sitz et al. 2005). Some studies have indicated that the dark muscles and yellow fat of grass-fed beef are viewed as inferior by some mainstream consumers while they perceive the meat with pure white fat and bright muscles to be premium quality (Bowing et al. 1977). Mainstream consumers also complain that grass-fed beef tastes "too strong," tough, or dry (Bowing et al. 1977; Crouse, Cross, and Seideman1984; Martz 2000). Kerth et al. (2004) show that out of 1,250 domestic participants, only one-third prefer the flavor of grass-fed beef over grain-fed beef. Umberger et al. (2002) reveal that only about 25% of participants that primarily consist of Caucasians prefer the flavor of Argentine grass-fed beef to domestic corn-fed beef, although about 60% of grass-fed preferring participants are willing to pay price premiums for it. Sitz et al. (2005) show that the majority of US consumers (about 65%) prefer domestic corn-fed beef over Australian grass-fed beef and place a lower value on Australian grass-fed than domestic corn-fed beef.

Unlike U.S. conventional beef production that combines feedlots with high-energy grain-based feed, many Latin American countries base their beef production on grass feeding. According to the USDA (2001), approximately 90% of beef produced in Argentina is entirely grass fed. Argentina and Brazil are two of the world's largest grass-fed beef exporters, accounting for 15% of global beef trade. Thanks to inexpensive pastureland and a year-round

grass supply, grass-fed production is also a predominant practice in Central America and only costs one-forth that in the U.S. (Place 2001). Eighty-five percent of national land in Uruguay is used for grazing (USDA 1997). Anecdotal evidence (e.g. Myers 1980; Paganini 2004; Umberger et al.2002; USDA 1997) show that other Hispanic/Latin countries such as Mexico, Venezuela, Uruguay, and Paraguay pursue grass-fed management practices. In the Latin American countries that rely on grass-feeding, consumers are hypothesized to be accustomed to and perhaps even prefer the sensory attributes of grass-fed beef (Paganini 2004; USDA 1997). While the unique visual appearance and taste of grass-fed beef seem to discourage U.S. mainstream consumers from consuming grass-fed beef and probably limit the market of grass-fed beef among them, it appears reasonable to hypothesize that people from the Latin American countries that primarily use grass feeding practices are more likely to prefer grass-fed beef over U.S. conventional grain-fed beef.

Compared to other ethnic groups, Hispanics tend to be heavy meat eaters and meat accounts for a greater portion of their annual food expenditure relative to other ethnicities. Hispanic consumers spend 35% more on average than other consumers on meat, poultry, fish, and seafood (BLS/CEX 2005a). In U.S beef markets, the annual expenditure on beef per Hispanic was approximately $90 more than that by Asians and Blacks and $60 more than non-Hispanic Whites (BLS/CEX 2005a and 2005b). Based on the 1994-1996 and the 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII), Davis and Lin (2005) indicate that daily beef consumption per Hispanic is five grams more than that of a non-Hispanic consumer. Furthermore, a bigger proportion of Hispanics consume beef on a daily basis than that of other ethnic groups, and they consume more beef prepared at home. Davis and Lin (2005) also found that 70% of all beef products consumed by Hispanics are prepared at home while Whites and Blacks consume 64% and 61% at home, respectively. This implies that Hispanics purchase more beef products at retail stores. In sum, compared

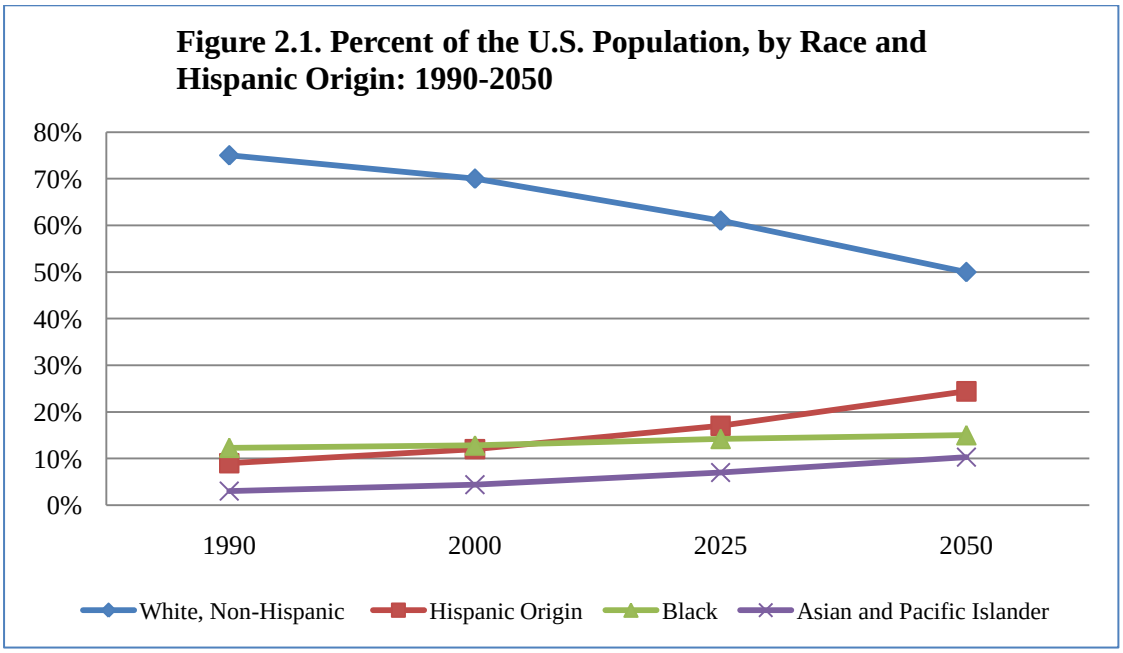
with other ethnic groups, Hispanics consume and spend more on beef products and therefore represent a significant consumer segment in U.S beef market.

Ethnicity is a term used to distinguish groups of people according to culture, language, and tradition rather than physical or biological characteristics. The U.S. census uses the Hispanic category to represent people of all races who have the heritage of Spain or Spanish-speaking Latin America. According to the origin of countries, the Hispanic population is composed of people who, regardless of their racial groups, have origins in Mexico, Puerto Rico, Cuba, Central or South America, and other Spanish/Hispanic/Latin countries (Pollard and O'Hare 1999).

The Hispanic population in the U.S. has grown rapidly over the last two decades. It increased 57% between 1990 and 2000, from 22.4 million to 35.3 million. In 2004, one of every seven persons in the U.S had Hispanic origin, accounting for 14% of total U.S population (U.S. Census Bureau 2000-2005). The U.S. Census Bureau's (2008) population projections state that the Hispanic population will increase to 16% of the total U.S. population by 2010, 20% by 2030, and approximately 25% by 2050. The USDA projections (2003) report that by 2020 the U.S. population is expected to increase by 50 to 80 million with an annual population growth of 1.2 million for Latinos compared to 0.5 million for Whites and 0.4 million for both Blacks and Asians. As shown in Figure 1.1., while the non-Hispanic White population has decreased from about 75% in 1990 to 68% by now and will continue to decrease in the coming decades, Hispanics are growing rapidly and have become the largest ethnic minority in the U.S. The Hispanic population is anticipated to continue this rapid growth in the coming decades.

The Hispanic population is not only growing quickly; it is also expected to become an important purchasing power in U.S. markets. Data from the Selig Center of Economic Growth (Humphreys 2006) show that Hispanics constituted a $212 billion market in 1990,

Figure 2.1. Percentage of the U.S. Population by Race and Hispanic Origin: 1990-2050



Source: U.S. Census Bureau, 1990 and 2000 Decennial Censuses; Population Projections, 2010 to 2050.

$490 billion in 2000, and $798 billion in 2006. The Hispanic market is projected to expand to $1.2 trillion by 2011. The growth of the Hispanic food market is also very impressive. Data from 2004 Consumer Expenditures Survey of Bureau of Labor Statistics (BLS/CEX 2005a and 2005b) indicate that although the average annual expenditure of Hispanic household is $6,000 less than that of the average U.S. household, Hispanic consumers spend more on food, especially items such as beef, poultry and fresh vegetables, than all other consumer groups.

Along with significant beef consumption and potential preferences for grass-fed beef, the fast-growing Hispanic population is likely to become an important purchase power and promising market of grass-fed beef. Existing studies and research on the demand of grass-fed beef, however, are mostly targeted to mainstream consumers (e.g. Evans 2007; Field et al. 2006; Sitz et al. 2005; Umberger 2001; Umberger et al. 2002). No known study has been done to focus on the potential Hispanic market for grass-fed beef and determine whether Hispanic consumers prefer grass-fed beef over conventional U.S. grain-fed beef and whether they are willing to pay more for grass-fed beef if they like it. Therefore, research is in need to

explore the market potential of grass-fed beef among the fast-growing Hispanic population and is expected to contribute to literature in this regard.

2.5. Virginia's Relevance as a Research Site

Virginia, the site for the empirical research, is relevant to both the production and potential Hispanic market for grass-fed beef.

2.5.1. Virginia's Suitability for Production of Grass-Fed Beef

Twenty-five counties in Virginia are located in Appalachian region where land is mountainous and suited for grazing (Evans et al. 2004; USDA 2004a). Furthermore, the moderate climate, soil, and abundant water resources in Virginia favor the production of plenteous and high-quality forage (White and Wolf 1996; McKinnon and Snodgrass 2000). Steep farmland in Virginia, in contrast, doesn't seem to support crop planting and the relatively high prices of grain in the Virginia region make conventional grain-fed production less profitable than in other major grain-fed cattle production areas of the U.S. (Evans et al. 2004; McKinnon and Snodgrass 2000; USDA 2004a). Therefore, grass-fed beef production (primarily cow-calf farms) is common in this region and is potentially attractive for small family farms interested in pursuing beef production (Mainville et al. 2009; USDA 2004a).

2.5.2. The Hispanic Market in Virginia

Virginia is a state with a diverse ethnic composition and Hispanics are the fastest growing ethnic group within this region. Hispanics grew from 2% to 6% of the Virginia population between 1990 and 2004, while the non-Hispanic white population fell from 72% to 69% (U.S. Census Bureau 2005; Cai 2008; Cai and Krazen 2006). Although at present the percentage of Hispanic population in Virginia and Washington DC are significantly lower

than the 14.5% in the U.S, it is growing very rapidly. The foreign-born population has doubled from 5% of Virginians in 1990 to almost 10% in 2004, about one-third of whom are identified as Hispanics (U.S. Census Bureau 2005; Cai 2006a). Recent immigrants mainly come from Latin American countries, such as Mexico, EI Salvador, Guatemala, and Bolivia, which account for almost half of international migrants from the top ten sending countries in Virginia (Cai 2006b). Due to high fertility and increasing immigration, the growth of the Hispanic population in Virginia will continue in the coming decades (U.S. Census Bureau 2005; Cai 2008; Cai 2006a). Washington DC, in close proximity to Virginia, is also a potentially large Hispanic market. According to the 2005 American Community Survey (U.S. Census Bureau/ACS 2005), 11% of the population in Washington DC, about 577,000 individuals, has Hispanic background.

Given that people from Latin American countries that primarily pursue grass-fed production have been identified as potential consumers and are assumed to comprise a potential market for grass-fed beef, the fast-growing Hispanic population and favorable geographic conditions for grass-fed beef production in Virginia make it an appropriate context for this study.

CHAPTER III

CONCEPTUAL FRAMEWORK

The conceptual framework for this study builds on the framework of Lancaster (1966), in which consumers' utilities or preference orderings are not derived directly from goods or combinations of goods per se but from the attributes or characteristics embodied in the goods.

We also build on the Perception of Quality for Beef (PQB) model proposed by Wierenga (1982). In terms of PQB, consumers establish their perceptions of beef quality/expected utilities at the moment of purchase and obtain their experience of beef quality/experienced utilities at the moment of consumption. At the different phases of evaluation, consumers use different criteria to determine beef quality. Consumers' expectations of beef quality are formulated based on quality cues since no actual consumption takes place at the moment of purchase. Individuals obtain their experienced quality of beef based on its quality attributes that are evaluated at the moment of actual consumption.

Numerous studies have examined the quality characteristics that underlie consumers' perceptions of product quality and affect their expected and experienced utilities (e.g. Acebron and Dopico 2000; Becker 2000; Grunert 1996 and 1997; Steenkamp and Trijp 1996; Wierenga 1982). This literature argues that at the purchase stage perceived intrinsic cues such as freshness, cut, color, marbling, meat texture, and fat lumps influence consumer choices; perceived extrinsic quality cues from characteristics such as price, promotion, brand, label content, and store image have been assumed to impact consumer decisions (Acebron and Dopico 2000; Grunert et al. 1996; Wierenga 1982). In our study, extrinsic cues are not included since we focus on the effects of sensory attributes of beef on consumers' preferences and its impacts on WTP for grass-fed beef. With respect to quality attributes, in common with

the literature (e.g. Forbes, Vaisey, and Diamant 1974; Grunert 1997; Huffman et al. 1996; Jeremiah, Carpenter, and Smith 1972; Lusk et al. 2001; Miller et al 1995; Wierenga 1982), we assume that at the consumption stage, tenderness, juiciness and flavor are important experienced quality attributes that influence consumers' preferences and valuations on beef products.

In this study, based on the PQB model, we identify the determinants of consumers' heterogeneous preferences for beef products (see Table 3.1.). First, we classify two categories of attributes based on the two stages of evaluation: intrinsic quality cues that affect consumers' expected utilities and quality attributes that determine their experienced utilities.

Table 3.1. Hypothesized Determinants of Consumers' Preferences for Beef Products

	Content
Sensory attributes	1) Visual attributes of beef products, such as fat color, lean meat color, and meat texture. 2) Taste attributes of beef products, such as tenderness, juiciness, and flavor.
Consumer's characteristics	1) Demographic and socio-economic characteristics 2) Beef consumption and purchase behavior

We also build on several studies that document consumers' preferences and valuations of meat products as being influenced by socioeconomic and demographic characteristics (e.g., Capps, Moen, and Branson 1988; Evans 2007; Huffman et al. 1996; Lusk et al. 2001; Moon and Ward 1999; Nayga 1996; Nayga, Aiew, and Woodward 2006; Rimal 2002; Umberger et al. 2002). Most of these studies also indicate the importance of beef consumption behavior on consumers' preferences for beef. For example, Evans (2007) reports that preferences for grass-fed beef are significantly influenced both by socio-demographic variables (e.g., age, gender) and by the frequency of home-prepared steak consumption, the amount of beef consumed per week, and previous grass-fed beef purchase experience. Umberger et al. (2002)

found that there exist demographic differences between grass-fed and corn-fed beef preferring consumers, and that socio-demographic characteristics such as age and ethnicity are identified to be important to their preferences. This study also reports that the more frequently a consumer eats beef the more likely s/he prefers grass-fed beef. Lusk et al. (2001) investigate consumers' valuations of steak tenderness, and indicate that consumers who like beef steak to be cooked to a higher level of doneness are more likely to prefer the tender steak.

Consumers' health attitudes and knowledge potentially influence their demand for meat products (e.g. Kinnucn et al. 1997; Moon and Ward 1999; Schroeder and Mark 2000). McCluskey et al. (2005) indicate that consumer health concerns can be translated to an average $5.65 price premium for beef products with health attributes such as low calorie or cholesterol. Consumers are willing to pay more for specialty food products that are perceived to be more nutritious, healthier, and safer than conventional products (e.g. Grannis, Hooker, and Thilmany 2000; Huang 1996). Numerous studies also report the potential and positive effects of consumers' previous purchase experience in beef products with health/nutrition benefits on their current and future purchase decisions on these products (e.g. Ziehl, Thilmany, and Umberger 2005; Huang 1996). Given the significant impacts of health/nutrition knowledge and consciousness on consumers' preferences, factors related consumers' potential health attitudes are included in the conceptual framework.

This study is focused on Hispanic consumers. Hispanics have ethnic-specific socio-demographic characteristics, and express distinct food consumption behavior from mainstream consumers. Thomas Tseng, the former director of Marketing Cultural Access Group, proposed the "Four Fs" to describe food consumption and purchasing behavior of Hispanics: Family, Freshness, Flavor, and Friendliness (Ross 2003). That is, Hispanic consumers, on average, have a relatively larger household size (Family) and spend more on

food than mainstream consumers; they prefer fresh food (Freshness), and authentic ingredients from their origins and food products with a taste and flavor they are accustomed to (Flavor); finally, they value a pleasant shopping experience (Friendly). The Hispanic population living in the U.S. is influenced by both dominant American culture and their original culture. As a result, Hispanic consumers with different acculturation levels will have different food preferences and consumption behavior. Highly acculturated Hispanic consumers are less likely to be influenced by Tseng's four "Fs" (Ross 2003). They tend to present more similar dietary patterns and consumption behavior to mainstream consumers of the host society than their low-acculturated counterparts (Ogden, Ogden, and Schau 2004). Based on economic theory and previous studies, we build on Lancaster (1966) by including individual characteristics in consumer utilities, and hypothesize that Hispanic consumers' preferences and WTP for grass-fed beef are affected by socio-demographics, beef consumption behavior, and other Hispanic-specific characteristics.

In terms of the discussion above, we define an individual *i*'s utility function based on the following components:

1. A vector of alternative beef products X (such as grass-fed and conventional grain-fed beef);
2. Beef product sensory attributes S, including intrinsic cues G, such as color and meat texture, and quality attributes R, such as flavor and tenderness;
3. Individual *i*' s characteristics D, including socio-economic and demographic characteristics, such as age, gender, and education, and beef consumption behavior, such as the frequency of beef consumed at home and away from home. Consumers' potential health attitudes are included.

Following the framework proposed by Hanemann (1984), an individual consumer maximizes his/her utility function subject to a budget constraint:

$$\underset{X,z}{Max} \quad u(X,S,Z,D) \tag{3.1}$$

$$s.t. \qquad \sum_{j=1}^{J} p_j x_j + Z = I \qquad j \in \{1,2,...,J\}$$

$$x_i \cdot x_j = 0, \forall i \neq j, \quad i,j = 1,2,...,J$$

$$X \geq 0, Z \geq 0$$

where: 1) X is a vector of alternative beef products

$$X = (x_1, x_2, ..., x_j, ..., x_J), \quad j \in \{1,2,...,J\};$$

2) Beef product x_j consists of a vector of attributes S_j. S_j includes a vector of m intrinsic cues *G*, and a vector of n quality attributes *R*; that is,

$$S_j = (G_j, R_j) = (g_{j1}, g_{j2}, \dots, g_{jm}; r_{j1}, r_{j2}, \dots, r_{jn}), j \in \{1,2, \dots, J\};$$

S is a matrix of attributes for X ;

3) P_j is the price of beef product x_j ; P is a vector of prices of X ;

$$P = (p_1, p_2, ..., p_j, ...p_J), \quad j \in \{1,2,...,J\};$$

4) Z represents the numeraire;

5) *D* is a vector of individual characteristics, including socio-demographics and beef consumption behavior;

6) I represents earned annual income;

7) Individual consumer's objective function satisfies:

$$\frac{\partial U}{\partial \Omega} > 0, \qquad \frac{\partial^2 U}{\partial \Omega^2} < 0; \quad \Omega = S, Z, D$$

In this model, it is assumed that only one of the discrete alternatives of beef will be selected, that is, $\forall i \neq j,\ x_i \ and \ x_j$ are mutually exclusive[1].

[1] In this study, it is assumed that there are only two alternative beef products, grass-fed and conventional grain-fed beef, and they are mutually exclusive such that subjects can only choose one from the two alternatives. In reality, however, it is noted that consumers have more than the two choices and alternative beef products may not be mutually exclusive.

If an individual consumer *i* chooses the *jth* beef product, s/he obtains a conditional direct utility as:

$$\bar{u}_j = u(0,0,...,0,x_j,0,...,0,S_j,D,Z) = \bar{u}_j(x_j,S_j,D,Z)$$

To maximize an individual consumer's utility function subject to budget constraint under the condition that he/she chooses beef product *j*, we consider Lagrangean function as:

$$L = U(X,S,Z,D) - \lambda \cdot (I - X \cdot P - Z)$$

$$\equiv \bar{u}_j(x_j,S_j,Z,D) - \lambda \cdot (I - p_j \cdot x_j - Z)$$

Solving this utility maximization problem, conditional demand functions will be attained by $\bar{x}_j = \bar{x}_j(p_j,I,S_j,D)$ and $\bar{Z} = I - \sum_{j=1}^{n} p_j \bar{x}_j = I - p_j \bar{x}_j$ with $\partial \bar{u}_j(\cdot) \big/ \partial (I - p_j \bar{x}_j) > 0$; the conditional indirect utility function takes the following form:

$$\bar{v}_j \equiv \bar{u}_j(\bar{x}_j(p_j,I,S_j,D),\bar{z}(p_j,I,S_j,D),S_j,D)$$

$$\equiv \bar{u}(\bar{x}_j(\cdot),I - p_j\bar{x}_j(\cdot),S_j,D) = \bar{v}(p_j,I,S_j,D)$$

$$\Rightarrow \bar{v}_j = \bar{v}_j(p_j,I,S_j,D) \equiv E(\bar{v}_j(\cdot)) + \varepsilon_j \qquad (3.2)$$

where ε_j represents the unobservable components of utility; $\varepsilon_j \in \varepsilon = \{\varepsilon_1,\varepsilon_2,...,\varepsilon_J\}$. ε is a set of random variables with joint c.d.f. $F_\varepsilon(\varepsilon_1,\varepsilon_2,...,\varepsilon_J)$ that determines the distribution of utility function. Nunes, Cunha-e-Sa´, and Ducla-Soares (1998) have proven that given the conditional indirect utility function $\bar{v}_j(p_j,I,S_j,D)$, and $\partial \bar{v}_j(p_j,I,S_j,D)/\partial p_j \le 0$, $j \in \{1,2,...,J\}$, then

$$\bar{v} = \bar{v}(\cdot) = Max\{\bar{v}_1(p_1,I,S_1,D),\bar{v}_2(p_2,I,S_2,D),...,\bar{v}_J(p_J,I,S_J,D)\} \qquad (3.3)$$

is also an indirect utility function. That is, among J alternative products, consumers derive the maximum utility from consuming the *jth* product. The conditional indirect utility on product *j* is unconditional indirect utility, therefore establishing the relationship between conditional

and unconditional indirect utility functions.

In this study, we assume that an individual consumer *i* chooses one of two alternative beef products: grass-fed beef or conventional grain-fed beef. Based on the random utility model (RUM), there are unobservable components in consumers' utility that can be treated as random variables (Hanemann 1984). For example, unobservable components could be consumer characteristics and/or product attributes. Therefore, a consumer's utility function is constituted by a systematic part and a stochastic part. If consumer *i* chooses to consume grass-fed beef, s/he obtains conditional indirect utility given by

$$\bar{v}_{Grass-fed}(p_{Grass-fed}, I, S_{Grass-fed}, D) \equiv E(\bar{v}_{Grass-fed}(\cdot)) + \varepsilon_{Grass-fed} \tag{3.4}$$

where $E(\bar{v}_{Grass-fed}(\cdot))$ is the systematic part of the utility function and $\varepsilon_{Grass-fed}$ is a stochastic part produced by unobservable consumer characteristics and/or beef attributes.

If the *ith* individual consumer chooses to consume conventional grain-fed beef, s/he has conditional indirect utility as:

$$\bar{v}_{Grain-fed}(p_{Grain-fed}, I, S_{Grain-fed}, D) \equiv E(\bar{v}_{Grain-fed}(\cdot)) + \varepsilon_{Grain-fed} \tag{3.5}$$

where $E(\bar{v}_{Grain-fed}(\cdot))$ is the systematic part of the utility function and $\varepsilon_{Grain-fed}$ is a stochastic part determined by unobservable consumer characteristics and/or beef attributes.

We assume the consumer chooses grass-fed beef over conventional grain-fed beef if and only if

$$\bar{v}_{Grass-fed}(\cdot) > \bar{v}_{Grain-fed}(\cdot)$$

$$\Rightarrow \quad E(\bar{v}_{Grass-fed}(\cdot)) + \varepsilon_{Grass-fed} > E(\bar{v}_{Grain-fed}(\cdot)) + \varepsilon_{Grain-fed}$$

$$\Rightarrow \quad E(\bar{v}_{Grass-fed}(\cdot)) - E(\bar{v}_{Grain-fed}(\cdot)) > \varepsilon_{Grain-fed} - \varepsilon_{Grass-fed}$$

$$\Rightarrow \quad \Delta E\bar{v} > \mu \ , \quad \text{where} \quad \Delta E\bar{v} = E(\bar{v}_{Grass-fed}(\cdot)) - E(\bar{v}_{Grain-fed}(\cdot))$$

$$\mu = \varepsilon_{Grass-fed} - \varepsilon_{Grass-fed} \tag{3.6}$$

Consumer utilities are not observed. Nonetheless, one can observe consumers' choice. For a set of alternatives $\{1,2,...,J\}$, there is a vector of choice outcomes, defined by $\delta = \{\delta_1, \delta_2, ..., \delta_J\}$, where $\delta_j = 1$ if an individual consumer chooses good j, i.e. $x_j > 0$; otherwise, $\delta_j = 0$. In this study, consumers' preferences for grass-fed beef and conventional grain-fed beef are defined via discrete binary choices:

$$y = \begin{cases} 1 \ \ if\ prefers\ grass-fed\ beef \\ 0 \ \ if\ prefers\ grain-fed\ beef \end{cases}$$

where the binary variable has mean $E(y) = \pi_{Grass-fed}$ defined as

$$\pi_{Grass-fed} = P(y=1) = \Pr(\Delta E\bar{v} > \mu)$$

If the distribution of μ is symmetric, then

$$P(y=1) = \Pr(\Delta E\bar{v} > \mu)$$

$$= \Pr(\mu \geq -\Delta E\bar{v}(\cdot))$$

$$\Rightarrow \quad P(y=1) = 1 - \Pr(\mu \leq -\Delta E\bar{v}(\cdot))$$

$$= 1 - F(-\Delta E\bar{v}(\cdot))$$

$$= F(\Delta E\bar{v}(\cdot)) \qquad (3.7)$$

$$\Rightarrow \quad P(y=0) = 1 - F(\Delta E\bar{v}(\cdot)) \qquad (3.8)$$

where F(.) is c.d.f of μ.

Hicksian compensating surplus, a measure of consumer willingness to pay (WTP), is the maximum amount of money a consumer is willing to pay for a beef product to obtain the same level of utility as that s/he obtains by consuming other alternative beef products. WTP provides the monetary gauges to reveal consumers' valuation of a product and/or its attributes (Feldkamp, Schroeder, and Lusk 2005). In our framework, WTP is equivalent to the price premium a consumer is willing to pay for grass-fed beef over conventional grain-fed beef. That is,

WTP= the price for one pound of grass-fed beef steak – the price for one pound of conventional grain-fed beef steak (3.9)

Consistent with our assumptions on preferences, a consumer is willing to pay a price premium for grass-fed beef if and only if the following equality holds:

$$\bar{v}_{Grass-fed}(p_{Grain-fed} + WTP, I, S_{Grass-fed}, D) = \bar{v}_{Grain-fed}(p_{Grain-fed}, I, S_{Grain-fed}, D) \quad (3.10)$$

By solving (3.10), we have his/her WTP function as

$$WTP = W(p_{Grain-fed}, I, S, D) = E(W(\cdot)) + \eta \quad (3.11)$$

where η is the error term of individual consumers' WTP function. In the event that the consumer is unwilling to pay a price premium for grass-fed beef, his/her WTP is non-positive.

CHAPTER IV

METHODS FOR MEASURING CONSUMERS' PREFERENCES AND WILLINGNESS-TO-PAY

4.1. Research Methodology

In order to evaluate Hispanic consumers' preferences and WTP for grass-fed beef relative to conventional grain-fed beef, laboratory experiments were conducted in four sites in Virginia from September to November, 2008. One of the experimental economics methods, Multiple Price Lists (MPL) experiments combined with consumer surveys and direct sensory evaluations were used to investigate consumers' preferences and WTP for grass-fed beef.

4.1.1. Multiple Price Lists (MPL)—Background

MPL belongs to contingent valuation method (CVM). CVM is a survey-based elicitation technique that hypothetically asks respondents to state their values on a product or service of interest rather than eliciting values from actual choices (Ahmed and Gotoh 2007; Mitchell and Carson 1989). Hypothetical elicitation methods do not require respondents to make actual financial commitments and thus have been widely used to evaluate environmental amenities, non-market goods, and new products that are not currently available. In contrast, non-hypothetical elicitation approaches, such as experimental auctions, pertain to real products, real money, and actual exchanges (Lusk and Hudson 2004; Mitchell and Carson 1989; Voelckner 2006); in other words, consumers are obligated to pay the values they place on the product or service of interest. CVM is typically criticized for lack of incentive compatibility. Incentive compatibility is a term used in game theory to describe a mechanism that the best choice for participants is to honestly reveal their preferences (Lusk 2003; Lusk and Hudson 2004). The lack of incentive compatibility usually results in an

overestimated WTP and thus induces hypothetical bias, which defines the difference between respondents' stated values and their true payment for a product or service (Ahmed and Gotoh 2007; List and Gallet 2001; Lusk and Huson 2004). Numerous studies have revealed that hypothetical bias exists widely in hypothetical elicitation methods (e.g. Cummings, Harrison, and Rutstrom 1995; List and Gallet 2001; List and Shogren 1998; Lusk and Fox 2003). For example, Cummings, Harrison, and Rutstrom (1995) conducted both hypothetical and non-hypothetical dichotomous choice experiments for three household goods; their findings indicate that a significantly higher percentage of subjects in hypothetical valuation chose "Yes" to the provided prices than that in the non-hypothetical setting.

Nevertheless, compared to non-hypothetical elicitation methods, CVM is cheap and easy to use. Moreover, it has flexibility in applications in non-use values and can provide an immediate monetary evaluation of respondents' preferences (Mitchell and Carson 1989). At the same time, Lusk and Hudson (2004) indicate that for agribusiness applications, it is possible to make hypothetical elicitation incentive compatible since products for valuation are typically private and deliverable. Several existing studies have applied hypothetical elicitation methods to a non-hypothetical scenario by incorporating real economic commitments (e.g. Nayga, Aiew, and Woodward 2004; Lusk and Schroeder 2004).

As a CVM, MPL is widely used to elicit homegrown values rather than induced values. The standard MPL presents subjects with a fixed array of ordered prices or price intervals with paired options (yes and no) and asks them to choose an option for each price or price interval (Andersen et al. 2006). The primary advantages of MPL rest on easy explanation and implementation. There are two extended forms of MPL: switching MPL (sMPL) and iterative MPL (iMPL). In standard MPL, when multiple switching points appear, it implies that subjects are indifferent between prices or price intervals. sMPL extends MPL by including an indifferent option and allowing a single switching point in each table, therefore eliciting

consistent responses. iMPL allows more refined elicitation of preference by asking subjects to make choices within the interval that a subject switches at (Andersen et al. 2006 and 2007).

In order to reduce hypothetical bias, some studies attempt to evaluate consumers' values by putting MPL into a non-hypothetical environment (e.g. Andersen et al. 2007). Andersen et al. (2007) conducted an in-lab MPL experiment to measure consumer WTP for four different products: regular ketchup, organic ketchup, chocolate truffles, and a MP3 player. Their MPL experiments were non-hypothetical as one of the choice rows was selected randomly to implement. Their findings reveal that both non-hypothetical MPL and its extended form iMPL can lead to robust WTP in laboratory. They also indicate that iMPL is better than MPL in valuation by improving precision without inducing behavior bias.

The non-hypothetical MPL is considered to be incentive compatible. Considering a situation where MPL has only one decision row, each subject is endowed with $15 and will make a choice ("yes" or "no") for the stated price of $10 at that row. There is X percent chance that this row will be selected as binding; otherwise no payments will be made at all. If a subject's true WTP is less than $10, he/she would always say "no" and keep the full $15 with X percent chance. If his/her real WTP is above $10 he/she would choose "yes" and obtain real WTP + $5, which is greater than $15 with X percent chance. As long as the utility function is concave, subjects will reveal their real WTP for the product measured and there is no strategic behavior in the process.

As indicated by Lusk and Hudson (2004), it is reasonable to make the valuation setting non-hypothetical for private and deliverable goods. In this study, real products (grass-fed and conventional grain-fed beef steaks), real money, and actual transactions were involved such that a non-hypothetical MPL valuation could be conducted. Following the valuation method by Andersen et al. (2007), an iMPL experiment was designed and applied in a non-hypothetical environment in order for incentive compatibility and greater precision.

4.1.2. Experiment Sites

Four locations in Virginia were chosen as experiment sites: Galax, Roanoke, Richmond, and Blacksburg. These sites were selected not to mirror the preference differences across regions, but to maximize the diversity of subjects and represent different socio-economic groups within the Hispanic population in Virginia. Galax and Roanoke were chosen including low-income and less educated subjects. Galax is a Hispanic-concentrated city whose Hispanic population grew by 1,065% from 1990 to 2000 (U.S. Census Bureau 2000) and accounted for 14% of its total population in 2006 (U.S. Census Bureau/ACS 2006). Hispanics in Roanoke are characterized as low-income households with smaller household size and average level of education when compared to the Hispanic population of Virginia (U.S. Census Bureau 2000).

Richmond's Hispanic population has a lower median household income and similar average education level to that of Virginia's Hispanics population (U.S. Census Bureau 2000). Subjects from this city, however, were recruited through the Hispanic Chamber of Commerce that helped target to its high-income and well-educated members. Therefore, the sample in Richmond was intended to reflect this group of consumers. Finally, Blacksburg is a university-based town where Virginia Tech is located, and most potential subjects would come from Hispanic/Latino students, faculty, and staff, providing a relatively well-educated sample pool.

4.1.3. Subject Recruitment and Experiment Sessions

The study was targeted to consumers whose ethnicities were identified as Hispanic or Latino; therefore, subjects included Hispanic/Latino consumers whose origins are Mexican, Puerto Rican, Cuban, Dominican, Central or South American, or other Hispanic/Latino backgrounds regardless of their races.

Laboratory rather than filed experiments were conducted in this study. Compared to

field valuation, laboratory valuation has better experimental control. However, it limits researchers' accesses to the population of interest, therefore increasing sample selection bias (Lusk and Fox 2003). At the same time, several studies have revealed that consumers' socioeconomic and demographic characteristics play an important role in consumer WTP and demand for beef products (e.g. Alfnes and Rickertsen 2003; Lusk et al. 2001; Umberber et al. 2002). Hence, the subject pool of conventional laboratory experiments, which typically consists of standard student participants, limits the ability to detect consumers' heterogeneity (Harrison and List 2004). In order the address this problem of laboratory valuation and better target the population in question, Harrison, Lau and Williams (2002) conducted an *artefactual field experiment,* in which non-standard subjects, who were representative of population of interest, were recruited from field and participated in a laboratory experiment. In order to reflect the socioeconomic profile of the Hispanic population in Virginia, artefactual field experiments with non-standard subjects were conducted in our experiments. Potential subjects were recruited from Hispanic consumers at local Hispanic or Spanish-speaking churches, Hispanic/Latino restaurants, supermarkets or chain grocery stores, Hispanic or international food stores, libraries, universities, and Hispanic organizations. Recruitment flyers, word of mouth, and email announcements sent over Hispanic association listservs were the primary means of recruitment.

Potential subjects were screened for their eligibilities. The following criteria were required and participants had to: 1) be Hispanic or Latin American; 2) be responsible for food buying and /or preparing in their households; 3) be over 18 years old; and 4) consume and purchase beef products regularly. Moreover, only one person in each household was allowed to participate in the experiment. Subjects were selected and screened for eligibility through face-to-face or phone interviews.

If qualified, subjects were invited to participate in the laboratory experiment. They

were informed that they were going to take part in a survey and sensory evaluation for different types of beef and compensation of $30 in Galax and Roanoke and $50 in Richmond and Blacksburg was offered. The variation of participation compensation was necessary to address differences in opportunity costs of participation considering income levels and transportation costs among experiment sites. In addition to monetary compensation, subjects were told that they might also receive a pound of fresh beef steak in the course of experiment.

The experiment facilities differed among experiment sites. In Galax, sessions covered two days, and were held in the conference room at a public library. In Roanoke, the first day's experiment was held in the conference room of a hotel, and the second day's experiment was held in a Hispanic Catholic church where subjects participated in experiments right after the Sunday Mass. In Richmond, experiments were held in the conference room of a Mexican restaurant over one day. In Blacksburg, experiments were conducted in a university classroom over three consecutive days including two weekdays and one weekend day.

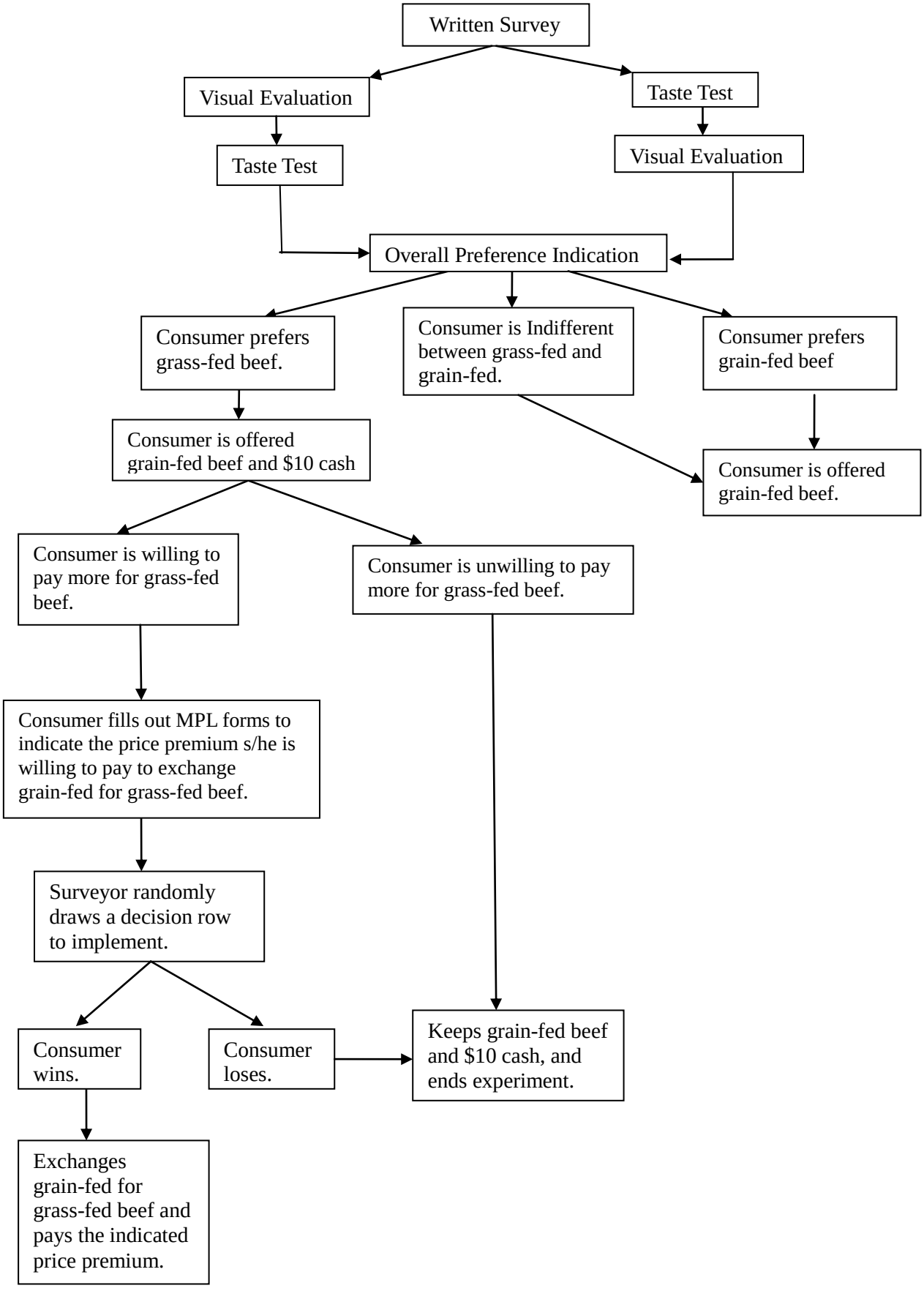
In each experiment site, there were five to seven sessions, each of which scheduled for a specific time slot and lasted 1 to 1.5 hours. Each session typically contained 8-15 subjects depending on the availability of qualified participants for the session. Subjects were able to select their sessions to participate according to their time preferences and availability.

4.1.4. Experiment Procedure

In order to understand Hispanic consumers' preferences and WTP for grass-fed beef, five sets of experimental methods were used in the experiment: a written survey, visual evaluations, taste tests, overall preference evaluations, and economics experiments that elicited subjects' values on grass-fed beef. Survey instruments were made available in both English and Spanish and bilingual staff helped in each experiment.

Figure 4.1 provides a flow diagram of the experiment procedure.

Figure 4.1.: Flow Diagram of Experiment Procedure



4.1.4.1. Written Survey

The first section of the experiment was a written survey. This survey was composed of five sections: 1) Beef eating and purchase behavior; 2) Information and knowledge of specialty meat products; 3) Exercise and Health; 4) Ethnic background; and 5) Socioeconomic and demographic information. The first section collected the information concerning subjects' fresh meat consumption and purchase behavior, beef eating habits and preferred preparation methods, and the factors that affected their beef purchase decisions. The second section was related to subjects' knowledge of, perceptions of, and prior experience with specialty meat products. The third section collected data about subject's health status, frequency of physical exercises, and habits of reading health/nutrition labels when purchasing food. The fourth section is on consumer's ethnic background. The fifth section collected data on subjects' socioeconomic and demographic characteristics, such as age, gender, income, education attainment, employment status, and household size.

The fourth section was employed to measure individuals' acculturation levels. The questions in this section consisted of subject ethnicity, country of origin, length of residence in the U.S., languages used in various situations, mass media preferences, and social relationships. These questions were selected and designed with reference to existing literature in acculturation research (e.g. Cabassa 2003; Gardner, Winkleby, and Viteri 1995; Lee 1993; Marin et al. 1987). Each question has either dichotomous or multipoint scales. Subjects' responses to the questions were used to create a 10-point acculturation index[2]. The higher the score, the more acculturated a subject was.

Because acculturation index was constructed by multiple items, Cronbach's alpha was calculated to examine the reliability of the constructed acculturation index. Cronbach's alpha aims to measure the reliability of a test score based on internal consistency; that is, estimating

[2] Q.4.7. in written survey is regarding the level of people from the same ethnic group living in the current neighborhood. This question was used to evaluate peer effects such that it was not included when computing acculturation index.

how well a set of items correlate with each other to represent the true score (Cronbach 1951). The standardized Cronbach's alpha is formulated as

$$\alpha = \frac{N \cdot \overline{C}}{\overline{V} + (N-1) \cdot \overline{C}}$$

where N is the number of items,

$\overline{C}$ is the average inter-item covariance between the items,

$\overline{V}$ is the average variance,

α takes value in the range from 0 to 1. The higher the value, the more reliable the constructed scale is. α with value at 0.7 or higher is considered reasonable in most social science research. If Cronbach' s alpha is lower than 0.7, items that construct the acculturation index need to be reexamined, modified, or even replaced in order to obtain an acceptable reliability coefficient.

In this study, a reliability test of assessing the inner consistency of the items that constituted the acculturation index was conducted, which indicates an Alpha coefficient at 0.86 (raw)[3] and 0.87 (standardized)[4], higher than the cut-off value for acceptance, 0.70.

4.1.4.2. Visual Evaluation

After finishing the written survey, subjects moved to the visual evaluation and taste test. Two treatments were also included in order to determine whether there existed order effects between the visual evaluation and taste test. In treatment A, the visual evaluation was conducted immediately before the taste test. Treatment B switched the order, that is, the taste test was conducted first and immediately before the visual evaluation. Subjects were assigned to a specific treatment based on the session they participated in, with treatment alternating by sessions.

[3] Raw coefficients are based on item correlation.
[4] Standardized coefficients are based on item covariance.

The visual evaluation was designed to obtain information on subjects' visual appraisal of the lean meat color, fat color, and meat texture of grass-fed vs. conventional grain-fed beef. In the visual session, two types of beef steak samples were displayed in polystyrene trays for evaluation: grass-fed and conventional grain-fed beef. Both samples were prepared from wholesale cuts of USDA select grade New York Strip steak. The samples were prepared identically in terms of size, shape, seam fat distribution, and trim level. Conventional grain-fed beef steak was labeled "Sample A" and grass-fed beef steak was labeled "Sample B." The visual evaluation was a blind test using the labeled samples with no indication of which was which. Subjects filled out a Visual Evaluation Form rating the lean meat color[5], fat color[6], and meat texture[7] for each sample using a seven-point Likert scale. After rating each sample, subjects indicated which sample they preferred visually.

4.1.4.3. Taste Test

The taste test was used to obtain subjects' ratings on tenderness, juiciness, and flavor of grass-fed vs. conventional grain-fed beef. Beef cuts were prepared as in the visual evaluation, and as in the visual evaluation, the taste tests were blind. Sample #1 was conventional grain-fed beef and Sample #2 was grass-fed beef. Beef Sample #1 was from the same strip loin as beef Sample A of visual evaluation. Beef Sample #2 was from the same strip loin as beef Sample B of visual evaluation. Beef samples in the taste test were cooked to medium or medium-well done using a meat thermometer to determine when the steak was done. Upon sampling each type of beef, subjects filled out Taste Evaluation forms, in which they rated tenderness[8], juiciness[9], and flavor[10] for each sample using a seven-point Likert scale. After

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5 The seven-point rating scale for lean meat color: 1=Very pale, 2= Pale, 3= Somewhat pale, 4= Neutral, 5= Red, 6= Dark, 7= Very dark

6 The seven-point rating scale for fat color: 1=Very white, 2= White, 3= Somewhat white, 4= Neutral, 5= Somewhat yellow, 6= Yellow, 7= Very Yellow.

7 The seven-point rating scale for meat texture: 1=Very fine, 2= Fine, 3= Somewhat fine, 4= Neutral, 5= Somewhat tough, 6= Tough, 7= Very tough.

8 The seven-point rating scale for tenderness:1=Very tender , 2=Tender, 3= Somewhat tender, 4=Neutral, 5=Somewhat tough 6=Tough, 7=Very tough.

rating taste attributes for the two samples, subjects indicated whose taste they preferred.

4.1.4.4. Overall Preference Evaluation

After the visual evaluation and taste tests, subjects were given an Overall Preference Evaluation form. They were informed that beef Sample #1 in the taste test was the same type of beef as Sample A in the visual evaluation, and that Sample #2 in the taste test corresponded to Sample B in the visual evaluation. By comprehensively considering their visual and taste preferences for grass-fed beef vs. conventional grain-fed beef, subjects were asked to state which sample they preferred overall. They were provided with three options in the Overall Preference Evaluation form: Sample #1/A, Sample #2/B, and Indifferent.

4.1.4.5. Measurement of Consumers' WTP using MPL

After the overall preference evaluation, the MPL experiment was conducted to measure subjects' WTP for grass-fed beef. In order to achieve incentive compatibility and reduce hypothetical bias, the MPL experiment was made non-hypothetical. Two beef steak samples (grass-fed beef and conventional grain-fed beef), with the same marbling degree - USDA Select, were presented to subjects. Following Andersen et. al. (2007), we only included symmetric framing condition of MPL in the WTP experiment because there were no significant framing effects found in their study. Moreover, due to the small sample size in total, iMPL rather than standard MPL was employed in order to obtain greater precision with small standard errors.

Before the MPL experiment, subjects were given, free of charge, a pound of conventional grain-fed beef steak. Subjects were then divided into two groups depending on their overall preferences between the two types of beef samples. The first group consisted of

[9] The seven-point rating scale for juiciness: 1=Very juicy, 2= Juicy, 3= Somewhat juicy, 4= Neutral, 5= Somewhat dry, 6= Dry, 7= Very dry.

[10] The seven-point rating scale for flavor: 1=Very intense, 2= Intense, 3= Somewhat Intense, 4= Neutral, 5= Somewhat bland, 6= Bland, 7= Very bland.

subjects who preferred conventional grain-fed beef over grass-fed beef or were indifferent between the two types of beef. For subjects in this group, their experiments were finished since they didn't preferred grass-fed beef. They were paid for their participation and could leave the experiment facility with the pound of beef given to them.

The MPL experiment was conducted with subjects in the second group who preferred grass-fed beef over conventional grain-fed beef. The research staff explained the MPL experiment process and demonstrated the MPL experiment using cookies and brownies as products. The demonstrations helped not only familiarize subjects with the MPL procedure but also to understand why stating their true WTP was their best interest. After the demonstration, subjects were informed that Sample #1/A was conventional grain-fed beef. Then, they were given $10 cash as endowment. The current retail price for a pound of conventional New York Strip streak at USDA-Select degree was stated and posted. Subjects were first asked whether they would be willing to pay more for one pound of grass-fed beef. The portion of subjects who preferred grass-fed beef but were unwilling to pay more for it finished their experiments, were paid for their participation, and could leave the experiment facility with the endowed grain-fed beef steak and $10 cash. The subjects who preferred grass-fed beef and were willing to pay more for it went on to the MPL experiment for grass-fed beef.

In the MPL experiment, subjects were asked to indicate the amount of money they were willing to give up from the $10 cash to exchange the one pound of conventional grain-fed beef steak for a pound of Sample #2/B (i.e. grass-fed beef). There were two levels in the MPL experiment. In the level-one MPL table, subjects confronted an array of decision rows, each of which indicated a price premium for grass-fed beef. There were 15 decision rows that represented price premiums from $1.00 to $15.00 in ascending order. Each row had three options: yes, no, and indifferent. At each decision row, the subject indicated whether

s/he was willing ("yes"), unwilling ("no"), or indifferent about paying the premium indicated to exchange the pound of conventional grain-fed beef for a pound of grass-fed beef. If the subject did not accept any of the price premiums, s/he could simply mark "no" to all decision rows.

If the subject switched her/his answer from "yes" to "no" at a certain row, s/he needed to fill out the level-two MPL table, which was formatted the same as the level-one MPL table but with premiums in ten cent increments rather than dollars. This extra step was unnecessary if the subject indicated "indifferent" in any of the decision rows, or answered all "yes" or all "no" to the decision rows of the level-one MPL table. The purpose of the level-two MPL table was to present more refined price premiums and therefore elicited more precise WTP for grass-fed beef. For example, if, in the level-one MPL table, the maximum price premium a subject was willing to pay is $5.00 and the minimum price premium s/he indicated "no" to was $6.00. It was known that the subject accepted $5.00 and was unwilling to pay for $6.00 but unknown whether s/he was willing to pay $5.10, $5.20, and so on until $5.90. For this purpose, the level-two MPL table displayed nine decision rows representing incremented price premiums from $5.10 to $5.90, therefore eliciting subjects' WTP with greater precision.

After completing MPL forms, a random integer from 1 to 15 would be drawn to determine which price premium in the level-one table to be implemented. Each integer corresponded to a specific price premium. That is, integer one represented the price premium of $1.00, two represented $2.00, and so on till 15 represented $15.00. Thus, if integer three was randomly drawn, the price premium $3.00 indicated at decision row three would be implemented and the price premium at this row was the "market price." If the subject's maximum WTP was $3.00 or greater, then s/he was obligated to exchange a pound of conventional grain-fed beef steak for a pound of grass-fed beef by paying the price premium $3.00 and kept the rest of the money from the $10 cash endowment. If the subject's

maximum WTP was less than $3.00, then s/he was not willing to pay the binding price premium and was unable/unobligated to make the trade. If s/he answered "indifferent" at decision row three, another integer from one and two would be chosen at random to determine whether to make the exchange or not. When one was chosen, the subject needed to trade for grass-fed beef as if s/he indicated "yes" to this price premium; otherwise, s/he did not need to exchange and could keep one pound of conventional grain-fed beef steak and the $10.00 cash endowment. If a binding price premium more than $10 was drawn and the subject was willing to pay it, then the difference between the premium and $10 endowment was paid from the subject's pocket.

The MPL experiment was incentive compatible because subjects were unable to predict which price premium would be implemented beforehand; therefore they were willing to reveal their true WTP to "win" the chance to trade for grass-fed beef. If the subject understated her/his true WTP, s/he might lose the chance to trade for the grass-fed beef that s/he preferred if the binding premium was within her/his true WTP but exceeded her/his stated WTP. If the subject overstated her/his true WTP, s/he could be forced to pay more than her/his true WTP for the beef if the binding premium fell between her/his true and stated WTP. As a result, the best interest for subjects was to reveal her/his true WTP.

4.2. Data and Summary Statistics

4.2.1. Subjects' Socioeconomic and Demographic Characteristics

A total of 239 subjects participated in the laboratory experiments. Among them, 231 usable observations were included in the data analysis. Table 4.1. provides the number and percentage of subjects in each experiment site. Subjects recruited in Roanoke were the biggest group, accounting for 36% of all subjects. The second biggest group of subjects was recruited in Richmond, accounting for 29%. The number of subjects recruited in Blacksburg

and Galax was roughly equal, accounting 18% and 17%, respectively.

Table 4.1. Experiment Sites and Number of Subjects

Experiment Site	Number of Subjects	Percentage (%)
Galax, VA	39	17
Roanoke, VA	82	36
Richmond, VA	68	29
Blacksburg, VA	42	18
Total	**231**	**100**

According to their overall preferences, subjects were classified as grass-fed preferring or conventional grain-fed preferring. Four subjects who were indifferent between the two types of beef were classified to the conventional grain-fed preferring group. Summary statistics of grass-fed and conventional grain-fed preferring subjects' socioeconomic and demographic characteristics are reported in Table 4.2. Non-parametric Wilcoxon-Mann-Whiteney tests were conducted to test the differences of these socioeconomic and demographic characteristics between the two groups of subjects.

As shown in Table 4.2., the division of subjects between grass-fed and conventional grain-fed beef preferences was roughly equal. The majority of subjects were female, accounting for 64% of the sample. Given the fact that women are more likely than men to be the primary food buyers and preparers in their households, it is not surprising to see a higher percentage of females who were willing to participate in the experiments. The Wilcoxon-Mann-Whiteney test didn't find statistically significant differences in the gender breakdown between grass-fed and conventional grain-fed preferring subjects (Test statistic $z=0.298$ and P-value is 0.766). The participants' average age was 38 years and the majority of them (72%) were in the age range from 25 to 54 years. Grass-fed preferring subjects were, on average, 3 years older than conventional grain-fed preferring subjects, and these differences were statistically significant at 5% level (Test statistic $z=-2.101$ and $P<0.04$).

The average education attainment was some college. Approximately, half of subjects were with high school diploma or less whereas another half of them have college education or above. About 40% had a Bachelor's or graduate degree and most of these subjects participated in the sessions in Blacksburg or Richmond. Compared to grass-fed preferring subjects, a few more conventional grain-fed preferring subjects had high school education or less. Nevertheless, the difference was not statistically significant (Test statistic z=0.231 and P-value is 0.818).

More than 70% of subjects worked full-time or part-time and 75% of them lived with family, including such situations as living with spouse only, with spouse and children, with children only, and with extended family. About 70% of subjects had full-time or part-time job. The average number of adult family members in a subject's household was 2.50 and the average number of children in the household was 1.04. T-test indicates a statistically insignificant difference between the two groups of subjects on the base of average adults in the household (Test statistic t=0.255 and P-value is 0.799) and number of children in the household (Test statistic t=0.012 and P-value is 0.991).

The average annual pre-tax household income was in the range between $30,000 and $40,000. More than 65% of subjects had annual household income less than $40000, which suggests that our sample was concentrated on a relatively low-income level. The variation in income distributions was insignificant between grass-fed preferring and conventional grain-fed preferring subjects (Test statistic z=0.528 and P-value is 0.598).

The vast majority (more than 90%) of subjects was foreign-born, including immigrants and naturalized citizens (i.e. the first generation citizen). Compared to 53% of foreign-born in the Hispanic population of Virginia (Cai 2008), this figure was very high. For foreign-born subjects, the average years of living in the U.S. were about 12. The average acculturation degree was 5.87 out of 10. The higher the degree a subject had the more acculturated s/he

Table 4.2. Definition of Socioeconomic and Demographic Variables and Summary Statistics

Definition	Grass-Fed Preferring		Conventional Grain-Fed Preferring		Overall	
	Freq.	%	Freq.	%	Freq.	%
Number of subjects	118	51	113	50	231	100
Treatment						
1 = Treatment A	34	29	31	27	65	28
2 = Treatment B	82	71	82	73	164	72
Location						
1 = Galax	15	13	24	21	39	17
2 = Roanoke	40	34	42	37	82	36
3 = Richmond	45	38	23	20	68	29
4 = Blacksburg	18	15	24	22	42	18
Gender:						
1=Female	74	63	73	65	147	64
0=Male	44	37	40	35	84	36
Education:						
1=Less than high school diploma	22	19	25	22	47	20
2=High school diploma or equivalent	40	34	30	26	70	30
3=Some College/technical school	15	13	12	11	27	12
4=Associate's Degree	6	5	12	11	18	8
5=Bachelor's degree	27	22	27	24	54	23
6=Graduate or Professional Degree	8	7	7	6	15	7
Employment status						
1 = Full time or part time	83	70	76	67	159	69
0 = Other	35	30	37	33	72	31
Living arrangement						
1=Live with family	95	81	79	70	174	75
0=Other	23	19	34	30	57	25
Income						
1 = Less than $20,000	35	30	43	38	78	34
2 = $20,000-$39,999	39	33	34	30	73	32
3 = $40,000-$59,999	26	23	16	15	43	19
4 = $60,000-$79,999	9	8	8	7	17	7
5 = $80,000-$99,999	4	3	6	5	10	4
6 = Greater than $100,000	4	3	6	5	10	4

Table 4.2. Continued

Definition	Grass-Fed Preferring		Conventional Grain-Fed Preferring		Overall	
	Freq.	%	Freq.	%	Freq.	%
Country of Origin						
1 = Mexican and Mexican American	48	41	34	30	82	35
2 = Salvadoran /Honduran	23	19	30	27	53	23
3 = Colombian	23	19	27	24	50	22
4 = Other Hispanics	24	21	22	19	46	20
Citizenship						
1 = Foreign-born	108	92	102	90	210	91
0 = US-born citizen	10	8	11	10	21	9
Age Categories						
1 = Under 25 years	17	14	21	19	38	17
2 = 25-34 years	36	31	41	37	77	34
3 = 35-44 years	28	24	18	16	46	20
4 = 45-54 years	22	19	20	18	42	18
5 = 55-64 years	8	7	8	7	16	7
6 = Over 65 years	7	6	3	3	10	4
Level of same-country neighbors living in the current neighborhood						
1= Almost none or none	44	52	41	48	85	37
2= Few	30	51	29	49	59	26
3= Some	18	46	21	54	39	17
4= Many	16	52	15	48	31	13
5= All or almost all	9	56	7	44	16	7
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Age in years	39.3	14.0	36.1	13.3	37.7	13.74
Years of residence in the U.S	14.7	13.3	12.3	10.6	13.6	12.1
Number of adults in a subject's household	2.48	1.07	2.50	0.96	2.49	1.02
Number of children in a subject's household	1.06	1.22	1.03	1.28	1.04	1.25
Acculturation level	5.90	1.28	5.84	1.44	5.87	1.36

was. The main countries of origin were Mexico (36%), Columbia (22%), Honduras (16%), and El Salvador (7%). The rest of subjects, approximately 20%, were originated from other Hispanic countries such as Puerto Rico, Peru, Ecuador, Venezuela**,** and Cuba. Significant differences in acculturation degrees was detected across countries of origin at 1% significance (Test statistic z=32.344 and P<.000). For example, subjects originated from Colombia are more acculturated with a 0.9 higher degree of acculturation than El Salvadoran/Honduran subjects and a 0.7 higher degree than Mexican subjects.

The profiles of subjects based on the survey results and the Hispanic population in Virginia are presented in Table 4.3. As shown in Table 4.3., the distributions of education attainment and living arrangement of this study's sample are largely representative to the Hispanic population in Virginia. Also, the mean household size of our sample is similar to the population of interest. Our sample, however, has a lower percentage of males and is older on average compared to the Hispanic population in Virginia. A significant difference between the study's sample and the Virginia's Hispanic population is the status of citizenship. Also, countries of origin of the sample are less diverse (80% of subjects are from Mexico, El Salvador, Honduras, and Colombia); our sample has relatively low level of average household income compared to the Hispanic population in Virginia. Since the sample's socioeconomic and demographic makeup is not equivalent to that of Virginia's Hispanic population, attention should be paid when interpreting survey data and estimation results.

4.2.2. Subjects' Beef Consumption and Purchase Behavior

Table 4.4. summarizes the subjects' beef consumption and purchase behavior. Twice as many subjects consumed beef prepared at home at least once a week as subjects who consumed beef away from home with the same frequency. The data were consistent with the study by Davis and Lin (2005) that indicates that compared to other ethnicities, Hispanics

Table 4.3. Comparison of Socioeconomic and Demographic Profiles of the Hispanic Population in Virginia and Sample in this Study

	Population Percentage[+]	Sample Percentage
Citizenship		
Foreign-born (Including immigrants and naturalized citizens)	53	91
U.S born citizens	47	9
Gender		
Male	54	36
Female	46	64
Education attainment		
Less than High School	15	20
High School	27	30
Some college/Associate degree	25	20
Bachelor degree	20	23
Graduate degree	13	7
Country of origin		
Mexican	25	35
Colombian	3	22
Salvadoran/Honduran	5	23
Other	11	20
Living arrangement		
Living with family	30	25
Other	70	75
	Mean	**Mean**
Median Household Income	$42,169	$ 30000-$39,999
Household size	3.58	3.54
Median age	26.5	37.7

Source of (+): U.S. Census Bureau. American Community Survey (ACS), selected data, 2005.

consume more beef at home, eating about 70% of their beef prepared at home. The majority of subjects (68%) liked their beef cooked to medium-well done or more. Sirloin was the most often purchased beef cuts for consumption at home (28%), followed by ribeye (19%) and tenderloin (18%). The vast majority (over 80%) of subjects most often purchased boneless beef. The reported average weekly expenditure on beef for a household was $26.07. The differences in beef consumption and purchase behavior between grass-fed and conventional grain-fed preferring subjects were statistically insignificant.

Table 4.4. Definition of Beef Consumption and Purchase Behavior Variables and Summary Statistics

Definition	Grass-Fed Preferring		Grain-Fed Preferring		Overall	
	Freq.	%	Freq	%	Freq.	%
How often do you eat beef prepared at home?						
0= Never	0	0	1	1	1	1
1= Less than once a month	4	3	4	4	8	3
2=1-2 times a month	20	17	23	20	43	19
3= 1-2 times a week	55	47	50	44	105	45
4= More than 3 times a week	39	33	35	31	74	32
How often do you eat beef prepared away from home?						
0=Never	4	3	3	3	7	3
1= Less than once a month	34	29	38	37	72	31
2=1-2 times a month	38	32	34	30	72	31
3= 1-2 times a week	32	27	27	24	59	26
4= More than 3times a week	10	8	11	10	21	9
How well done do you like beef steak?						
1 = Rare or less	2	2	1	1	3	1
2 = Medium Rare	18	15	9	8	27	12
3 = Medium	16	14	10	10	26	11
4 = Medium well	24	21	32	29	56	25
5 = Well done or more	47	40	51	45	98	43
6 = It varies by cuts	10	8	9	8	19	8
Which USDA grade of conventional beef steak do you usually purchase?						
1 = USDA Select	16	14	22	20	38	17
2 = USDA Choice	21	18	8	7	29	13
3 = USDA Prime	18	15	15	13	33	14
4 = Not graded or don't know	63	53	67	60	130	56
What fat content do you most often purchase when you buy ground beef?						
1 = 70-79% lean	21	18	18	16	39	17
2 = 80-89% lean	27	23	22	19	49	21
3 = More than 90% lean	29	25	26	23	55	24
4 = No fat content label or don't know	41	35	47	42	88	38
What beef cuts do you most often purchase for consumption at home?						
1 = Ribeye	25	22	18	17	43	19
2 = T-bone	15	13	14	13	29	13
3 = Tenderloin	24	21	17	16	41	18
4 = Sirloin	31	27	32	29	63	28
5 = other	23	17	32	25	55	22

Table 4.4. Continued

Definition	Grass-Fed Preferring		Conventional Grain-Fed Preferring		Overall	
	Freq.	%	Freq.	%	Freq.	%
Which type of beef do you most often purchase?						
1 = Bone-in	19	16	21	19	40	17
0 = Boneless	98	83	91	81	189	83
How often do you read nutrition labels when deciding to buy a food product?						
1= Never	2	2	11	10	13	6
2= Rarely	14	12	16	14	30	13
3= Sometimes	34	29	38	34	72	31
4= Most of the time	39	33	25	22	64	28
5= Always	28	24	24	20	51	22
How much does presence of marbling affect your beef purchases?						
1= Not important	4	3	12	11	16	7
2= Somewhat important	18	15	17	15	35	15
3= Important	35	30	29	26	64	28
4= Very important	39	33	39	35	78	34
5= Extremely important	22	19	14	13	36	16
Have you ever purchased meat products with label “Natural,” “Organic,” and "Free Range"?						
1 = Yes	87	74	71	63	158	68
0 = No	31	26	42	37	73	32
Have you ever taken a health or nutrition class?						
1 = Yes	48	41	39	35	87	38
0 = No	69	59	72	65	141	62
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
How much do you spend on beef each week?	26.69	19.21	25.42	19.54	26.07	19.34
How often do you often purchase beef from the flowing outlets? (1=Never, 2= Occasionally, 3= Sometimes, 4= Frequently)						
Supermarkets/Retail grocery stores	3.67	0.68	3.65	0.71	3.66	0.69
international/ethnic food stores	2.03	1.03	1.98	1.09	2.01	1.06
health/natural foods stores	1.89	1.07	1.76	1.09	1.82	1.08
Farmers' markets	1.57	0.86	1.52	0.85	1.55	0.85

With respect of other purchase behavior, 50% of subjects read nutrition labels most of the time or always when purchasing food. The presence of marbling was important or more to 78% of subjects when purchasing beef. Approximately 70% of subjects had prior experience in purchasing specialty meat products labeled “Natural,” “Organic,” or “Free-range.” Moreover, 40% of subjects have ever taken a health or nutrition class. The Wilcoxon-Mann-Whiteney tests reveal significant differences between grass-fed and conventional grain-fed preferring subjects in terms of the frequency of reading nutrition labels (Test statistic $z=-0.957$ and $P<0.051$) and the prior experience with specialty meat products (Test statistic $z=-1.777$ and $P<0.076$) . However, no statistically significant differences in heath-class taking and the importance of marbling were revealed between grass-fed and conventional grain-fed preferring subjects.

4.2.3. Subjects’ Sensory Evaluation and WTP for Grass-Fed Beef vs. Conventional Grain-Fed Beef

4.2.3.1. Sensory Evaluation

With respect to the visual evaluation, 60% of subjects visually preferred grass-fed beef over conventional grain-fed beef. In contrast, about 40% of subjects preferred the taste of conventional grain-fed beef over grass-fed beef. Approximately half of subjects preferred grass-fed beef overall to conventional grain-fed beef (see Figure 4.2.).

Figure 4.3. illustrates the average ratings of lean meat color, fat color, and meat texture. Compared to conventional grain-fed beef, subjects perceived the meat muscles of grass-fed beef to be much darker than conventional grain-fed beef. They rated the meat muscles of grass-fed beef nearly 1.4 point higher than conventional grain-fed beef. With respect to the distributions of lean meat color ratings (see Figure 4.4.), the majority of subjects (more than 90%) rated meat muscles of grass-fed beef as “red” or more whereas only about 33% of them had the same ratings for conventional grain-fed beef.

Figure 4. 2. Overall, Taste, and Visual Preferences for Grass-Fed versus Conventional Grain-Fed Beef

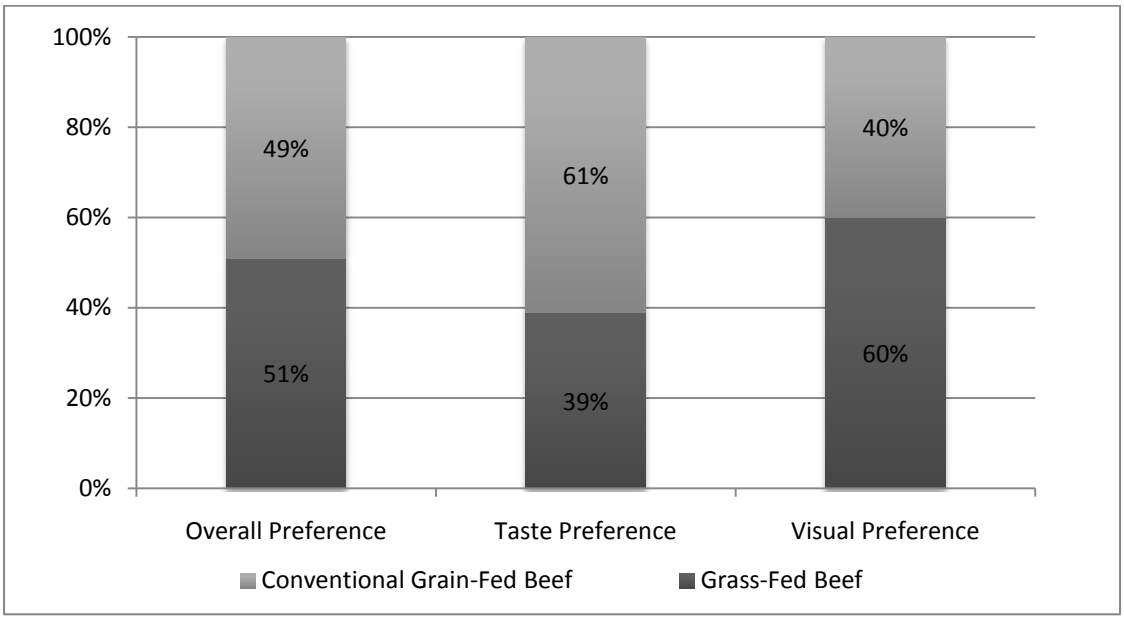
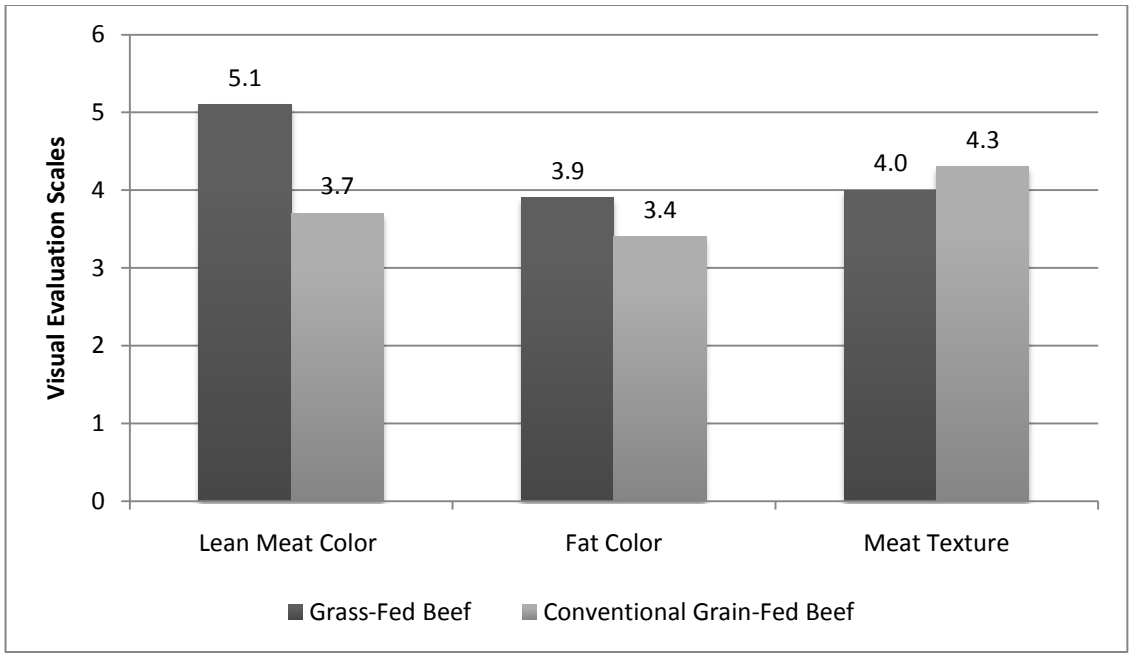


Figure 4. 3. Average Ratings of Visual Attributes for Grass-Fed and Conventional Grain-Fed Beef



Likert Scales of Visual Attributes

Lean Meat Color	1=Very Pale	2=Pale	3=Pink	4=Neutral	5=Red	6=Dark	7=Very Dark
Fat Color	1= Very White	2=White	3=Somewhat White	4=Neutral	5=Somewhat Yellow	6=Yellow	7=Very Yellow
Meat Texture	1=Very Fine	2=Fine	3=Somewhat Fine	4=Neutral	5=Somewhat Coarse	6=Coarse	7=Very Coarse

Figure 4. 4. Distributions of Lean Meat Color Ratings for Grass-Fed and Conventional Grain-Fed Beef

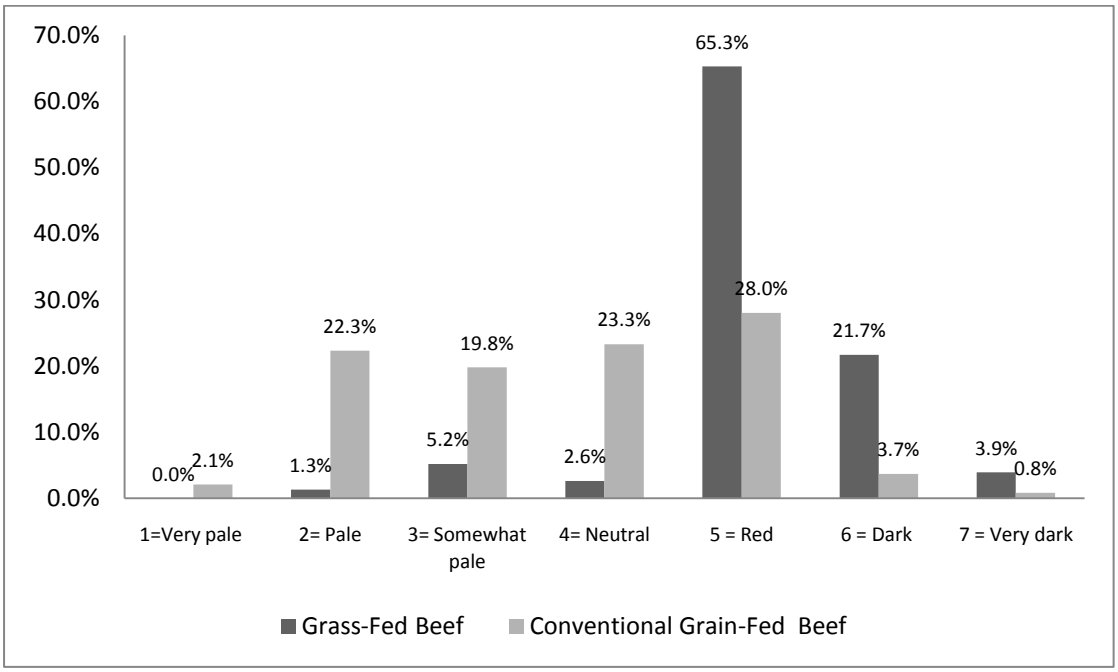


Figure 4.5. Distributions of Fat Color Ratings for Grass-Fed and Conventional Grain-Fed Beef

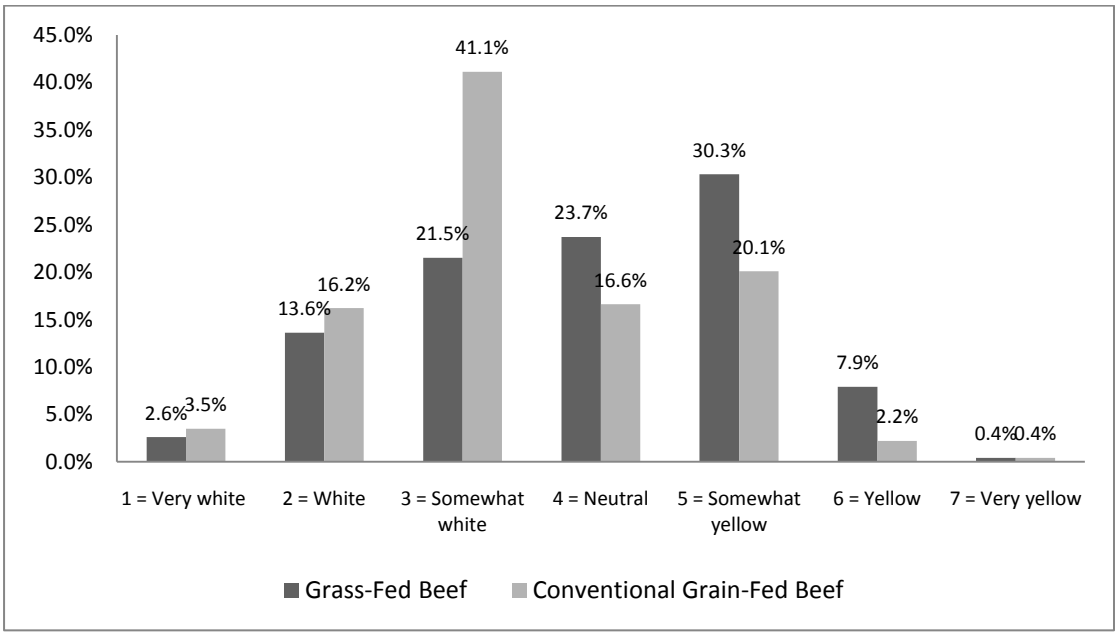


Figure 4.6 Distributions of Meat Texture Ratings for Grass-Fed and Conventional Grain-Fed Beef

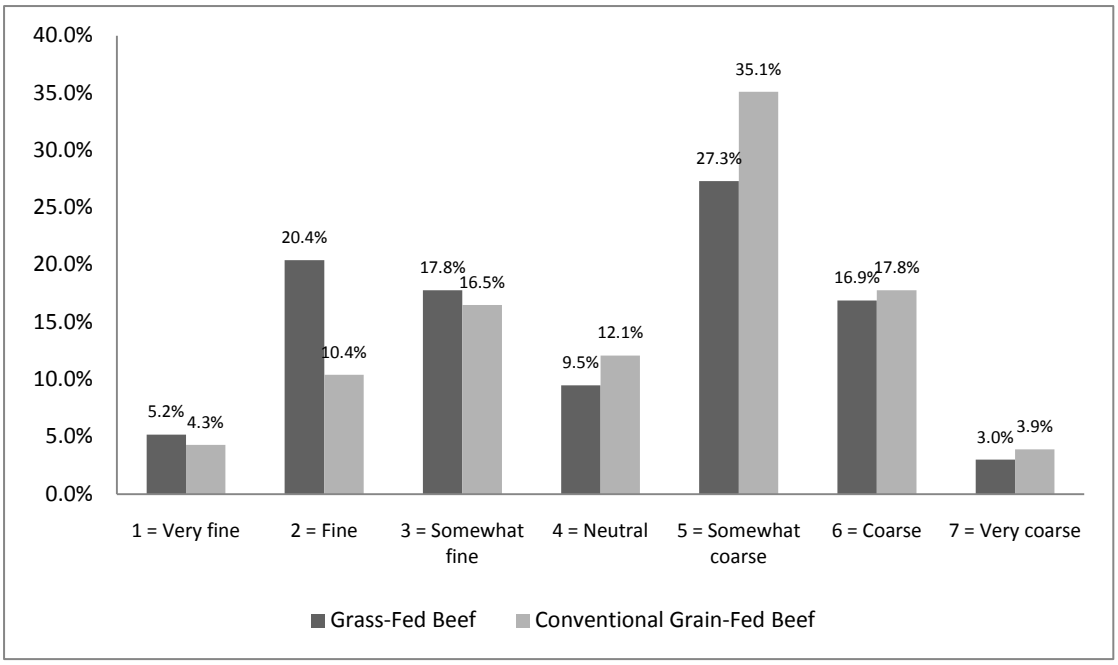


Table 4.5. Comparison of Summary Statistics of Visual Attributes Ratings between Preference Groups

	Lean Meat Color (Mean, Std)			Fat Color (Mean, Std)			Meat Texture (Mean, Std)		
	All	Grass-fed preferring	Grain-fed preferring	All	Grass-fed preferring	Grain-fed preferring	All	Grass-fed preferring	Grain-fed preferring
Grass-Fed	5.12 (.84)	5.03 (.71)	5.22 (.96)	3.91 (1.30)	3.89 (1.20)	3.96 (1.40)	3.96 (1.64)	3.81 (1.64)	4.12 (1.63)
Conventional Grain-Fed	3.67 (1.31)	3.45 (1.36)	3.89 (1.22)	3.43 (1.16)	3.30 (1.15)	3.56 (1.16)	4.32 (1.51)	4.41 (1.51)	4.23 (1.51)
Difference	1.46	1.58	1.33	.48	.56	.40	-.36	-.60	-.11
S.E.	.095	.133	.134	.111	.150	.163	.152	.211	.218
P-value	.000	.000	.000	.000	.000	.016	.019	.005	.627

With regard to the fat color, subjects perceived grass-fed beef to have somewhat yellower fat than conventional grain-fed beef. With respect to the distributions of fat color ratings (see Figure 4.5.), approximately 39% of the subjects perceived grass-fed beef to have somewhat yellow or yellower fat whereas about 23% of them have the same ratings on the fat color of conventional grain-fed beef. In contrast, a much higher percentage of subjects rated the fat of conventional grain-fed beef as "somewhat white" or more than the percentage of subjects who had the same ratings on grass-fed beef (62% vs. 38%). A statistically significant difference of ratings on the fat color of grass-fed beef was revealed between the two groups of subjects.

Subjects found that the meat texture of grass-fed was almost as fine as that of conventional grain-fed (see Figure 4.3.). Figure 4.6. shows the distributions of ratings on the meat texture of the two types of beef. More than 20% of subjects found the meat texture of grass-fed beef to be "fine" while about 10% of them had the same ratings on the meat texture of conventional grain-fed beef. Thirty-five percent of subjects rated the meat texture of conventional grain-fed beef as "somewhat coarse"; the percentage, however, decreased to about 27% when it comes to grass-fed beef. The Wilcoxon-Mann-Whiteney tests failed to reject the hypothesis that the different meat texture ratings were not significantly different between the two groups of subjects.

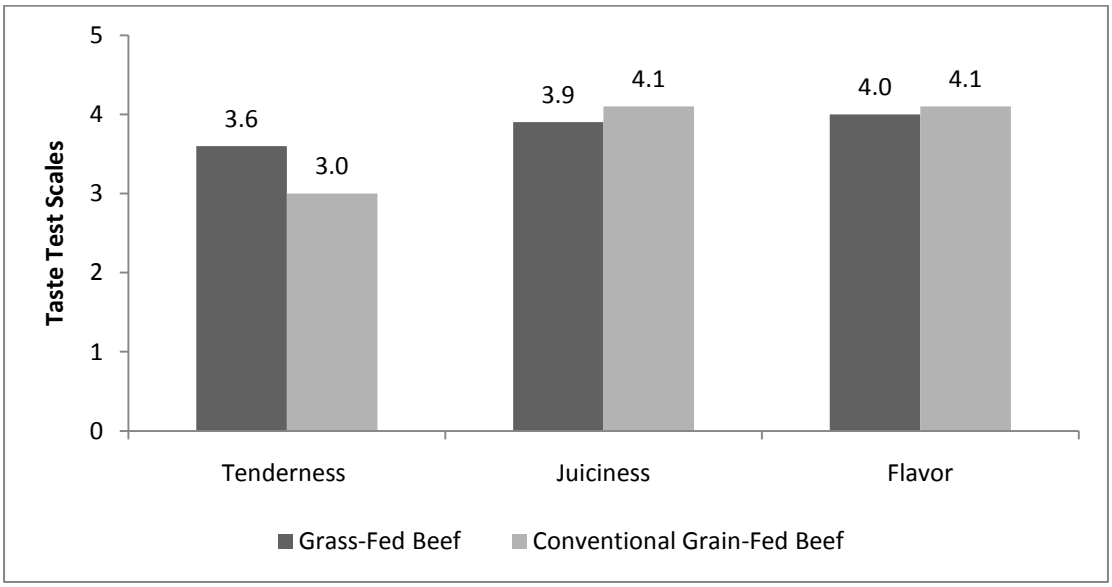
T-tests were conducted to compare the average ratings of visual attributes of grass-fed beef and conventional grain-fed beef (see Table 4.5.). P-values for the three visual attributes (lean meat color, fat color, and meat texture) were below .02 and indicate significant differences in average ratings of grass-fed beef and conventional grain-fed beef. Both grass-fed- and conventional grain-fed-preferring groups found significant differences of visual attributes between the two types of beef with the exception of meat texture by conventional grain-fed beef preferring subjects.

Figure 4.7 reports the average ratings of individual taste attributes: tenderness, juiciness, and flavor. Compared to conventional grain-fed beef, subjects generally perceived grass-fed beef to be less tender. Especially for conventional grain-fed preferring subjects, the difference in the average ratings of tenderness between the two types of beef was 1.27, which was statistically significant and thus implies that this group of subjects perceived grass-fed beef to be much tougher than grass-fed beef preferring subjects did (see Table 4.6.). Figure 4.8. illustrates the distributions of tenderness ratings between the two types of beef. A higher percentage of subjects rated conventional grain-fed beef as "tender" than the percentage of subjects who had the same ratings on grass-fed beef (68% vs. 53%) whereas a larger proportion of subjects rated grass-fed beef as "somewhat tough" or more (45% vs. 23%). The Wilcoxon-Mann-Whiteney tests showed that the rating distributions of tenderness of grass-fed beef were significantly different between grass-fed preferring and conventional grain-fed beef preferring subjects.

With respect to juiciness, subjects, on average, found grass-fed beef to be a little bit juicier than conventional grain-fed beef but the difference was very small at only 0.2 points. Figure 4.9. demonstrates the distributions of average juiciness ratings between the two types of beef. A statistically significant difference in juiciness ratings of grass-fed beef were detected between the two groups of subjects. The percentage of subjects who rated conventional grain-fed beef as "somewhat dry" was 10% higher than the percentage of subjects who gave the same ratings to grass-fed beef. The results are different from other studies on grass-fed beef (e.g. Bowing et al. 1977, Crouse, Cross, and Seideman1984), which found that more consumers perceive grass-fed beef to be drier than conventional grain-fed beef.

As for flavor, according to the average ratings, subjects perceive the flavor of grass-fed beef to be almost as intense as that of conventional grain-fed beef. Figure 4.10. displays the

Figure 4. 7. Average Ratings of Taste Attributes for Grass-Fed and Conventional Grain-Fed Beef



Likert Scales of Taste Attributes

Tenderness	1=Very tender	2=Tender	3=Somewhat Tender	4=Neutral	5=Somewhat Tough	6=Tough	7=Very tough
Juiciness	1=Very Juicy	2=Juicy	3=Somewhat Juicy	4=Neutral	5=Somewhat Dry	6=Dry	7=Very Dry
Flavor	1= Very Intense	2=Intense	3=Somewhat Intense	4=Neutral	5=Somewhat Bland	6=Bland	7 =Very Bland

Figure 4.8. Distributions of Tenderness Ratings for Grass-Fed and Conventional Grain-Fed Beef

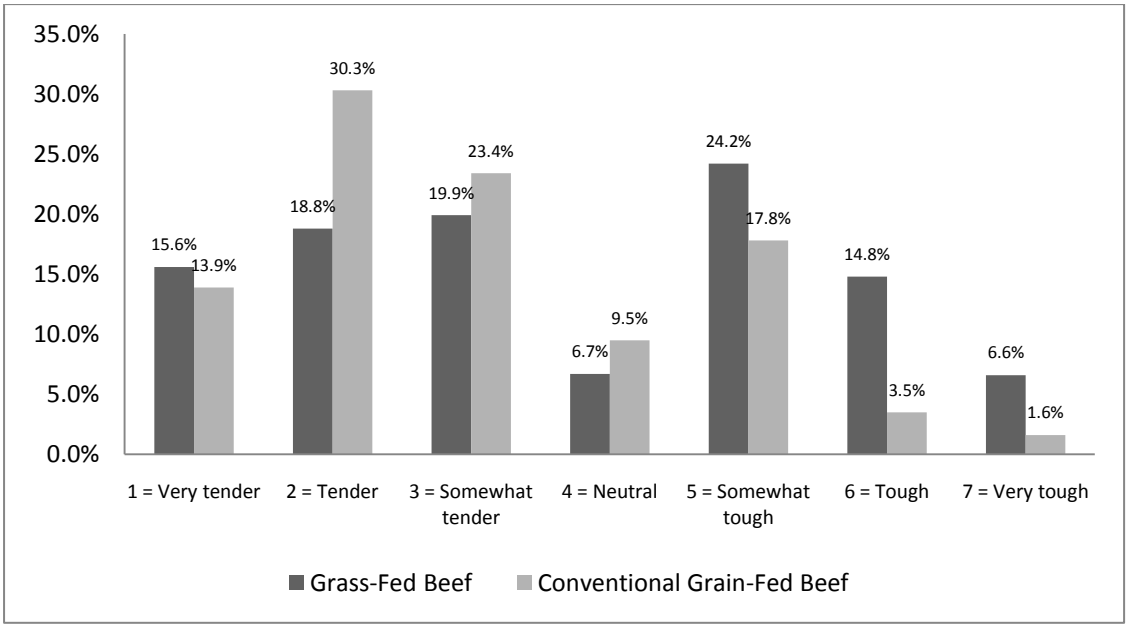


Figure 4.9. Distributions of Juiciness Ratings for Grass-Fed and Conventional Grain-Fed Beef

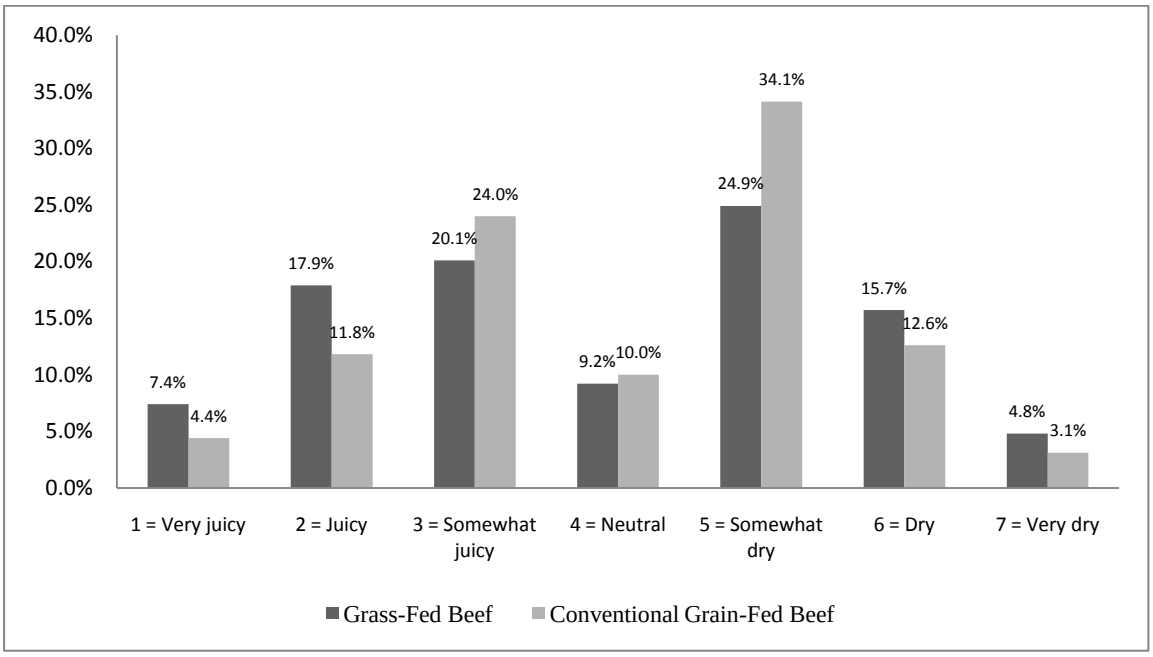


Figure 4.10. Distributions of Flavor Ratings for Grass-Fed and Conventional Grain-Fed Beef

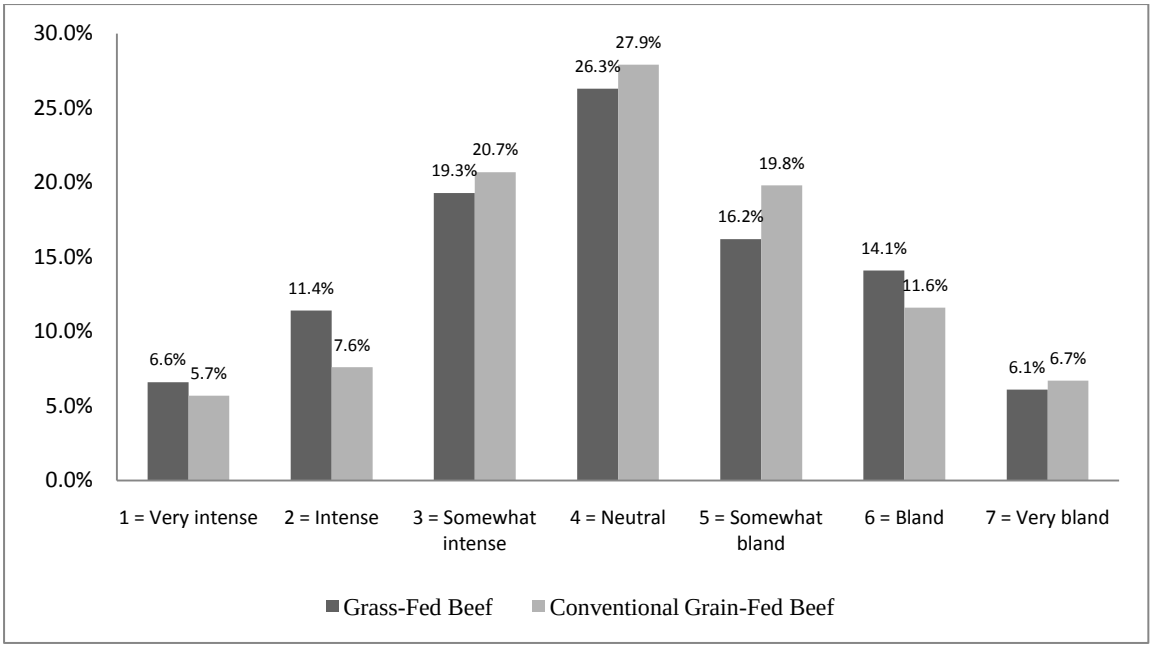


Table 4.6. Comparison of Summary Statistics of Taste Attributes Ratings between Preference Groups

	Tenderness (Mean, Std)			Juiciness (Mean, Std)			Flavor (Mean, Std)		
	All	Grass-fed preferring	Grain-fed preferring	All	Grass-fed preferring	Grain-fed preferring	All	Grass-fed preferring	Grain-fed preferring
Grass-fed	3.61 (1.83)	3.09 (1.68)	4.15 (1.85)	3.92 (1.70)	3.43 (1.55)	4.43 (1.71)	4.00 (1.58)	3.74 (1.53)	4.25 (1.60)
Conventional grain-fed	3.04 (1.50)	3.20 (1.46)	2.87 (1.53)	4.08 (1.49)	4.31 (1.41)	3.84 (1.54)	4.11 (1.53)	4.31 (1.67)	3.92 (1.47)
Difference	.57	-.11	1.27	-.15	-.88	.59	-.12	-.56	.33
S.E.	.138	.192	.175	.128	.162	.173	.122	.179	.154
P-value	.000	.56	.000	.233	.000	.000	.329	.002	.036

distributions of flavor ratings between the two types of beef. No apparent distribution differences of flavor ratings were detected. However, there existed a significant difference in flavor ratings on grass-fed beef between the two groups of subjects.

T-tests were conducted to compare the average ratings of taste attributes of grass-fed beef and conventional grain-fed beef (see Table 4.6.). The average tenderness ratings on the two types of beef were significantly different among all subjects and for the conventional grain-fed preferring group ($p<.000$). For all subjects in general, average ratings of juiciness and flavor were not significantly different between grass-fed and conventional grain-fed beef. Grass-fed beef preferring subjects, however, perceived that grass-fed beef was juicier ($p<.000$) and had more intense flavor ($p<.002$) than conventional grain-fed beef. In contrast, conventional grain-fed preferring subjects found grass-fed beef to be drier and blander than conventional grain-fed beef ($P<.036$).

Table 4.7. presents the consistency of visual, taste, and overall preferences. Nearly 50% of grass-fed preferring subjects consistently preferred grass-fed beef's appearance and taste whereas 53% of conventional grain-fed preferring subjects preferred the appearance and taste of conventional grain-fed beef. Among grass-fed preferring subjects who indicated discrepant visual and taste preferences, 15% more of them based their overall preferences on visual acceptances than those who based their overall preferences on taste acceptances. The subjects

Table 4.7. Combination of Overall, Taste, and Visual Preferences

Taste Preference		Visual Preference		Overall Preference		WTP
Grass-fed preferring	Grain-fed preferring	Grass-fed preferring	Grain-fed preferring	Grass-fed preferring	Grain-fed preferring	Grass-fed preferring
√		√		59 (49%)	-	$3.25 (2.42)
	√		√	-	61 (53%)	-
√			√	20 (18%)	12 (12%)	$3.95 (3.31)
	√	√		39 (33%)	40 (35%)	$3.79 (2.65)
				118 (100%)	113 (100%)	$3.62 (2.76)

who consistently preferred the taste and visual appearance of grass-fed beef didn't indicate higher price premium for grass-fed beef than subjects who had dispersant visual and taste preferences. On the contrary, they were willing to pay $.70 less than the subjects who preferred the taste of grass-fed beef but the appearance of conventional grain-fed beef. Similarly, they paid $.54 less than the subjects who preferred the appearance of grass-fed beef but the taste of conventional grain-fed beef.

4.3.3.2. WTP

The MPL experiment that elicited price premiums for grass-fed beef was completed only by grass-fed preferring subjects; therefore the WTP of conventional grain-fed preferring subjects was unobservable. Their WTP was assumed to be zero. Sixteen of the grass-fed preferring subjects were unwilling to pay a price premium. The majority of them (102 subjects) were willing to a positive price premium. As shown in Table 4.8., the mean WTP of grass-fed preferring subjects was $3.62 with standard deviation at 2.76. The maximum value of WTP was $12.00 and the minimum value was zero. The mean WTP varied across experiment sites. For grass-fed preferring subjects, Galax had the highest mean WTP of $4.20

Table 4.8. Summary Statistics of WTP between Experiment Sites

	Overall		Galax		Roanoke		Richmond		Blacksburg	
Subjects	N	Mean (Std)	N	Mean (Std)	N	Mean (Std)	N	Mean (Std)	N	Mean (Std)
Overall	231	$1.95[a] (2.69)	39	$1.67[a] (2.66)	82	$2.23[a] (2.83)	68	$2.29[a] (2.92)	42	$1.13[a] (1.79)
Grass-fed preferring	118	$3.62 (2.76)	15	$4.20 (2.77)	40	$4.04 (2.79)	45	$3.46 (2.98)	18	$2.64 (1.87)

[a]: WTP takes value of zero for the subjects who preferred conventional grain-fed beef and did not participate in WTP experiments.

with standard deviation at 2.77 while Blacksburg had the lowest mean WTP of $2.64 with standard deviation at 1.87. A large proportion of subjects in Blacksburg were university students, which may partially explain the low mean WTP in this location.

Figure 4.11 and 4.12 presents the distribution of grass-fed preferring subjects' WTP. More than 50% of subjects' WTP were in the range of $2.00 to $4.90. Eighty-six percent of grass-fed preferring subjects were willing to pay a price premium of at least $1.00; 78% of them were willing to pay at least $2.00 and 55% willing to pay at least $3.00.

Figure 4.11. Distribution of Grass-Fed Preferring Consumers' WTP

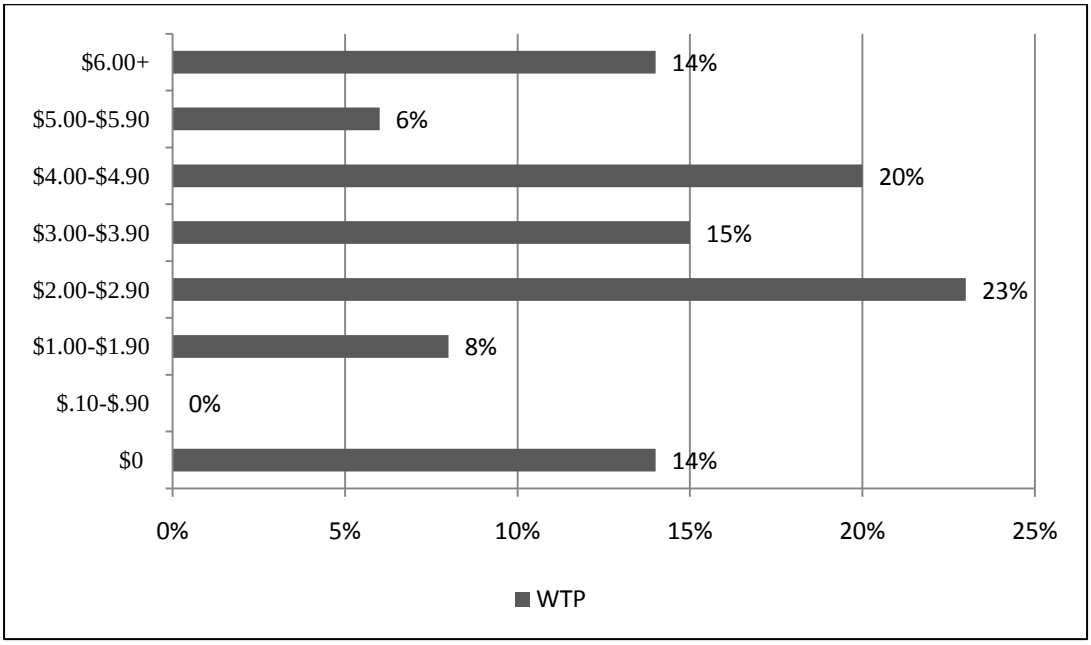
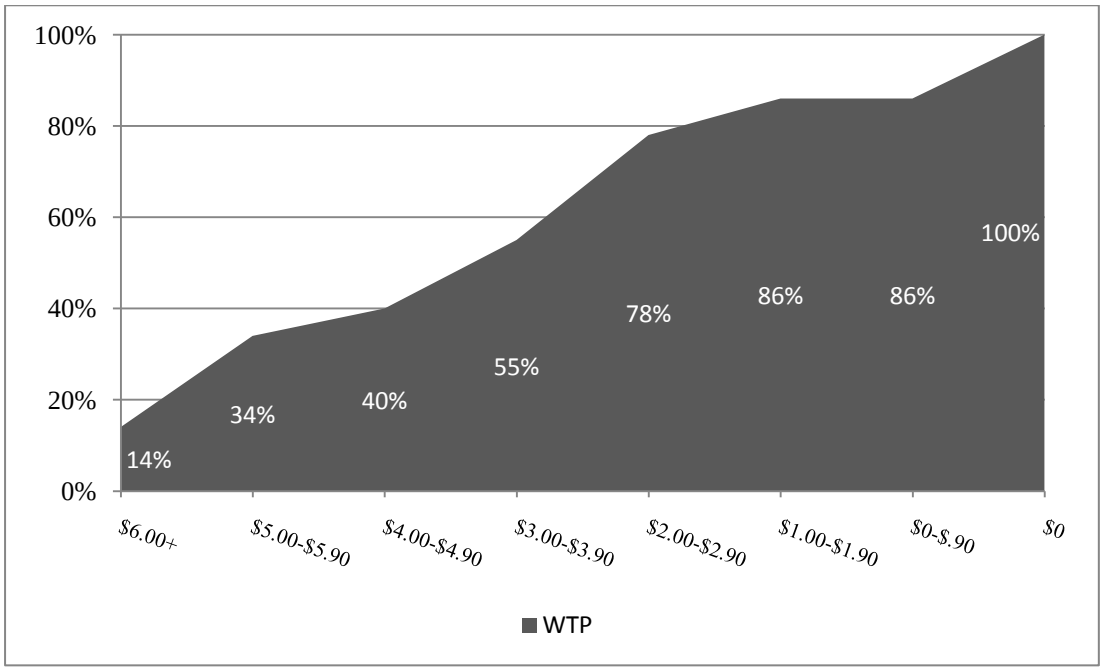


Figure 4.12. Cumulative Distribution of WTP for Grass-Fed Beef



CHAPTER V

EMPIRICAL/ESTIMATION MODELS FOR PREFERENCES AND WTP

5.1. Empirical Models for Hispanic Consumers' Preferences for Grass-Fed Beef

Following the conceptual framework of Chapter III, it was assumed that an individual consumer *i* faces two alternative beef products: grass-fed beef and conventional grain-fed beef. Under the Random Utility Model (RUM), the consumer prefers grass-fed beef to conventional grain-fed beef if and only if s/he derives greater utilities from the consumption of grass-fed beef than with conventional grain-fed beef. That is,

$$\bar{v}_{Grass-fed}(p_{Grass-fed}, I, S_{Grass-fed}, D) > \bar{v}_{Grain-fed}(p_{Grain-fed}, I, S_{Grain-fed}, D)$$

$$\Rightarrow \quad E(\bar{v}_{Grass-fed}(\cdot)) + \varepsilon_{Grass-fed} > E(\bar{v}_{Grain-fed}(\cdot)) + \varepsilon_{Grain-fed}$$

$$\Rightarrow \quad E(\bar{v}_{Grass-fed}(\cdot)) - E(\bar{v}_{Grain-fed}(\cdot)) > \varepsilon_{Grain-fed} - \varepsilon_{Grass-fed}$$

$$\Rightarrow \quad \Delta E\bar{v} > \mu \tag{5.1}$$

Where $\Delta E\bar{v} = E(\bar{v}_{Grass-fed}(\cdot)) - E(\bar{v}_{Grain-fed}(\cdot))$ (5.2)

and

$$\mu = \varepsilon_{Grain-fed} - \varepsilon_{Grass-fed} \tag{5.3}$$

Consumer utilities are not observed. Nonetheless, one can observe consumer choices. For each consumer i, we define a binary choice outcome y as:

$$y_i = \begin{cases} 1 & if\ consumer\ i\ chooses\ grass-fed\ beef \\ 0 & if consumer\ i\ chooses\ conventional\ grain-fed\ beef \end{cases};$$

that is, y_i is a binary variable which equals 1 if $\Delta E\bar{v} > \mu$ and is 0 otherwise.

Visual evaluations and taste tests were designed to collect data about consumers' visual and taste preferences for grass-fed vs. conventional grain-fed beef. Each type of preference is measured by a binary variable with value one if a consumer preferred grass-fed and value

zero if s/he preferred conventional grain-fed beef.

The empirical analysis of consumers' preferences involves binary dependent variables. For discrete dependent variables, Ordinary Least Square (OLS) regression may lead to heteroskedasticity of standard errors; the predicted probabilities for the binary values of dependent variable are not constrained to the interval [0, 1], and variance could be negative (Greene 2003; Cameron and Trivedi 2005). Therefore, OLS might not be an appropriate tool for the estimation for binary choice models.

Logit or Probit models are widely used in the estimation of binary discrete models. The Logit model arises if the cumulative distribution function (cdf) of μ follows logistic distribution whereas the Probit model is based on the standard normal cumulative distribution. Theoretically, it is a hard-to-justified issue to choose one distribution over the other. The two distributions are similar but the logistic distribution has heavier tails than normal distribution (Amemiya 1983, Greene 2003). In empirical applications, the two models usually result in similar estimations of predicted probabilities. The estimates by a Logit model are approximately 1.6 times of those by a Probit model (Cameron and Trivedi 2005). The merits of using a Probit model lie in where it works with central limit theory and follows a normal distribution (Amemiya 1983) that "naturally extends to Tobit models[11]" (Cameron and Trivedi 2005, pp.472). In the present study, error terms are assumed to follow a normal distribution, yielding a Probit model for estimation.

For visual and taste preferences, two Probit models were constructed, respectively. Here, a consumer's visual preference or expected utility was defined as $\bar{v}_1$, so Equation (5.2) and (5.3) take the form: $\Delta E\bar{v}_1 = E(\bar{v}_{1a}(\cdot)) - E(\bar{v}_{1b}(\cdot))$, and $\mu_1 = \varepsilon_{1b} - \varepsilon_{1a}$, where the subscript *a* represents grass-fed beef and *b* denotes conventional grain-fed beef. Likewise, consumer's taste preference or experienced utility was defined as $\bar{v}_2$; therefore, we have $\Delta E\bar{v}_2 =$

[11] The Tobit model will be discussed in the subsection 5.2.1. for estimation of consumers' bidding behavior.

$E(\bar{v}_{2a}(\cdot)) - E(\bar{v}_{2b}(\cdot))$ and $\mu_2 = \varepsilon_{2b} - \varepsilon_{2a}$. In addition, we define

$$y_k^* = \Delta E\bar{v}_k - \mu_k = \beta_k X_k + \tau_k, \qquad k \in \{1,2\} \tag{5.4}$$

where y_k^* is a latent function that defines the difference in expected utilities or experienced utilities between grass-fed and conventional grain-fed beef; subscript *k*=1 representing visual preference and *k*=2 representing taste preference; $\beta_k X_k$ is the deterministic components of the latent function, in which X_k denotes the vector of explanatory variables and β_k describes the corresponding vector of parameters; and τ_k represents the random components of latent functions with $\tau_k \sim N(0,1)$.

A binary choice outcome was observed after evaluating the appearance or taste of the paired beef samples and defined as

$$y_k = \begin{cases} 1, \ if\ y_k^* > 0\ , i.e.\ \Delta E\bar{v}_k > \mu_k \\ 0\ , \ otherwise \end{cases} \tag{5.5}$$

Then, the probability of preferring the appearance or taste of grass-fed beef is specified as:

$$P(y_k = 1) = \Pr(y_k^* > 0) = \Pr(\Delta E\bar{v}_k > \mu_k) = \Phi(\Delta E\bar{v}_k) = \int_{-\infty}^{\Delta E\bar{v}_k} \phi(z)dz \tag{5.6}$$

In line with discussion on the PQB model (see Chapter III), consumers' visual preferences may influence taste preferences. Moreover, visual and taste preferences might be potentially correlated to affect consumers' overall acceptance and repeat purchase (Melton et al. 1996). At the same time, previous studies suggest that consumers' visual and taste experience are not always consistent and possibly have counteracting roles in determining the potential acceptance of beef products (e.g. Acebron and Dopico 2000; Melton et al. 1996; Umberger et al. 2002). For example, Umberger et al. (2002) show that marbling (intramuscular fat) might lead to discrepant visual and taste experience. On one hand, less marbled beef steak is typically preferred by consumers due to its less observable fat content; this, on the other hand, may result in an unfavorable taste experience since consumers felt

that less marbled beef tastes drier. Melton et al. (1996) employed experimental auction methods to evaluate consumers' perceptions on fresh pork chops. Their findings reveal contradictory visual and taste acceptance rankings when using photographs for visual evaluations and actual products for taste tests, but largely consistent rankings when both visual evaluations and taste tests are based on fresh products. As a result, it is of interest to explore the relationship between and ascertain the determinants of visual and taste preferences.

Similar to the Seemingly Unrelated Regression model (SUR), the bivariate Probit model estimates the two binary Probit equations for visual and taste preferences (Equation 5.6) together and allows the correlation between their error terms (τ_1 and τ_2). That is, the covariance of (τ_1, τ_2) could be equal to a constant ρ rather than zero (Greene 2003). As a natural extension of binary Probit models, the bivariate Probit model assumes that the error terms in the two equations follow a bivariate normal distribution (Amemiya 1985; Greene 2003). Given the potential correlation between Hispanic consumers' visual and taste preferences for grass-fed beef, the bivariate Probit model is introduced here to control for the relationship between the two types of preferences and account for the possibility that consumers' visual preferences for grass-fed beef are correlated to their taste preferences.

Here, we have a bivariate binary dependent variable vector (y_1, y_2), which consists of the two types of preferences: visual preference (y_1) and taste preference (y_2). There are four combinations of binary responses: (y_1, y_2)= (1, 1), (1, 0), (0, 1), (0, 0).

Under the bivairiate Probit model, Equation (5.4) and (5.5) are modified as

$$y_k^* = \beta_k X_k + \tau_k,$$

$$y_k = 1 \; if \; y_k^* > 0, \; 0 \; otherwise$$

$$\begin{pmatrix}\tau_1 \\ \tau_2\end{pmatrix} \sim N\left[\begin{pmatrix}0 \\ 0\end{pmatrix}, \begin{pmatrix}1 & \rho \\ \rho & 1\end{pmatrix}\right] \tag{5.7}$$

where τ_1 and τ_2 are the error terms of latent functions (y_1^* and y_2^*) following a joint normal distribution; and ρ is the correlation of error terms (τ_1 and τ_2).

The joint probability of the bivariate Probit model is specified as:

$$\Pr(y_{i1}, y_{i2}|x_1, x_2)$$
$$= \int_{A1} \int_{A2} \phi(z_1, z_2, \rho) dz_1 dz_2 \quad (5.8)$$

where ϕ is the density function of a bivariate normal distribution; A_1 and A_2 represent the integration intervals for each preference combination. In particular $A_1 = (-\infty, \Delta E\bar{v}_{i1})$ if $y_{i1} = 1$ and $A_1 = (\Delta E\bar{v}_{i1}, \infty)$ if $y_{i1} = 0$. A_2 is defined analogously for y_{i2}.

In a discrete choice model, marginal effects work as a measure for the effects of changes of an explanatory variable on the predicted probability. Unlike a linear regression model, the marginal effects of a discrete choice model cannot be inferred directly by parameter estimates. Instead, they are obtained by calculating the derivatives of the conditional probability function with respect to explanatory variables (Greene 2003). For a continuous independent variable, marginal effects are the partial derivatives with respect of the variable. The marginal effects can be evaluated at sample mean or computed based on every individual observation to obtain an average marginal change (Anderson and Newell 2003; Greene 2003). For a dummy independent variable, discrete changes are derived from the differences in predicted probabilities when the value of the variable changes from 1 to 0.

According to the formulae proposed by Christofides, Stengos, and Swidinsky (1997), in the bivariate probit model, as illustrated by $y_1 = 1$, the predicted joint probabilities are specified as

$$\Pr(y_1 = 1, y_2 = 1|x_1, x_2) = \Phi_2(\beta_1 X_1, \beta_2 X_2, \rho) \quad (5.9)$$

$$\Pr(y_1 = 1, y_2 = 0|x_1, x_2) = \Phi_2(\beta_1 X_1, -\beta_2 X_2, \rho) \quad (5.10)$$

where $\Phi_2(.)$ denotes the bivariate normal cumulative distribution function.

The predicted probability of $y_1 = 1$ is specified as

$$\Pr(y_{i1} = 1|x_1, x_2) = \Pr(y_{i1} = 1, y_{i2} = 1|x_1, x_2) + \Pr(y_{i1} = 1, y_{i2} = 0|x_1, x_2) \quad (5.11)$$

Suppose that x_l is an independent variable appearing in both visual and taste preference models, marginal effects for predicted probability of $y_1 = 1$ and $y_2 = 1$ is given by:

$$\frac{\partial \Phi_2(\beta_1 X_1, \beta_2 X_2, \rho)}{\partial x_l} = \Phi_{y_2=1|y_1=1}\phi_{y_1=1}\beta_{1l} + \Phi_{y_1=1}\phi_{y_2=1|y_1=1}\beta_{2l} \quad (5.12)$$

Likewise, marginal effects for the predicted probability of $y_1 = 1$ and $y_2 = 0$ are given by:

$$\frac{\partial \Phi_2(\beta_1 X_1, -\beta_2 X_2, \rho)}{\partial x_l} = \Phi_{y_2=0|y_1=1}\phi_{y_1=1}\beta_{1l} + \Phi_{y_1=1}\phi_{y_2=0|y_1=1}(-\beta_{2l}) \quad (5.13)$$

Marginal changes of predicted probability of $y_1 = 1$ consist of the RHS terms of Equations (5.12) and (5.13), which equal to the marginal effects of a univariate probit model due to the symmetry of normal distribution (Christofides, Stengos, and Swidinsky 1997).

The visual and taste preference functions were specified as Equation (5.14) and (5.15), respectively. All variables used in the bivariate Probit model are described in Table 5.1.

Specifically, we have

$$\begin{aligned}\Pr(VP = 1) &= f_1(\text{visual attributes, individual characteristics}) \\ &= f_1(\textit{MEATCLR, FATCLR, TEXTURE, TREATMENT, FEMALE, AGE, EDUCATION, INCOME, ADULTS, CHILDREN, MEXICAN, SALHON, COLOMBIAN, ACCULTURATION, NEIGHBOR, FHOME, FAWAY, FL\_NUTRI, LABELING, MBLING}) \quad (5.14)\end{aligned}$$

$$\begin{aligned}\Pr(TP = 1) &= f_2(\text{taste attributes, individual characteristics}) \\ &= f_2(\textit{TENDERNESS, JUICINESS, FLAVOR, TREATMENT, FEMALE, AGE, EDUCATION, INCOME, ADULTS, CHILDREN, MEXICAN, SALHON, COLOMBIAN, ACCULTURATION, NEIGHBOR, FHOME, FAWAY, DONE, FHOME, FAWAY, FL\_NUTRI, LABELING, MBLING}) \quad (5.15)\end{aligned}$$

where *VP* is a binary variable representing consumers' visual preferences for grass-fed beef versus conventional grain-fed beef. *VP* assumes the values of 1 and 0 for consumers who

Table 5.1. Variable Definitions and Summarized Statistics

Variable	Description	Mean	Std.
	Experimental Variables		
WTP	Price premium placed on grass-fed beef	1.95	2.69
TASTE	1 if preferring the taste of grass-fed beef; 0 otherwise.	0.39	0.49
VISUAL	1 if visually preferring grass-fed beef; 0 otherwise.	0.60	0.49
PREF	1 if overall preferring grass-fed beef; 0 otherwise.	0.51	0.50
TREATMENT	1= Treatment A; 0= Treatment B	.072	0.45
ENDOWMENT	1 if the compensation for participation is $30; 0 otherwise.		
	Socio-Demographic Variables		
FEMALE	1= Female; 0=Male	0.64	0.48
AGE	Age in years	37.70	13.74
EDUCATION	1= Less than high school diploma; 2= High school diploma or equivalent; 3= Some College; 4= Associates Degree; 5= Bachelors degree; 6= Graduate or Professional Degree	3.03	1.65
INCOME	1=less than $10,000; 2=$10,000-$19,999; 3=$20,000-$29,999; 4= $30,000- $39,999; 5=$40,000-$49,999; 6=$50,000-$59,999; 7=$60,000-$69,999; 8= $70,000-$79,999; 9=$80,000-$89,999; 10=$90,000- $99,999; 11= $100,000	4.0	2.68
ADULTS	The number of people over 18 years old in a subject's household	2.49	1.02
CHILDREN	The number of children under 18 years old in a subject's household	1.04	1.25
MEXICAN[a]	1 if the subject's country of origin is Mexico; 0 otherwise.	0.35	0.48
SALHON[a]	1 if the subject's country of origin is Salvador/Honduras; 0 otherwise.	0.23	0.42
COLOMBIAN[a]	1 if the subject's country of origin is Colombia; 0 otherwise.	0.22	0.41
ACCULTURATION	The degree of acculturation.	0.59	0.14
NEIGHBOR	The level of people originated from your country living in current neighborhood: 1=Almost none or none; 2= Few; 3=Some; 4=Many; 5=All or almost all.	2.78	1.28
PEER_MEX	MEXICAN*NEIGHBOR	0.95	1.54
PEER_SAL	SALHON*NEIGHBOR	0.65	1.32
PEER_COL	COLOMBIAN*NEIGHBOR	0.31	0.69
PEER_OTH	"Other Hispanic country" *NEIGHBOR	0.37	0.84
	Beef Consumption Behavior and Other Relevant Variables		
FHOME	The frequency of consuming beef prepared at home: 1= Less than once a month; 2= 1-2 times a month; 3= 1-2 times a week; 4= More than 3times a week.	3.07	0.81
FAWAY	The frequency of consuming beef away from home: 1= Less than once a month; 2= 1-2 times a month; 3= 1-2 times a week; 4= More than 3 times a week.	2.21	1.08
DONE	Preferred doneness of beef steak: 1= Rare or less; 2= Medium rare; 3= Medium; 4 = Medium well; 5= Well done or more; 6= It varies by cut.	4.21	1.19
FL_NUTRI	The frequency of reading nutrition labels when purchasing food: 1=Never; 2=Rarely; 3=sometimes; 4=Most of time; 5=Always	3.48	1.14
LABELING	1 if the consumer has experience of purchasing specialty meat products labeled "Natural", "Organic", or "Free range"; 0 otherwise.	0.68	0.47

Table 5.1. Continued

Variable	Description	Mean	Std.
MBLING	The importance of the presence of marbling in beef purchases: 1=Not important; 2=Somewhat important; 3=important; 4=very important; 5=extremely important	3.36	1.13
	Variables of Beef Attributes		
TENDERNESS	Difference between tenderness ratings of grass-fed and conventional grain-fed beef.	0.57	2.09
JUICINESS	Difference between juiciness ratings of grass-fed and conventional grain-fed beef.	-0.15	1.93
FLAVOR	Difference between flavor ratings of grass-fed and conventional grain-fed beef.	0.09	1.87
MEATCLR	Difference between meat color ratings of grass-fed and conventional grain-fed beef.	1.43	1.48
FATCLR	Difference between fat color ratings of grass-fed and conventional grain-fed beef.	0.48	1.67
TEXTURE	Difference between meat texture ratings of grass-fed and conventional grain-fed beef	-0.36	2.31

[a]: The reference group is "other" Hispanics that include subjects from countries other than Mexico, El Salvador, Honduras, and Colombia.

visually preferred grass-fed beef and consumers who visually preferred conventional grain-fed beef, respectively.

TP is a binary variable representing consumers' taste preferences for grass-fed beef versus conventional grain-fed beef. *TP* takes the values of 1 and 0 for consumers who preferred the taste of grass-fed beef and consumers who preferred the taste of conventional grain-fed beef, respectively.

The explanatory variables were composed of sensory attributes, consumers' sociodemographic characteristics and beef consumption behavior. *MEATCLR*, *FATCLR*, and *TEXTURE* are the visual attributes whose values are specified as the rating differences of lean meat color, fat color, and meat texture between grass-fed and conventional grain-fed beef, respectively. *TENDERNESS*, *JUICINESS*, and *FLAVOR* are the taste attributes whose values are defined as the rating differences of tenderness, juiciness, and flavor between grass-fed and conventional grain-fed beef, respectively. *TREATMENT* is a dummy variable referring to the two treatments in the sensory evaluation. *FEMALE*, *AGE*, *EDUCATION*, *INCOME*, *ADULTS*,

and *CHILDREN* are socio-demographic variables that represent subjects' gender, age in years, education attainment, annual household income, the number of adult family members in a subject's household, and the number of children in the household, respectively. *MEXICAN, SALHON,* and *COLOMBIAN* are dummy variables regarding subjects' countries of origin: Mexico, El Salvador/Honduras, and Colombia. *ACCULTURATION* refers to subjects' acculturation degrees. *NEIGHBOR* reflects the peer effects defined as the level of same-country neighbors living in the current neighborhood. The variables regarding consumers' beef consumption and purchase behavior include *FHOME, FAWAY, DONE, FL_NUTRI, LABELING,* and *MBLING. FHOME* and *FAWAY* describe the frequencies of consuming beef prepared at home and away from home, respectively. *DONE* defines the preferred cooking doneness of beef steak. *FL_NUTRI* denotes the frequency of reading health/nutrition labels when purchasing food. *LABELING* refers to the purchase experience with specialty meat products labeled as "Natural," "Organic," or "Free Range." *MBLING* ranks the importance of the presence of marbling in beef purchase decisions.

5.2. Hispanic Consumers' WTP for Grass-Fed-Beef

Multiple Price Lists (MPL) experiments were utilized to elicit subjects' WTP for grass-fed beef. Based on their overall preferences, subjects who preferred grass-fed beef were endowed with a pound of conventional grain-fed beef steak, hereafter referred to as the base product, and asked to fill out the MPL form to reveal the amount of money they were willing to pay for exchanging the base product to a pound of grass-fed beef. Hence, WTP was denoted here as a price premium that Hispanic consumers were willing to pay for grass-fed beef when compared to conventional grain-fed beef.

WTP = the price of a pound of grass-fed beef steak – the price of a pound of conventional grain-fed beef steak (5.16)

The MPL experiment eliciting subjects' WTP for grass-fed beef was designed to immediately follow up sensory evaluations. Only the group of subjects who preferred grass-fed beef overall could participate in the MPL experiment. We constructed a binary variable to represent participation status, which took value one if a subject preferred grass-fed to conventional grain-fed beef --- thus participating in the following MPL experiment --- and the value of zero otherwise. With respect to the conventional grain-fed preferring subjects, we assume that they were unwilling to pay a price premium for grass-fed beef. Nevertheless, their values of WTP were unobservable as a result of non-participation. For this group of subjects, it is reasonable to assume that they would rather keep the base product, had they participated in the MPL experiment; that is, zero value of WTP would be observed. Therefore, the dependent variable representing WTP for grass-fed beef is left censored at zero in the sense that the WTP of those subjects who preferred conventional grain-fed beef and did not participate in MPL experiment were all reported as zero.

In the actual MPL experiments, only grass-fed preferring subjects were eligible to participate. After endowed with a pound of base product---conventional grain-fed beef--- and $10 cash, subjects were informed about the day's retail price of base product. Then, subjects were asked whether they were willing to trade the pound of conventional grain-fed beef for a pound of grass-fed beef by giving up any amount of money from the $10 cash. WTP for grass-fed beef was recorded as zero if subjects responded "No." Positive WTP would be revealed by subjects who responded "Yes" and then continued the following MPL experiment. Table 5.2. illustrates the number and percentage of subjects who preferred conventional grain-fed beef, who were unwilling to pay more given their preferences for grass-fed beef, and who preferred grass-fed beef and also were willing to pay a price premium for it.

In Table 5.2., 56% of observations of WTP were zero. For censored distributions, however, OLS regression usually leads to biased and inconsistent estimates of parameters

Table 5.2. Number and Percentage of Grass-Fed and Conventional Grain-Fed Preferring Subjects

	Total	Conventional Grain-Fed Preferring	Grass-Fed Beef Preferring	
			Zero WTP	Positive WTP
Number of Observations	231	113	16	102
Percentage (%)	100	49	7	44

(Amemiya 1985; Cameron and Trivedi 2005). Moreover, dropping "zero" observations from the sample may result in the loss of efficiency (Amemiya 1985). According to our WTP data, approximately 50% of observations were left-censored at zero. For this reason, appropriate regression models other than OLS need to be specified to address these issues.

Table 5.2. indicates that nearly 50% of subjects preferred conventional grain-fed beef and 7% of subjects would pay a zero price premium for grass-fed beef given their preferences for this product. Hence, we assume that zero observations of WTP primarily come from: 1) Non-participation; that is, consumer didn't prefer grass-fed beef and thus were unwilling to pay a price premium for it; and 2) A corner solution; that is, given participation in the market, consumers were unable to afford or unwilling to pay for a price premium for grass-fed beef. Different econometric models could be considered in estimation of consumers' WTP under different assumptions on the sources of zero observations. The following sections present relevant theoretical background of different censored regression models and discuss their potential appropriateness in analyzing Hispanic consumers' WTP for grass-fed beef.

5.2.1. Standard Tobit Model

A widely used regression accounting for censored distribution is the standard Tobit model. This model considers the qualitative difference between the censored observations (zero WTP) and uncensored observations (positive WTP) while assuming zero WTP as a

corner solution. It incorporates the information of both the MPL participation decision and the WTP after participation, hence combining discrete and continuous densities.

In a standard Tobit model, the latent WTP function is defined as:

$$w_i^* = X_i\beta + \eta_i\ , \qquad \eta_i \big| X_i \sim N(0,\sigma^2) \tag{5.17}$$

where w_i^* is consumer *i*'s latent WTP, which is unobservable. X_i is a vector of observable explanatory variables as defined in the conceptual model and β is a vector of coefficients. The error term η is assumed to follow a normal distribution with zero mean and standard deviation σ.

The relationship between observed and modeled values of WTP is assumed to be

$$w_i = Max\{w_i^*, 0\} = Max\{X_i\beta + \eta, 0\}$$

In what follows, it is convenient to write this relationship as

$$w_i = \begin{cases} w_i^*, w_i^* > 0 \\ 0, w_i^* \le 0 \end{cases} \tag{5.18}$$

The maximum likelihood function for Equation (5.18) is given by:

$$\boldsymbol{L} = \prod_{w=0}(1 - \boldsymbol{\Phi}(\tfrac{X\beta}{\sigma})) \prod_{w>0}\{\tfrac{1}{\sigma}\phi(\tfrac{w - X\beta}{\sigma})\} \tag{5.19}$$

According to Greene (2003) and Cameron and Trivedi (2005), the major weakness of the standard Tobit model rests on its heavy dependence on the assumption of a normal distribution and homoskedasticity. Any violation of normality and homoskedasticity results in inconsistent maximum likelihood estimators (MLE). As illustrated in the likelihood function (Equation 5.19), the standard Tobit model is restrictive in that it depends on the same determinants to account for both subjects' MPL participation decisions and their WTP given participation. As a result, it implies that the factors that increase the probability of participation in the MPL experiment will also affect the conditional mean of positive WTP and their effects are in the same direction. Therefore, the model permits incorporation of all

observations including censored data (zero WTP), but it fails to consider the sources of zeros. It ignores the zero observations as a result of non-participation decision and thus imposes an assumption that all the zeros come from corner solutions alone.

Caveats also apply to marginal effects of the Standard Tobit model (Greene 2003). For the latent WTP function, i.e. the actual value of WTP for grass-fed beef, a change in x_i has effects on: 1) the probability that the individual prefers grass-fed beef overall and thus her/his participation decision of the MPL experiment; and 2) the level of WTP for grass-fed beef given participation.

The combined marginal effects for the latent variable are formulated as:

$$\frac{\partial E[w_i^*|X_i]}{\partial X_i} = \beta \tag{5.20}$$

However, for the primary interest, the observed WTP w_i, the marginal effects takes the form as follows:

$$\frac{\partial E[w_i|X_i]}{\partial X_i} = \beta \boldsymbol{\Phi}\left(\frac{X_i\beta}{\sigma}\right) \tag{5.21}$$

where $\Phi(.)$ is the normal cumulative distribution function.

Given the difference in marginal effects, special attention should be given to the interpretation of estimation results in the model.

5.2.2. Heckman's Sample Selection Model

Different from the Standard Tobit model, Heckman's sample selection model allows for separate determinants for limit (zero) observations and nonlimit (positive) observations (Heckman 1979). Thus, subjects' MPL participation decisions and their WTP given participation are assumed to be determined by different variables. In the study, subjects' bidding behavior was evaluated through a two-step procedure: 1) Based on overall preferences, subjects who preferred grass-fed beef were selected to participate in a MPL

experiment; and 2) the selected sample, i.e. grass-fed preferring subjects, bid their WTP for grass-fed beef. For this reason, a sample selection model seems appropriate to reflect subjects' participation and bidding behavior. However, the Heckman's sample selection model is subject to the first-hurdle dominance assumption (Jones 1989 and 1992; Madden 2008; Puhani 2000). That is, once the first hurdle (participation decision) is passed, a positive WTP for grass-fed beef must be observed. Under this assumption, zero observations of WTP arise not from a corner solution but completely from individuals' participation decisions, which implies that censoring is not relevant any more in subjects' WTP decisions.

Heckman's sample selection model typically consists of a participation equation and an outcome equation. The participation (sample selection) equation can be written as:

$$d_i^* \equiv \Delta \mathrm{E}\bar{\mathrm{v}} - \mu = Z_i\gamma + \nu_i \tag{5.22}$$

$$d_i = \begin{cases} 1, if\ d_i^* > 0 \\ 0, if\ d_i^* \leq 0 \end{cases} \tag{5.23}$$

where d_i^* is the latent sample selection variable. It can be viewed as the difference between the utilities derived by consuming grass-fed beef versus conventional grain-fed beef. Subject *i* participates in the MPL experiment only if s/he prefers grass-fed beef over conventional grain-fed beef and therefore his/her utility difference is greater than zero. The observed participation variable d_i is defined as binary with value one if the *ith* subject is a MPL participant and value zero otherwise. Z_i represents a vector of observable explanatory variables that determine the subject's participation and γ is a vector of coefficients.

The outcome (WTP) equation given participation is formulated as

$$w_i^* = X_i\beta + \eta_i \tag{5.24}$$

$$w_i = \begin{cases} w_i^*, if\ d_i = 1 \\ 0, if\ d_i = 0 \end{cases} \tag{5.25}$$

$$\begin{pmatrix} \nu_i \\ \eta_i \end{pmatrix} \Big| X_i, Z_i \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix} \begin{pmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{pmatrix} \right)$$

where w_i are the *ith* consumer's WTP, which is observed only when $d_i = 1$, i.e. only when the subject prefers grass-fed beef and participates in the MPL experiment. X_i is a vector of observable explanatory variables that determine the subject's positive WTP for grass-fed beef and β is a vector of coefficients. Error terms η_i and ν_i have a bivariate normal distribution with zero mean and correlation coefficient ρ.

The likelihood function of Heckman's Selection model is derived as:

$$L = \prod_0 [1 - p(d = 1)] \prod_{>0} p(d = 1)\, g(\mathrm{w_i^*}|\mathrm{d} = 1)$$

$$= \prod_0 \{\Phi(-Z\gamma)\} \prod_{>0} \left\{ \Phi\left(\frac{Z\gamma + \frac{\rho}{\sigma}(w - X\beta)}{\sqrt{1-\rho^2}} \right) \frac{1}{\sigma} \phi\left\{ \frac{w - X\beta}{\sigma} \right\} \right\} \quad (5.26)$$

This model consists of a Probit part and a truncated regression part.

Given the non-zero correlation of η_i and ν_i, the conditional mean of WTP by the selected sample $(d_i = 1)$ is:

$$E(w_i | X_{i,} Z_{i,} d_i = 1) = X_i\, \beta + \rho\sigma\lambda(Z_i\gamma) \quad (5.27)$$

where $\lambda(.) = \frac{\phi(.)}{\Phi(.)}$ is called the Inverse Mills Ratio.

As illustrated in Equation (5.27), it is obvious that when $\rho \neq 0$, OLS regression of w_i on X_i using only the uncensored values of WTP ($w_i > 0$) results in inconsistent estimates of β since the truncated mean is not $X_i\beta$. Unlike OLS, the essence of sample selection models is to use the Inverse Mills Ratio to correct the selection bias when estimating grass-fed preferring subjects' (i.e. MPL participants') WTP, therefore leading to consistent estimators.

The sample selection model can be estimated using MLE. However, MLE is complicated to implement and strongly relies on the distributional assumption of joint normality of η_i and ν_i (Cameron and Trivedi 2005; Greene 2003). A widely used alternative to MLE is a two-step procedure suggested by Heckman (1979). The procedure

consists of the following two steps:

Step I: Estimate the participation equation by computing the Probit MLE, i.e.

$$P(d = 1) = \Pr(d^* > 0) = \Phi(Z\gamma) \quad (5.28)$$

Step II: Use only the observations for which $d_i = 1$ to estimate the parameters in the outcome equation, either by OLS or Weighted Least Square regression (WLS)

$$w_i = X_i\beta + \rho\sigma\tilde{\lambda} + \xi_i \quad (5.29)$$

where $\tilde{\lambda} = \lambda(Z_i\gamma)$ represents the Inverse Mill Ratio.

Compared with MLE, Heckman's two-step procedure weakens the distributional assumption in that normality is required only for the Probit model but is unnecessary to the joint distribution of d_i^* and w_i^*. With respect to marginal effects, Heckman's two-step procedure can compute the pure effects of various factors on the uncensored WTP.

5.2.3. Cragg's Double-Hurdle Model

Similar to Heckman's sample selection model, the double-hurdle model originally developed by Cragg (1971) accounts for both consumers' participation and outcome decisions and assumes that each decision is determined by a different set of explanatory variables. Unlike Heckman's sample selection, however, Cragg's double-hurdle model is not subject to the first-hurdle domination assumption such that given participation, zero values of WTP can be observed. Therefore, the zero observations of WTP are not only a result of non-participation but also because of other reasons such as a corner solution or infrequency of purchase (Jones 1989 and 1992; Madden 2008). In this model, WTP can be zero or positive given participation. Therefore, in order to observe positive values of WTP, two hurdles need to be passed: 1) the individual participates in the MPL experiment (the first hurdle); and 2) the level of WTP is greater than zero (the second hurdle). Furthermore, for the

sake of simplicity, Cragg's double-hurdle model assumes the independence between participation and WTP decisions.

Here, the outcome equation (5. 25) is modified as:

$$w_i = \begin{cases} w_i^*, if\ d_i = 1\ and\ w_i^* > 0 \\ 0, otherwise \end{cases} \tag{5.30}$$

$$\begin{pmatrix} v_i \\ \eta_i \end{pmatrix} \Big| X_i, Z_i \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right)$$

In this model, the first hurdle is the consumer's participation decision. The probability that a subject preferred conventional grain-fed beef and didn't participate in the MPL experiment is formulated as:

$$P(d_i = 0) = \Phi(-Z_i\gamma_i) \tag{5.31}$$

where $\Phi(.)$ is a standard normal distribution function.

The second hurdle determines the effects of explanatory variables on consumer WTP given participation, i.e. preference for grass-fed beef. The distribution of WTP conditional on being positive is specified as:

$$f(w_i > 0) = \left\{ \frac{1}{\sigma} \phi \left(\frac{w_i - X_i\beta_i}{\sigma} \right) \right\} / \Phi \left(\frac{X_i\beta_i}{\sigma} \right) \tag{5.32}$$

The Likelihood function of Cragg's double-hurdle model is specified as:

$$L = \prod_0 [1 - p(d = 1)p(\mathrm{w}^* > 0)] \prod_{>0} p(d = 1)p(\mathrm{w}^* > 0)g(\mathrm{w}^* | \mathrm{w}^* > 0)$$

$$= \prod_0 \{\Phi(-Z\gamma)\} \prod_{>0} \left\{ \Phi(Z\gamma) \left[\frac{1}{\sigma} \phi \left(\frac{w - X\beta}{\sigma} \right) \right] / \Phi \left(\frac{X\beta}{\sigma} \right) \right\} \tag{5.33}$$

5.2.4. Model Selection in this Study

The selection of an econometric model for WTP estimation is determined by three primary criteria: 1) the source of zero observations; 2) the correlation of error terms in participation and outcome equations; and 3) the first-hurdle dominance (Madden 2008; Jones 1989).

Based on the discussion aforementioned, in this study, zero WTP mainly comes from two sources: 1) non-participation, i.e. preferring conventional grain-fed beef, and 2) a corner solution[12], i.e. preferring grass-fed beef but willing to pay a zero price premium for it. The standard Tobit model doesn't distinguish between consumers' participation decisions and WTP outcomes and thus assumes all zero values of WTP as a corner solution. Heckman's Sample Selection model is superior to the standard Tobit model inasmuch as it considers the difference between consumer participation decisions and WTP decisions given participation. It, however, is subject to the first-hurdle dominance assumption in which all zero values come from self-selection, i.e. non-participation decisions. While zero observations of WTP occurred to some subjects who had passed the first hurdle (i.e. overall preference for grass-fed beef), a corner solution implies that the first-hurdle dominance assumption does not work in this study. On the contrary, Cragg's double-hurdle model differs between two stochastic processes of decision and takes into account the different sources of zero observations of WTP. Theoretically speaking, Cragg's double-hurdle model seems suited to apply to the study in this respect.

In the next chapter, estimation results by the standard Tobit model, Heckman's sample selection model, and Cragg's double hurdles will be reported and compared.

5.2.5. Empirical Models for Hispanic Consumers' WTP for Grass-Fed Beef

The standard Tobit model, Heckman's sample selection model, and Cragg's double-hurdle model are specified as follows. All the dependent variables and explanatory variables are summarized in Table 5.1.

1) Standard Tobit model

[12]: In our context, this means that a consumer would rather spend all her/his endowment in the composite good Z. Thus, the preference for grass-fed beef to conventional grain-fed beef reveals information when consumers restrict attention to these two beef products.

The WTP equation is specified as following:

$$wtp_i = f(\textit{VT, TP, ENDOWMENT, TREATMENT, FEMALE, AGE, EDUCATION, INCOME, ADULTS, CHILDREN, MEXICAN, SALHON, COLOMBIAN, ACCULTURATION, PEER\_MEX, PEER\_SAL, PEER\_COL, PEER\_OTH, FHOME, FAWAY, FL\_NUTRI, LABELING, MBLING}) \quad (5.34)$$

2) Heckman's sample selection model and double-hurdle model

The Probit model for subjects' participation decisions was formulated as

$$P(d_i = 1) = f(\textit{VT, TP, TREATMENT, FEMALE, AGE, EDUCATION, INCOME, ADULTS, CHILDREN, MEXICAN, SALHON, COLOMBIAN, ACCULTURATION, PEER\_MEX, PEER\_SAL, PEER\_COL, PEER\_OTH, FHOME, FAWAY, FL\_NUTRI, LABELING, MBLING}) \quad (5.35)$$

Likewise, the outcome equation for WTP is specified as

$$wtp_i = f(\textit{ENDOWMENT, TREATMENT, FEMALE, AGE, EDUCATION, INCOME, HDSIZE, CHILDREN, MEXICAN, SALHON, COLOMBIAN, ACCULTURATION, PEER\_MEX, PEER\_SAL, PEER\_COL, PEER\_OTH, FHOME, FAWAY, FL\_NUTRI, LABELING, MBLING}) \quad (5.36)$$

In Equation (5.35) and (5.36), d_i is a binary variable representing consumer *i*' s participation in the MPL experiment with 1 if s/he participated and zero otherwise. wtp_i is the *ith* consumer's observed WTP for grass-fed beef.

The explanatory variables are composed of sensory preferences, consumers' socio-demographic characteristics, and beef consumption behavior. *VP* and *TP* are binary variables representing consumers' visual and taste preferences for grass-fed beef versus conventional grain-fed beef. *ENDOWMENT* denotes the endowment given in the MPL

experiment with 1 representing $30 and 0 representing $50. *TREATMENT* is a dummy variable referring to two treatments in the sensory evaluation with 1 denoting treatment A and 0 otherwise. *FEMALE, AGE, EDUCATION, INCOME, ADULTS,* and *CHILDREN* are socio-demographic variables that represent subjects' gender, age in years, education attainment, annual household income, the number of adult family members in a subject's household, and the number of children in the household, respectively. *MEXICAN*, *SALHON*, and *COLOMBIAN* are dummy variables for subjects' country of origin: Mexico, El Salvador/Honduras, and Colombia, respectively. *PEER_MEX* defines the interaction between Mexican origin (*MEXICAN*) and peer effects (*NEIGHBOR*). Likewise, *PEER_COL, PEER_SAL,* and *PEER_OTH* denote the interactions between Colombian origin (*COLOMBIAN*) and *NEIGHBOR*, El Salvadoran/Honduran origin (*SALHON*) and *NEIGHBOR*, and "other" Hispanic origin and *NEIGHBOR*, respectively. *ACCULTURATION* refers to subjects' acculturation degree. *FHOME* and *FAWAY* describe the frequencies of consuming beef prepared at home and away from home, respectively. *FL_NUTRI* denotes the frequency of reading nutrition labels when purchasing food. *LABELING* refers to the purchase experience of meat products labeled as "Natural," "Organic," or "Free Range." *MBLING* indicates the importance of the presence of marbling in beef purchase decisions. All the dependent and explanatory variables are described in Table 5.1.

CHAPTER VI

DATA AND ESTIMATION RESULTS

6.1. Estimation Results of Visual and Taste Preferences

Hispanic consumers' visual and taste preferences were estimated by the bivariate Probit model. A total of 214 observations were used in the estimation. Estimation results are reported for both the independent restricted and unrestricted bivariate Probit models. The independent restriction assumes the correlation parameter (ρ) to be zero; therefore it is the same as estimating two separate Probit models for visual and taste preferences. The unrestricted bivariate Probit model estimates visual and taste preferences simultaneously and tests the hypothesis that the correlation (ρ) of visual and taste preferences is equal to zero.

The Likelihood-Ratio (LR) test provides grounds to choose between the independent restricted and unrestricted bivariate Probit models. As the independent restricted model is a special case of unrestricted model, the LR test statistic, $-2In\ (\frac{\hat{L}_R}{\hat{L}_U})$, was computed. This statistic follows a χ^2 distribution with degrees of freedom equal to the number of restrictions, i.e. one[13]. The Likelihood ratio $\chi^2(1)$ is 3.99, which is statistically significant at the 5% level of significance. Therefore, we rejected the hypothesis that correlation ρ was zero.

Akaike's information criterion (AIC) and Bayesian information criterion (BIC) are two other criteria for model selection. As measures of the goodness of fit of an estimated model, lower values of the two criteria are favored over higher ones (Greene 2003). As shown in Table 6.1., the unrestricted bivariate Probit model has smaller AIC and BIC than the independent restricted model. Along with the LR test, the unrestricted bivariate Probit model

[13]: $\hat{L}_R$ and $\hat{L}_U$ refer to the estimated likelihood of independent restricted and unrestricted models, respectively.

is preferred in this study. Therefore, for simplicity without losing generality, the following discussion is based on the unrestricted model only.

The estimate of ρ parameter under the unrestricted bivariate Probit model was 0.314 at a 10% significant level (see Table 6.1.). The positive estimate of ρ implies that visual and taste preferences were positively related— that is, as the probability of visually preferring grass-fed beef increased, the probability of preferring its taste increased as well and vice versa. This result is different from the study by Umberger (2001) who found a negative correlation between visual and taste preferences. However, Melton et al. (1996) indicate that a small but positive correlation exists between visual and taste appraisals for fresh pork chops.

Table 6.1. Comparison of Independent Restricted and Unrestricted Bivariate Probit Models

	ρ[14]	Number of Observations	Log-Likelihood	AIC	BIC
Independent Restricted	0	211	-202.516	511.52	645.97
Bivariate Unrestricted	0.314* (0.153)	211	-200.521	489.04	636.32

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.
Parenthesis represents Std. Dev.

Tables 6.2. and 6.3. provide the estimated coefficients and corresponding marginal effects of the bivariate Probit model. In the study, marginal effects were not computed based on sample mean of independent variables but by averaging discrete changes or partial derivatives over all observations, therefore yielding average marginal effects (AME).

In the visual preference model, the predicted probability of preferring the appearance of grass-fed beef was 0.632. The percentage of correct prediction was 75%. Among the three visual attributes, meat color (*MEATCLR)* and fat color (*FATCLR)* were statistically

[14] Defined as the correlation between visual and taste preferences.

Table 6.2. Estimation Results of Independent Restricted and Unrestricted Bivariate Probit Models

	Independent Restricted				Bivariate Unrestricted			
	Visual Preference		Taste Preference		Visual Preference		Taste Preference	
Variables	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
TREATMENT[+]	-0.076	0.243	0.055	0.262	-0.085	0.244	0.049	0.262
FEMALE[+]	0.075	0.226	-0.103	0.253	0.060	0.227	-0.097	0.252
AGE	0.006	0.008	-0.008	0.009	0.006	0.008	-0.008	0.009
EDUCATION	-0.090	0.077	0.067	0.083	-0.086	0.076	0.057	0.082
INCOME	0.033	0.045	-0.001	0.049	0.034	0.044	0.001	0.049
ADULTS	0.140	0.113	0.089	0.110	0.146	0.113	0.089	0.109
CHILDREN	-0.070	0.093	-0.167*	0.105	-0.074	0.093	-0.168*	0.104
MEXICAN[+]	0.790**	0.324	0.059	0.361	0.805**	0.324	0.013	0.365
SALHON[+]	0.442	0.339	-0.318	0.399	0.441	0.340	-0.326	0.401
COLOMBIAN[+]	0.661**	0.319	0.087	0.369	0.663**	0.318	0.096	0.370
ACCULTURATION	0.356***	0.108	-0.177	0.116	0.360***	0.108	-0.176	0.116
NEIGHBOR	0.061	0.097	0.025	0.109	0.060	0.097	0.025	0.108
FHOME	-0.268**	0.133	0.016	0.145	-0.266**	0.133	0.027	0.146
FAWAY	0.042	0.104	-0.324***	0.120	0.041	0.103	-0.322***	0.119
DONE			-0.241**	0.102			-0.236**	0.101
FL_NUTRI	0.096	0.096	0.203*	0.111	0.097	0.096	0.200*	0.110
LABELING	-0.219	0.245	0.440	0.274	-0.213	0.244	0.453*	0.273
MBLING	0.252***	0.093	-0.086	0.104	0.245***	0.092	-0.098	0.103
MEATCLR	0.079	0.071			0.048	0.072		
FATCLR	-0.048	0.066			-0.053	0.066		
TEXTURE	-0.206***	0.050			-0.209***	0.050		
TENDERNESS			-0.167***	0.064			-0.163**	0.063
JUICINESS			-0.319***	0.076	-	-	-0.330***	0.075
FLAVOR			-0.185***	0.067	-	-	-0.179***	0.067
CONS	-3.257***	1.073	1.650	1.189	-3.249***	1.073	1.668	1.185

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Number of observations=211

Percentage of correct predictions for visual preferences =75%

Percentage of correct predictions for taste preferences =76%

Table 6.3. Marginal Effects of Independent Restricted and Unrestricted Bivariate Probit Models

	Independent Restricted		Bivariate Unrestricted	
	Visual=1	Taste=1	Visual=1	Taste=1
Variables	dy/dx (S.E.)	dy/dx (S.E.)	dy/dx (S.E.)	dy/dx (S.E.)
TREATMENT[+]	-0.023 (0.097)	0.013 (0.082)	-0.026 (0.097)	0.012 (0.081)
FEMALE[+]	0.023 (0.093)	-0.025 (0.075)	0.018 (0.094)	-0.024 (0.074)
AGE	0.002 (0.003)	-0.002 (0.003)	0.002 (0.003)	-0.002 (0.003)
EDUCATION	-0.027 (0.031)	0.016 (0.025)	-0.026 (0.031)	0.014 (0.025)
INCOME	0.010 (0.018)	0.000 (0.015)	0.010 (0.018)	0.000 (0.015)
ADULTS	0.042 (0.043)	0.022 (0.035)	0.044 (0.043)	0.021 (0.034)
CHILDREN	-0.021 (0.038)	-0.041* (0.031)	-0.022 (0.038)	-0.041* (0.030)
MEXICAN[+]	0.220** (0.140)	0.015 (0.103)	0.224** (0.141)	0.003 (0.101)
SALHON[+]	0.127 (0.146)	-0.077 (0.103)	0.127 (0.148)	-0.078 (0.102)
COLOMBIAN[+]	0.193** (0.146)	0.021 (0.108)	0.193** (0.147)	0.024 (0.105)
ACCULTURATION	0.107*** (0.040)	-0.043 (0.034)	0.108*** (0.040)	-0.043 (0.034)
NEIGHBOR	0.019 (0.040)	0.006 (0.033)	0.018 (0.040)	0.006 (0.032)
FHOME	-0.081* (0.053)	0.004 (0.043)	-0.080** (0.053)	0.007 (0.043)
FAWAY	0.013 (0.042)	-0.079*** (0.035)	0.012 (0.042)	-0.078*** (0.034)
DONE		-0.059** (0.022)		-0.057** (0.021)
FL_NUTRI	0.029 (0.040)	0.049* (0.032)	0.029 (0.040)	0.049* (0.032)
LABELING[+]	-0.066 (0.100)	0.106 (0.086)	-0.064 (0.100)	0.109* (0.085)
MBLING	0.076*** (0.037)	-0.021 (0.030)	0.074*** (0.037)	-0.024 (0.030)
MEATCLR	0.024 (0.020)		0.015 (0.020)	
FATCLR	-0.015 (0.018)		-0.016 (0.018)	
TEXTURE	-0.063*** (0.013)		-0.063*** (0.012)	
TENDERNESS		-0.041*** (0.014)		-0.040*** (0.014)
JUICINESS		-0.078*** (0.015)		-0.080*** (0.015)
FLAVOR		-0.045*** (0.014)		-0.044*** (0.014)

Note: Average marginal effects are computed for the independent variables.
*, **, ***denote significance at the 10%, 5%, and 1% levels, respectively.
(+) dy/dx is the average discrete change of dummy variable from 0 to 1

insignificant. Only meat texture (*TEXTURE*) was significant at a 1% level. The variable *TEXTURE* denotes the difference in meat texture ratings between grass-fed and conventional grain-fed beef. The negative sign on the *TEXTURE* variable indicates that a subject was less likely to visually prefer grass-fed beef if s/he perceived its meat texture to be coarser than conventional grain-fed beef. For each one-point increase in rating difference, the subject was 6% less likely to prefer the appearance of grass-fed beef.

The socio-demographic variables, *MEXICAN, COLOMBIAN*, and *ACCULTURATION*, had significant impacts on visual preferences. Subjects who are originated from Mexico or Colombia were 22% and 19% more likely to favor the appearance of grass-fed beef, respectively. The variable *ACCULTURATION* is a measure of acculturation degree, which means that the more acculturated a Hispanic person is, the higher her/his degree of acculturation is. It is anticipated that a Hispanic consumer with a high acculturation degree would prefer conventional grain-fed beef over grass-fed beef since the former is the primary type of beef supplied in the U.S. beef market. Nevertheless, the effects of acculturation (*ACCULTURATION*) were positive as opposed to our expectation and statistically significant. Its marginal effects revealed that each one level increase of acculturation led to an11% increase of probability that the subject visually preferred grass-fed beef. A possible interpretation may be that subjects with relatively high acculturation degree were less knowledgeable of how to purchase beef products. For example, the average acculturation of subjects who preferred the appearance of grass-fed beef but not its taste (6.34) was higher than those who consistently preferred grass-fed beef (5.80) and who consistently preferred conventional grain-fed beef (5.52). The possible interpretation could also be supported by subjects' living status and gender breakdown. Subjects living alone had higher average acculturation degree than subjects who lived with family (6.69 vs. 5.57). Likewise, the average acculturation degree of male subjects was higher than their female counterparts (6.15

vs. 5.71). It is likely that subjects living alone cooked less frequently than those living with family; similarly, male subjects were less likely to be the primary food purchasers and preparers in their households and therefore lacked the knowledgeable of evaluating beef appearance.

With respect to the variables for beef purchase and consumption behavior, the frequency of in-home beef consumption (*FHOME)* had a significant and negative impact on the probability of visually preferring grass-fed beef. The increase of one frequency level of consuming beef prepared at home (e.g., from "Once or twice a week" to "Three times or more a week") would lead to an 8% decrease of probability that the Hispanic subject preferred grass-fed beef. A higher level of *FHOME* suggests a greater frequency of cooking at home. However, grass-fed beef is currently unavailable in most supermarket/retail grocery stores and these stores were primary outlets Hispanic subjects purchased beef products; therefore subjects were likely to be familiar with the appearance of conventional grain-fed beef, which may partially explain the negative effects of *FHOME* on subjects' visual preferences for grass-fed beef. In contrast, *FHOME*, although insignificant, carried a positive sign in taste preferences. As indicated by Thomas Tseng (Ross 2003), Hispanic consumers have relatively larger household sizes, therefore family values and traditions lead to their preferences and interest in authentic ingredients and food products with a taste and flavor from their origins. In terms of living status, the more frequently a subject cooked at home, the more likely s/he lived with family rather than live alone. Hence, the subject was more likely to be affected by their traditional consumption habits.

Subjects' rankings of the importance of marbling (*MBLING*) were strongly significant and positive in visual preferences. A consumer was 7% more likely to prefer the appearance of grass-fed beef over conventional grain-fed beef if s/he considered the presence of marbling to be an important factor in her/his beef purchase decisions. Although the variable *MBLING*

didn't provide further information about whether the subject preferred high or low marbled beef, it suggests that grass-fed preferring subjects were more concerned about the presence of marbling.

In the taste preference model, the predicted probability of preferring the taste of grass-fed beef was 0.339. The percentage of correct prediction was 76%. In contrast to the visual preference model, all the three taste attribute variables, tenderness (*TENDERNESS),* juiciness *(JUICINESS),* and flavor (*FLAVOR)* were strongly significant at 1% level. *TENDERNESS, JUICINESS,* and *FLAVOR* were defined as the differences of ratings on tenderness, juiciness, and flavor of grass-fed and conventional grain-fed beef, respectively. The negative signs of the three taste attribute variables indicated that a subject was more likely to prefer the taste of grass-fed beef if s/he felt it more tender, juicer, and more flavorful than conventional grain-fed beef. The estimates of marginal effects indicated that for a one point increase in the rating difference of tenderness between grass-fed and conventional grain-fed beef, a subject was 4% less likely to prefer the taste of grass-fed beef. Likewise, for a one point increase in the rating difference in juiciness or flavor, a subject was 8% and 4% less likely to prefer the taste of grass-fed beef, respectively.

When it comes to socio-demographic variables, only the number of children in a subject's household (*CHILDREN*) had a statistically significant and negative influence on her/his taste preference. With one more child in the household, the subject was expected to be 4% less likely to prefer grass-fed beef. An explanation for this could be that parents may consider not only themselves but also their children's acceptance of the taste of grass-fed beef. If they sense the taste of grass-fed beef to be different from the type of beef their children typically consume at home, they may be hesitant to vote for grass-fed beef.

The beef consumption behavior variables, the frequency of consuming beef prepared away from home (*FAWAY)* and the preferred doneness of beef steak *(DONE)* had statistically

significant and negative influences on the probability that subjects preferred the taste of grass-fed beef. The increase of one frequency level of consuming beef away from home, (e.g., “Once or twice a week” to “Three times or more a week”) would lead to an 8% decrease of probability of preferring grass-fed beef. The negative impacts of *FAWAY* on taste preference may be attributed to the lower frequency of cooking at home and less peer influences at home. In terms of living status, the more frequently a subject consumed beef away from home, the less likely s/he lived with family and was affected by family members and the eating habits from their origins. With respect to *DONENESS*, for one "level" increase in preferred doneness of beef steak (e.g., from "medium" to "medium-well”), a subject was 6% less likely to prefer the taste of grass-fed beef. The fact that Hispanic consumers who typically like beef steak to be cooked well-done were less likely to prefer the taste of grass-fed beef was reflected by the descriptive statistics (see Table 4.4.). More grass-fed preferring consumers (30%) stated preferring beef cooked less well-done whereas the percentage was only 19% among conventional grain-fed preferring subjects.

Preferences for the taste of grass-fed beef were also significantly influenced by the frequency of reading nutrition labels when purchasing food (*FL_NUTRI*) and whether the subject had purchased specialty meat products labeled as “Natural,” “Organic,” or “Free-Range” (*LABELING*). One level increase in frequency of reading nutrition labels (*FL_NUTRI*) (e.g. from “Rarely” to “Sometime”) would cause a 5% increase in the probability of preferring the taste of grass-fed beef. Subject who had prior experience with specialty meat products would be 11% more likely to prefer the taste of grass-fed beef.

6.2. Estimation Results of WTP Models

Table 6.4. reports the estimation results of Hispanic consumers’ WTP for grass-fed beef using the standard Tobit model, Heckman’s two-step sample selection procedure, and

Cragg's double-hurdle model. The dependent variable in the three models was Hispanic consumers' WTP, which was defined as the price premium for grass-fed beef when compared with conventional grain-fed beef. Following the discussion on chapter V about WTP, the dependent variable was left censored at zero and 49% of the observations were with zero WTP due to non-participation.

In the standard Tobit model, both the decisions of whether to participate in the MPL experiment (i.e. overall preferring grass-fed beef) and how much to pay a premium for grass-fed beef given participation were captured in the $\boldsymbol{\beta}$ parameters. In Cragg's double-hurdle model, the participation decision was embodied in $\boldsymbol{\gamma}$, and $\boldsymbol{\beta}$ represented the second decision of WTP premium. A LR test was conducted to examine whether to accept the null hypothesis that $\gamma = \frac{\boldsymbol{\beta}}{\boldsymbol{\sigma}}$. If the null hypothesis is rejected and the Tobit model is used, coefficient estimates will be biased and inferences can be misleading. The LR test statistic was specified as: $\lambda = -2(\ln L_{Tobit} - \ln L_{double-hurdle})$. The null hypothesis was rejected at the 0.05 level where $\chi^2_{df=22}$=33.92 as the likelihood ratio statistic λ=72.39.

Unlike the standard Tobit model, both Heckman's sample selection model and Cragg's double-hurdle model used the information of MPL participation decisions and WTP premiums. The estimated coefficients distinguished the effects of various factors on WTP from their effects on the participation probability. However, the Heckman's sample selection model is subject to the first-hurdle dominance assumption; therefore it may lead to different estimates from those by Cragg's double-hurdle model. As shown in Table 6.4., the explanatory variables in these two models have the same signs, but their magnitudes and significances are different. For example, approximately, 80% of independent variables have more than 20% of change in magnitudes between the two models.

Table 6.4. Estimation Results of WTP by the Standard Tobit Model, Heckman's Two-Step Procedure, and Cragg's Double-Hurdle Model

	Tobit	Heckman's Two-Step		Cragg's Double-Hurdle	
		Participation	WTP	Participation	WTP
Variable	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)
VISUAL	5.158*** (.897)	2.521*** (0.456)		2.133*** (0.353)	
TASTE	4.823*** (0.765)	2.824*** (0.442)		1.924*** (0.302)	
ENDOWMENT	0.505 (1.000)		0.606 (0.676)		0.475 (0.881)
TREATMENT^{+}	1.208 (0.990)	0.072 (0.338)	1.360* (0.673)	0.353 (0.295)	1.698 (0.907)
FEMALE^{+}	-0.465 (0.772)	-0.254 (0.308)	-0.044 (0.551)	-0.555* 0.278)	1.28 (0.721)
AGE	-0.046 (0.028)	-0.005 (0.012)	-0.043** (0.019)	-0.009 (0.01)	-0.057** (0.026)
EDUCATION	-0.503* (0.274)	-0.021 (0.105)	-0.329* (0.189)	-0.037 (0.091)	-0.594** (0.251)
INCOME	0.077 (0.153)	0.014 (0.059)	0.109 (0.118)	0.027 (0.053)	0.143 (0.156)
ADULTS	-0.891** (0.358)	-0.202 (0.132)	-0.734*** (0.254)	-0.216* (0.119)	-0.769** (0.343)
CHILDREN	0.615* (0.313)	0.130 (0.127)	0.128 (0.220)	0.257** (0.117)	-0.150 (0.276)
MEXICAN^{+}	0.929 (2.305)	0.661 (0.806)	0.001 (1.708)	0.666 (0.751)	0.436 (2.333)
SALHON^{+}	-2.357 (2.710)	-1.336 (0.930)	1.941 (2.076)	-0.895 (0.856)	1.869 (2.734)
COLOMBIAN^{+}	0.176 (2.444)	0.692 (0.880)	-2.165 (1.878)	0.55 (0.785)	-2.995 (2.494)
PEER_MEX	-0.828** (0.434)	-0.017 (0.189)	-0.516* (0.305)	-0.191 (0.167)	-0.743** (0.39)
PEER_SAL	0.334 (0.618)	0.452** (0.224)	-0.872* (0.459)	0.18 (0.197)	-0.711 (0.575)
PEER_COL	-0.815 (0.967)	-0.489 (0.406)	0.833 (0.771)	-0.497 (0.331)	1.35 (0.911)
PEER_OTH	-1.383 (1.044)	-0.091 (0.317)	-0.937 (0.754)	-0.36 (0.325)	-0.353 (1.116)
ACCULTURATION	-0.206 (0.350)	-0.013 (0.141)	-0.319 (0.243)	-0.124 (0.129)	-0.186 (0.312)
FHOME	0.221 (0.451)	0.109 (0.180)	-0.236 (0.328)	0.098 (0.159)	-0.349 (0.409)

FAWAY	0.637* (0.371)	0.162 (0.139)	-0.016 (0.266)	0.26** (0.128)	-0.035 (0.406)
FL_NUTRI	0.757** (0.344)	0.267** (0.130)	0.573* (0.264)	0.191* (0.115)	0.641* (0.368)
LABELING^{+}	1.288* (0.816)	0.509* (0.311)	0.015 (0.612)	0.35 (0.273)	0.55 (0.799)
MBLING	-0.062 (0.317)	0.071 (0.117)	-0.039 (0.241)	0.06 (0.109)	-0.202 (0.295)
CONS	-4.841 (3.877)	-4.281*** (1.484)	7.835*** (2.729)	-2.681** (1.308)	8.066** (3.63)
Log Likelihood	-327.086			-285.554	
Rho		0.358		0	
Inverse Mills Ratio		0.855 (0.652)			
AIC		750.130		663.109	
BIC		909.846		819.006	

*, **, ***denote significance at the 10%, 5%, and 1% levels, respectively.
Number of observations=219

According to the post-estimation results (see Table 6.4), the Heckman's sample selection model has relatively bigger values of AIC (750.130) and BIC (909.846) than Cragg's double-hurdle model (AIC= 663.109 and BIC=819.006). Moreover, theoretically speaking, Cragg's double-hurdle model is superior to Heckman's sample selection model in this study as it accounts for different sources of zero observations of WTP.

Given the results from the LR test and post-estimation, Cragg's double-hurdle model seems better than the standard Tobit model and Heckman's sample selection model. The following discussion of the study focuses on the estimated coefficients from Cragg's double-hurdle model.

6.2.1. Estimation Results—Participation Choice

The estimation results of consumers' participation decisions (i.e. overall preferences for grass-fed beef) by Cragg's double-hurdle model are reported in Table 6.4. In this model, there were two hurdles to pass in order to observe positive WTP. The first hurdle determined consumers' participation, thus the dependent variable was binary with the value of one for

participation and the value of zero for non-participation. The fourth column of Table 6.4. and the fifth column of Table 6.5. display the estimated coefficients and corresponding marginal effects of participation decisions in Cragg's double-hurdle model. Visual and taste preferences (*VISUAL* and *TASTE*) were strongly significant as anticipated. Visually preferring grass-fed beef would increase the probability of participation by 64% whereas the probability increased by 66% due to preference for the taste of grass-fed beef. Male subjects were 21% more likely to prefer grass-fed beef. The number of children in the household (*CHILDREN*) was statistically significant and carried a positive sign. One more child in a subject's household would increase the probability of participation by 10%. In contrast, the number of adults at home *(ADULTS)* was significantly negative and suggested that the fewer adult family members in a subject's household, the higher the probability of her/his participation. The probability of participation would decrease 10% with one more adult at home. The opposite effects of the number of adults *(ADULTS)* and the number children at home (*CHILDREN*) suggested that the parents' participation decisions (i.e. preference for grass-fed beef) were primary for children rather than the adults at home. Unlike the Heckman's sample selection model, none of the variables on countries of origin (e.g. *MEXICAN, SALHON,* and *COLOMBIAN)* had significant impacts on the probability of participation. Likewise, the interaction effects between country of origin and *NEIGHBOR* were not detected to have significant influences on the probability of participation either.

With regards to beef consumption behavior, few independent variables were significant. The frequency of consuming beef prepared away from home (*FAWAY)* had a statistically significant positive influence on the probability of participation. One more frequency level of consuming beef away from home, (e.g., from "Once or twice a week" to "Three times or more a week") would lead to a 10% increase of probability that the Hispanic subject preferred grass-fed beef and participated in the MPL experiment. The frequency of reading

Table 6.5. Marginal Effects by the Standard Tobit Model, Heckman's Two-Step Procedure, and Cragg's Double-Hurdle Model

Variable	Standard Tobit Model		Heckman's Two-Step		Cragg's Double-Hurdle	
	Unconditional Expected Values	Conditional on Being Uncensored	Participation	WTP	Participation	WTP
	dy/dx (S.E.)	dy/dx (S.E.)	dy/dx (S.E.)	dy/dx (S.E.)	dy/dx (S.E.)	dy/dx (S.E.)
VISUAL^{+}	1.85*** (0.361)	1.521*** (0.281)	0.780*** (0.078)	-	0.638*** (0.066)	-
TASTE^{+}	2.19*** (0.308)	1.661*** (0.239)	0.821*** (0.078)	-	0.658*** (0.076)	-
ENDOWMENT^{+}	0.202 (0.402)	0.157 (0.313)		0.606 (0.676)		0.475 (0.882)
TREATMENT^{+}	0.453 (0.398)	0.362 (0.310)	0.029 (0.135)	1.360* (0.673)	0.128 (0.102)	1.698 (0.907)
FEMALE^{+}	-0.19 (0.310)	-0.147 (0.241)	-0.101 (0.121)	0.012 (0.556)	-0.211* (0.105)	1.28 (0.721)
AGE	-0.018 (0.011)	-0.014 (0.009)	-0.002 (0.005)	-0.043** (0.019)	-0.003 (0.004)	-0.057** (0.026)
EDUCATION	-0.202* (0.110)	-0.157* (0.086)	-0.008 (0.042)	-0.329* (0.189)	-0.014 (0.034)	-0.594** (0.251)
INCOME	0.031 (0.061)	0.024 (0.048)	0.006 (0.024)	0.109 (0.118)	0.01 (0.02)	0.143 (0.156)
ADULTS	-0.364** (0.146)	-0.281** (0.113)	-0.085 (0.053)	-0.738*** (0.257)	-0.082* (0.045)	-0.769** (0.343)
CHILDREN	0.251** (0.128)	0.194** (0.099)	0.052 (0.051)	0.129 (0.127)	0.097** (0.044)	-0.150 (0.276)
MEXICAN^{+}	0.386 (0.927)	0.297 (0.721)	0.257 (0.299)	0.001 (1.708)	0.253 (0.283)	0.436 (2.333)
SALHON^{+}	-0.804 (1.090)	-0.67 (0.848)	-0.471* (0.250)	1.941 (2.076)	-0.292 (0.228)	1.869 (2.734)
COLOMBIAN^{+}	0.072 (0.983)	0.055 (0.764)	0.264 (0.310)	-2.165 (1.878)	0.213 (0.305)	-2.995 (2.494)
PEER_MEX	-0.333** (0.175)	-0.259** (0.136)	-0.007 (0.075)	-0.516* (0.305)	-0.082 (0.013)	-0.199** (0.078)
PEER_SAL	0.134 (0.248)	0.104 (0.193)	0.180** (0.089)	-0.872* (0.459)	0.095 (0.019)	-0.854 (0.491)
PEER_COL	-0.328 (0.389)	-0.255 (0.303)	-0.195 (0.162)	0.833 (0.771)	-0.069 (0.023)	1.368 (0.248)
PEER_OTH	-0.556 (0.420)	-0.433 (0.326)	-0.036 (0.127)	-0.937 (0.754)	-0.058 (0.019)	-1.448 (1.616)
ACCULTURATION	-0.083 (0.141)	-0.064 (0.110)	0.001 (0.056)	-0.319 (0.243)	-0.046 (0.049)	-0.186 (0.312)
FHOME	0.089 (0.181)	0.069 (0.141)	0.044 (0.072)	-0.236 (0.328)	0.037 (0.06)	-0.349 (0.409)
FAWAY	0.256* (0.149)	0.199* (0.116)	0.065 (0.056)	0.027 (0.272)	0.098** (0.048)	-0.035 (0.320)
FL_NUTRI	0.305** (0.138)	0.237** (0.108)	0.107** (0.052)	0.573* (0.264)	0.072* (0.043)	0.641* (0.368)
LABELING^{+}	0.489 (0.328)	0.389* (0.255)	0.200* (0.119)	0.015 (0.612)	0.128 (0.096)	0.55 (0.799)
MBLING	-0.025 (0.127)	-0.019 (0.099)	0.028 (0.047)	-0.039 (0.241)	0.022 (0.041)	-0.202 (0.295)

Note: Marginal effects evaluated at the means of the independent variables. ($^{+}$) dy/dx is for discrete change of dummy variable from 0 to 1.
*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

nutrition labels when purchasing food (*FL_NUTRI*) was also statistically significant and positive. Marginal effects revealed that subjects who read nutrition labels more frequently (e.g. from "Sometime" to "Most of the time") were 7% more likely to prefer grass-fed beef.

6.2.2. Estimation Results—WTP

The estimated coefficients and their marginal effects on WTP by Cragg's double-hurdle model are presented in the fifth column of Table 6.4. and the sixth column of Table 6.5., respectively. In the WTP equation, marginal effects were computed based uncensored observations, that is, WTP given participation.

With respect to social-demographic variables, age (*AGE*), education attainment (*EDUCATION*), and the number of adults at home (*ADULTS*) were statistically significant, which means that subjects who were younger, less-educated, and from a household with fewer adult family members were more willing to pay a premium for grass-fed beef. Specifically, the marginal effects of *AGE* revealed that for one year younger in age, WTP for grass-fed beef increased by $0.06. Grass-fed preferring subjects who were willing to pay a premium also tended to be less educated. For each level decrease in education attainment (e.g., from "Bachelor's degree" to "Some college"), subjects were willing to pay $0.59 more for grass-fed beef. Among subjects with education levels at some college or above, a significant fraction of them were recruited from students at Virginia Tech. These subjects were with relatively low income, which possibly resulted in their small WTP for grass-fed beef. In other words, the variable *EDUCATION* might have captured income effects to some extent.

The number of adults in a subject's household (*ADULTS*) exerted negative influences on consumer WTP for grass-fed beef: one more adult family member in the household would decrease the subject's WTP by $0.77. The number of children in the household was

insignificant, but it carried a negative sign, which was consistent to the findings on mainstream consumers by Umberger et al's (2007). That is, consumers were more likely to pay a price premium for grass-fed beef if there were more children at home. Moreover, the combined negative effects of household size (the number of adults plus the number of children at home) may be due to tight budgets in larger-sized households.

The variable *PEER_MEX*, which controlled for the interaction effects of *MEXICAN* and *NEIGHBOR*, was statistically significant and negative. Mexican or Mexican-American subjects who lived in a neighborhood with fewer people originated from the same country were willing to pay more for grass-fed beef. Marginal effects indicated that for each level decrease of *NEIGHBOR* (e.g. from "Many" to "Some"), the Mexican or Mexican-American subject was willing to pay a premium of $0.20. As in the participation equation, none of the variables for countries of origin was significant.

For beef consumption behavior, only the frequency of reading nutrition labels (*FL_NUTRI*) was statistically significant. Subjects who read nutrition/health labels more frequently were willing to pay more for grass-fed beef. Each one level increase in the frequency of reading nutrition labels (*FL_NUTRI*) translated into $0.64 of WTP.

Order effects of visual and taste preferences were captured by the *TREATMENT* variable. However, no statistical significance was detected for order effects; therefore, the order of visual evaluation and taste test didn't influence subjects' overall preferences and WTP for grass-fed beef.

A comparison of the results between the standard Tobit model, Heckman's sample selection, and Cragg's double-hurdle model (see Table 6.4. and 6.5.) again confirmed the clear differences between the three models and call our attention to select the proper model in order for accurate interpretation of results, which depends on the research objective, experimental design, and data availability.

CHAPTER VII

DISCUSSION OF RESULTS AND IMPLICATIONS FOR THE PROMOTION OF GRASS-FED BEEF TO THE HISPANIC MARKET

7.1. Summary of Descriptive and Estimation Results

In order to understand Hispanic consumer preferences and WTP for grass-fed beef versus conventional grain-fed beef, surveys, sensory evaluations, and MPL experiments were conducted in laboratories in four experiment sites of Virginia. Results suggest a potential promising market for grass-fed beef among the fast-growing Hispanic population in Virginia.

Out of 231 Hispanic subjects who assessed the appearance and taste of grass-fed beef vs. conventional grain-fed beef, 51% of them reported overall preferences for grass-fed beef. The percentage of Hispanic consumers who preferred grass-fed beef was higher than that in other studies on mainstream consumers (e.g. Kerth et al. 2004; Sitz et al. 2005; Umberger et al. 2002). The findings by Sitz et al. (2005) indicate that only 19% of domestic consumers prefer Australian grass-fed beef to domestic grain-fed beef. Umberger et al. (2002) indicate that about 25% of Caucasian participants prefer the flavor of Argentine grass-fed to domestic corn-fed beef.

Based only on visual appearance and with no information about beef types, 60% of Hispanic respondents visually preferred grass-fed beef over conventional grain-fed beef. In contrast to their visual preferences, only 40% of Hispanic respondents preferred the taste of grass-fed beef over conventional grain-fed beef after sampling the two types of beef.

Nevertheless, visual and taste preferences were not always consistent; 49% of grass-fed preferring subjects stated consistent visual and taste preferences for grass-fed beef (see Table 4.7.). This percentage was much higher than the findings for mainstream consumers by Umberger (2002). Out of the remaining 51% of subjects, however, 18% of them preferred the taste of grass-fed beef but not its appearance while 33% preferred the appearance of grass-fed

beef but not its taste. The discrepancy indicates a likely mismatch between consumer purchase behavior and taste experience.

For visual preferences, Hispanic subjects, in general, perceived grass-fed beef's lean meat, fat, and meat texture to be darker, yellower, and finer than conventional grain-fed beef, respectively. However, among the three visual attributes, only meat texture was statistically significant. It seems that Hispanic subjects based their visual preferences on factors other than intrinsic cues. For example, subjects who were more concerned about the presence of marbling showed strong preferences for the appearance of grass-fed beef. Eighty-four percent of grass-fed preferring subjects rated marbling as an important or more than important factor in their beef purchase decisions. In contrast, three taste attributes, tenderness, juiciness and flavor had strong, significant influences on consumers' taste preferences. In general, Hispanic subjects perceived grass-fed beef to be tougher and juicier than conventional grain-fed beef (yet with comparable taste intensity). The probability of preferring the taste of grass-fed beef increased if subjects found it tenderer, juicier, and more flavorful than conventional grain-fed beef. In terms of both significance and magnitude, visual and taste preferences were the primary determinants in Hispanic subjects' overall preferences for grass-fed beef.

Several consumer socio-demographic characteristics were revealed to significantly influence subjects' overall preferences for grass-fed beef. Grass-fed preferring subjects were more likely to be male and from households with more children but fewer adults. However, the number of children in a subject's household adversely affected her/his taste preference for grass-fed beef. One possible explanation is that parents may be hesitant to accept the taste of grass-fed beef since they consider not only their preferences but also their children's acceptances. As a comprehensive appraisal, parents' overall preferences may be influenced by factors other than immediate sensory evaluations, for example, their health concerns and attitudes. Subjects with origin in Mexico or Colombia and with higher acculturation degrees

were more likely to prefer the appearance of grass-fed beef. This contradicted the expectation that highly acculturated Hispanic consumers would have similar preferences to mainstream consumers and would be more likely to prefer the visual attributes of conventional grain-fed beef. Possible explanation was due to the low frequency of in-home cooking and the living status of more acculturated subjects, which suggests that these subjects may be less knowledgeable of how to purchase beef and be less influenced by family members and traditional ethnic culture. Additionally, the joint probability of preferring both the appearance and taste of grass-fed beef decreased as subjects' acculturation degree increased.

Consumers' beef purchase and consumption behavior also affected their preferences for grass-fed beef. The frequency of consuming beef away from home had significant and positive impacts on overall preferences. The probability of preferring grass-fed beef increased when subjects ate beef steak away from home more frequently. Contrary to our expectations, grass-fed preferring subjects tended to like beef cooked less than well-done. These results are supported by the descriptive statistics presented in Figure 7.1. Compared to conventional grain-fed preferring subjects (19%), more grass-fed preferring subjects (31%) preferred beef cooked to medium or less well-done.

Although information about the health/nutrition benefits of grass-fed beef was not revealed during the whole experiment, some variables may suggest subjects' potential health attitudes. As illustrated in Figures 7.2., 7.3., and 7.4., a higher percentage of grass-fed preferring consumers read nutrition labels most of the time or always than conventional grain-fed preferring subjects (57% vs. 42%). Likewise, 82% of grass-fed preferring subjects considered the presence of marbling to be important or more whereas 74% of conventional grain-fed preferring subjects had the same rankings.

The majority of grass-fed preferring subjects (74%) had prior experience with specialty meat products labeled "Natural," "Organic," and "Free Range" while the percentage

Figure 7.1.: Preferred Doneness of Beef Steaks between by Grass-Fed and Conventional Grain-Fed Preferring Subjects

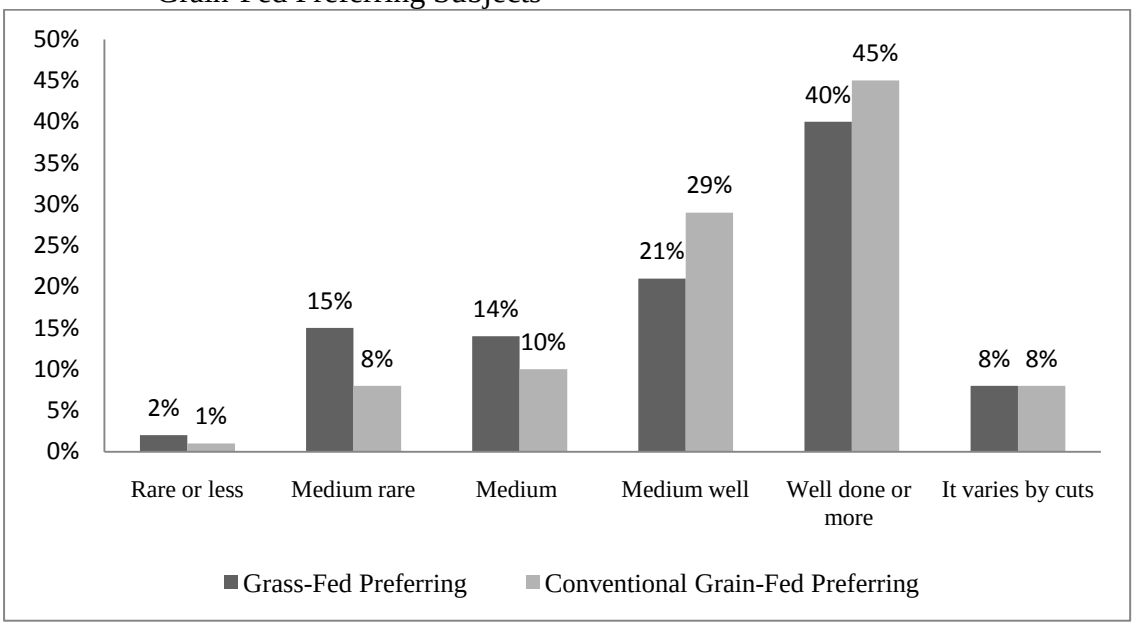


Figure 7.2.: Frequency of Reading Nutrition Labels between Grass-Fed and Conventional Grain-Fed Preferring Subjects

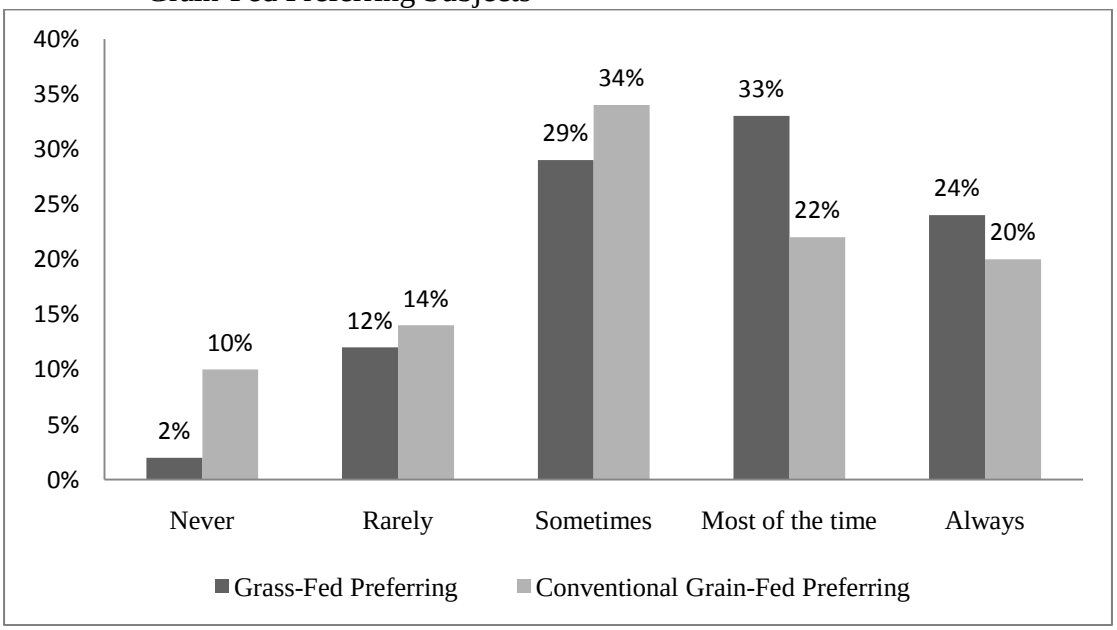


Figure 7.3.: Importance of Marbling in Beef Purchase Decisions between Grass-Fed and Conventional Grain-Fed Preferring Subjects

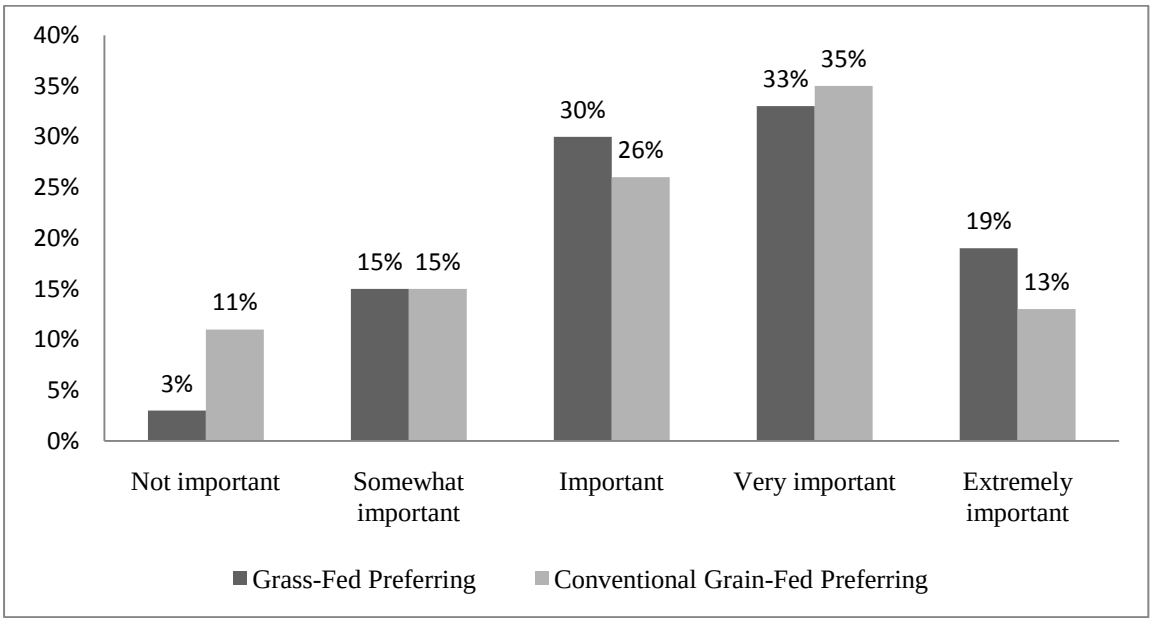
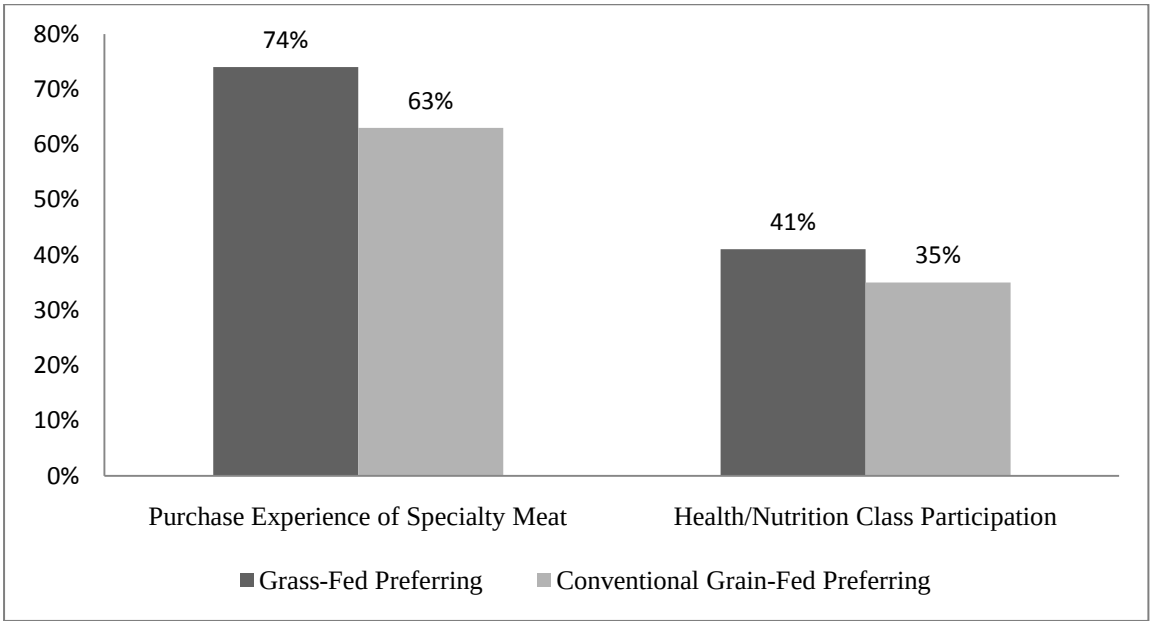


Figure 7.4.: Experience with Specialty Meat and Health/Nutrition Class Participation between Grass-Fed and Conventional Grain-Fed Preferring Subjects



decreased to 63% for conventional grain-fed preferring subjects. Also, more grass-fed preferring subjects ever took a health/nutrition class than conventional grain-fed preferring subjects. Moreover, subjects who read nutrition labels more often were more likely to have prior experience with specialty meat products, and be concerned about the presence of marbling (see Table 7.4.). Estimation results reveal that the frequency of reading nutrition labels and prior experience with specialty meat products positively influenced their overall and taste preferences for grass-fed beef. This also suggests that a satisfying consumption experience may determine consumer repeat purchases in the future. Although these variables could not directly explain subjects' health consciousness, they may have a potential correlation to subjects' health attitudes.

Through MPL experiments, only 16 grass-fed preferring subjects (14% of observations) bid zero. The vast majority of the Hispanic subjects who preferred grass-fed beef (86%) were willing to pay a price premium for grass-fed beef. Umberger et al. (2002) found that 60% of grass-fed preferring mainstream consumers were willing to pay a premium for it, much lower than the percentage of Hispanic consumers in this study. Younger and less-educated subjects were willing to pay more for grass-fed beef. Subjects who have a larger household were less willing to pay a price premium than those with smaller ones. This may be explained as a tighter budget constraint in a big family.

Income was insignificant in WTP model; however, the variables *NEIGHBOR* or country of origin may have partially captured income effects. Table 7.1. indicates that the average incomes ranged from $60,000 to $80,000 for subjects living in neighborhoods without same-country neighbors in contrast to ranges of 20,000 - $40,000 for subjects living in neighborhoods full of people from the same country. As subjects who lived in a neighborhood with fewer same-country neighbors had relatively high incomes, they were also willing to pay more for grass-fed beef. Subjects living with no same-country neighbors, on

average, were willing to pay $1.46 more than subjects living in a neighborhood full of same-country neighbors (see Tables 7.1. and 7.3.).

The income differences may be reflected across countries of origin. Subjects from Colombia or the "other" countries had higher average incomes than those from Mexico and El Salvador/Honduras (see Table 7.2.). Mexican and El Salvadoran/Honduran subjects had lower average acculturation degrees than subjects from Colombia or the "other" countries and tended to live in neighborhoods with more people from the same countries. Moreover, the interaction effects between income and *NEIGHBOR* varied across countries of origin (see Table 7.3.). For example, Mexican grass-fed preferring consumers who lived in a neighborhood with fewer same-country neighbors had relatively high income.

Consumers' potential health attitudes may influence their WTP. Table 7.4. shows that WTP increased for grass-fed preferring subjects who read nutrition labels more frequently. The grass-fed preferring consumers who read nutrition labels frequently had higher WTP than those who never read them ($4.05 vs. $2.95, respectively). Higher percentage of subjects who read nutrition labels most of the time or always preferred grass-fed beef than those who rarely read the labels. More of these subjects reading nutrition labels very frequently had prior experience with specialty meat products and were more concerned about presence of marbling when purchasing beef products.

The average price premium by grass-fed preferring subjects was $3.62/lb. Conditional on positive bids, the average price premium reached $4.23/lb. As illustrated in Figures 4.11. and 4.12., approximately 86% of the grass-fed preferring subjects would choose to purchase grass-fed beef at a premium of at least $1.00/lb. Approximately 78% of grass-fed preferring subjects were willing to pay at least $2.00/lb more for grass-fed beef whereas more than 50% of them would like to purchase the product by paying a premium of at least $3.00/lb. Given the average price premium of $3.62/lb, a price premium of $3.00/lb seems

Table 7.1. Interactions between Peer Effects and Relevant Variables

Peer Effects	#of Subjects (%)	#of Grass-Fed Preferring Subjects (%)	WTP (S.E.)	Income (S.E.)	Acculturation Degree (S.E.)	Years of Residence in the U.S. (S.E.)	Freq of Reading Nutrition Labels (S.E.)	Labeling (%)	The Importance of Marbling (S.E.)
Almost none or none	85 (37%)	44 (52%)	3.95 (2.88)	4.98 (2.89)	6.41 (1.28)	16.41 (13.30)	3.45 (1.12)	56 (66%)	3.48 (1.14)
Few	59 (26%)	30 (51%)	3.63 (2.81)	4.13 (2.69)	5.98 (1.20)	10.74 (9.52)	3.31 (1.45)	49 (83%)	3.54 (1.10)
Some	39 (17%)	18 (46%)	3.71 (3.10)	2.97 (2.03)	5.87 (1.20)	13.81 (14.28)	3.59 (1.14)	26 (67%)	3.21 (1.09)
Many	31 (13%)	16 (52%)	3.16 (2.06)	3.12 (1.85)	5.19 (1.11)	10.81 (8.97)	3.90 (1.12)	18 (58%)	3.13 (1.09)
All or almost all	16 (7%)	9 (56%)	2.49 (1.17)	2.44 (2.25)	4.0 (0.89)	11.87 (9.80)	3.13 (1.15)	8 (50%)	2.94 (1.29)
Kruskal-Wallis H Test statistic		0.423	2.728	28.556***	46.519 ***	8.362*	7.918*	6.585	5.845

*, **, ***denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7.2. Interactions between Country of Origin and Relevant Variables

Country of origin	#of Subjects (%)	#of Grass-Fed preferring Subjects (%)	WTP (S.E.)	Income (S.E.)	Acculturation Degree (S.E.)	Years of Residence in the U.S. (S.E.)	Peer Effects (S.E.)	Freq of Reading Nutrition Labels (S.E.)	Labeling (%)	The Importance of Marbling (S.E.)
Mexico	82 (36%)	48 (59%)	3.40 (2.29)	3.72 (2.52)	5.46 (1.44)	15.97 (14.90)	2.69 (1.42)	3.30 (1.09)	49 (60%)	3.32 (1.06)
El Salvador /Honduras	53 (23%)	23 (43%)	4.07 (3.31)	3.52 (2.81)	5.43 (1.20)	10.70 (7.54)	2.83 (1.16)	3.83 (1.26)	41 (77%)	3.24 (1.25)
Colombia	50 (22%)	27 (54%)	3.74 (2.47)	4.46 (1.98)	6.24 (0.98)	10.01 (8.57)	1.42 (0.78)	3.40 (1.11)	33 (66%)	3.47 (1.10)
Other	46 (19%)	20 (43%)	3.6 (3.44)	4.50 (3.31)	6.70 (1.26)	16.92 (12.33)	1.84 (0.92)	3.48 (1.07)	35 (76%)	3.46 (1.15)
Kruskal-Wallis H Test statistic		3.218	2.44	9.880**	32.344***	14.105***	45.704***	7.719*	3.999	1.100

*, **, ***denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7.3. Interactions between Peer Effects and Income

Peer Effects	#of Subjects (%)	#of Grass-Fed Preferring Subjects (%)	Income (S.E.)	Income of Mexican (S.E.)	Income of Salvadoran/Honduran (S.E.)	Income of Colombian (S.E.)	Income of Other Hispanics (S.E.)
Almost none or none	85 (37%)	44 (52%)	4.98 (2.89)	5.48 (2.91)	5.00 (4.20)	4.64 (2.06)	5.05 (3.78)
A Few	59 (26%)	30 (51%)	4.13 (2.69)	3.71 (1.96)	3.82 (3.19)	3.89 (1.90)	5.06 (3.13)
Some	39 (17%)	18 (46%)	2.97 (2.03)	3.08 (1.85)	3.00 (2.30)	5.33 (0.58)	1.71 (1.25)
Many	31 (13%)	16 (52%)	3.12 (1.85)	3.25 (2.41)	2.70 (0.95)	2.50 (0.71)	4.33 (0.58)
All or almost all	16 (7%)	9 (56%)	2.44 (2.25)	1.73 (0.90)	4.00 (3.54)	-	-
Kruskal-Wallis H Test Statistic		0.423	28.556***	19.321***	1.134	6.279*	7.259*

*, **, ***denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7.4. Interactions between the Frequency of Reading Food Nutrition Labels and Relevant Variables

The Frequency of Reading Nutrition labels	#of Subjects (%)	#of Grass-Fed Preferring Subjects (%)	WTP (S.E)	Acculturation Degree (S.E.)	Years of Residence in the U.S. (S.E)	Labeling (%)	The Importance of Marbling (S.E.)
Never	13 (6%)	2 (15%)	2.95 (1.34)	5.23 (1.24)	8.00 (4.43)	6 (46%)	2.31 (1.49)
Rarely	30 (13%)	14 (47%)	2.83 (1.99)	6.07 (1.26)	9.62 (8.96)	17 (57%)	3.45 (1.09)
Sometimes	72 (31%)	34 (47%)	3.46 (2.69)	5.64 (1.36)	14.06 (13.20)	43 (60%)	3.22 (1.05)
Most of the time	64 (28%)	39 (61%)	3.97 (2.64)	6.23 (1.31)	14.86 (13.83)	47 (73%)	3.58 (1.02)
Always	51 (22%)	28 (55%)	4.05 (3.25)	5.82 (1.41)	14.94 (10.54)	44 (86%)	3.52 (1.16)
Kruskal-Wallis H Test statistic		7.051	2.097	10.548**	9.592**	10.126**	10.678**

*, **, ***denote significance at the 10%, 5%, and 1% levels, respectively.

reasonable. It is representative of a significant proportion of the beef steak market since this price premium was acceptable to at least 50% of grass-fed preferring subjects. According to the prices of grass-fed beef steaks provided by Slanker's Grass-Fed Meat[15], New York Strip steak is $11.78/lb, which is similar to our suggested price for the same cuts. Other beef cuts from Slanker's are in the price range of $6.00 to$25.00. Our suggested price may provide a reference for pricing other beef cuts in the Hispanic market. It is worth noting that the pricing strategies cannot be extended to roasts and ground beef since this study is focused on beef steaks.

Regarding the market potential of grass-fed beef among the Hispanic population, the following conclusions can be obtained from the study:

- There exists a potential promising Hispanic market for grass-fed beef in Virginia. A significant proportion of Hispanic subjects preferred grass-fed beef over conventional grain-fed beef and the vast majority of grass-fed preferring subjects were willing to pay a price premium for it.
- Hispanic consumers can distinguish the appearance and taste between grass-fed beef and conventional grain-fed beef. Out of the six sensory attributes, meat texture, tenderness, juiciness, and flavor markedly influenced of Hispanic consumers' visual and taste preferences for grass-fed beef. Visual and taste satisfactions directly translate to overall preferences for grass-fed beef. However, the criteria subjects utilized to select beef may lead to unfavorable eating experience. Since a discrepancy may exist between visual expectation and taste experience, information and marketing efforts could be provided to consumers to make more consistent choices.
- Consumer characteristics influence Hispanic consumers' preferences and WTP for

[15]: The marketing company of Ted Slanker's ranch that is located in the Red River Valley of northeast and provi des grass-fed meat products. Grass-fed beef cuts and prices are available at: http://www.texasgrassfedbeef.com/beef_cuts_and_prices.htm.

grass-fed beef. Specifically speaking, gender, household size (i.e. the number of adults and children at home) affected subjects' overall preferences for grass-fed beef whereas age, education attainment, and the number of adults at home had significant impacts on subjects' WTP for grass-fed beef. Moreover, subjects' WTP varied across ethnic subgroups and was affected by the level of peers living in the current neighborhoods.

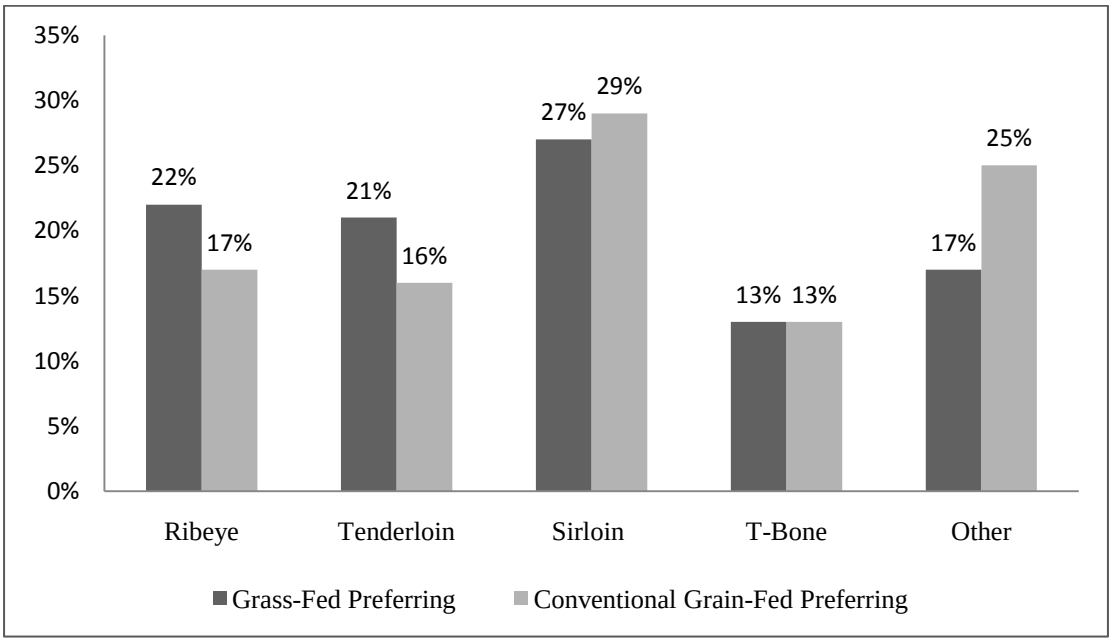
- Compared to conventional grain-fed preferring subjects, grass-fed preferring subjects were more likely to read nutrition labels when purchasing food, more concerned about the presence of marbling, were more knowledgeable about health/nutrition, and had more experience with specialty meat products. The potential health-related behavior of grass-fed preferring subjects influenced their preferences and WTP for grass-fed beef.

The study also revealed other characteristics and beef consumption behavior of Hispanic subjects who preferred grass-fed beef, which may help better target the potential Hispanic market for grass-fed beef.

For the sample considered in this study, grass-fed preferring subjects, on average, had stayed longer in the U.S. than conventional grain-fed preferring subjects. Most of grass-fed preferring subjects (81%) live with family (this rate was 70% among conventional beef-preferring subjects), implying stronger family or ethnic cultural influences among them. In addition, 70% of grass-fed preferring subjects were employed in full-time jobs. As presented in Figure 7.5., the most frequently purchased beef cuts by grass-fed preferring subjects were sirloin (27%), ribeye (22%) and tenderloin (21%).

Supermarkets/retail grocery stores were the primary outlets from which Hispanic subjects purchased beef (see Table 4.4.). However, many grass-fed preferring subjects also purchased beef frequently from international/ethnic food stores (38%), health/natural food

Figure 7.5.: Frequently Purchased Beef Cuts between by Grass-Fed and Conventional Grain-Fed Preferring Subjects



stores (29%), and farmers' markets ((19%). For the shopping environment, 36% of grass-fed preferring consumers preferred to use their non-English native language or both English and their native language when shopping for food while 64% of them primarily used English.

7.2. Marketing Implications

In order to attract potential Hispanic consumers, sirloin, ribeye, and tenderloin could be the main cuts of grass-fed beef steaks for sale in the market. The main marketing outlets of grass-fed beef could be supermarkets/retail grocery stores, international/ethnic food stores, and farmers' markets. According to Mainville et al. (2009), however, specialty beef products including grass-fed beef in Virginia are primarily sold through market outlets such as direct marketing (accounting for 74% of beef producers), natural food stores, farmers' markets, and restaurants. In this study, only a small percentage of subjects chose direct marketing as a frequently-visited market outlet. In order to access to potential Hispanic consumers of grass-fed beef, it would be a feasible practice for beef producers to cooperate with the

supermarkets/grocery chain stores and serve grass-fed beef in these outlets, especially those stores that are willing to launch programs to meet consumers' demand for special beef attributes and support local beef producers. In addition, expanding affordable advertising may help increase direct sales of grass-fed beef from producers to Hispanic consumers.

As indicated by Thomas Tseng (Ross 2003), Hispanic consumers treat shopping as a social activity. They value social communication opportunities and favor an inviting atmosphere when shopping. Hence, bilingual employees and bilingual signage such as product labels and packaging may create a friendly shopping environment to Hispanic customers; it could also help retailers understand Hispanic consumers' needs and explain and introduce new products to them. In this study, many subjects stated using Spanish and/or English when shopping; therefore it would be a practical marketing strategy to offer Hispanic consumers a more friendly shopping experience by presenting bilingual (Spanish and English) signage (i.e. brands, labels, and packaging) and bilingual employees.

Since grass-fed preferring consumers seem to read food health/nutrition labels frequently, the products could include labels that contain health/nutritional information of grass-fed beef when sold in supermarkets/retail grocery stores. Due to its high protein and low fat, grass-fed beef is easily overcooked using the cooking methods commonly for conventional grain-fed beef. Labels or pamphlets that include cooking tips or ethnic cooking recipes may help consumers cook grass-fed beef properly and obtain a favorable eating experience.

In order to reduce the inconsistency between visual preferences and taste experience, marketing efforts could provide consumers with information about how to purchase beef products they prefer on taste and offer them opportunities to sample the product before purchasing. Supplying free, properly-cooked, grass-fed beef samples in the meat section of supermarkets can be viewed as one possible initiative to achieve this goal.

CHAPTER VIII

CONCLUSIONS AND DISCUSSION

8.1. Summary and Conclusions

In U.S beef markets, consumers are increasing their consumption of beef produced using alternative methods to conventional grain-fed production. One such product, grass-fed beef, comes from cattle fed with grass, forage, or silage and graze on pasture over their lifespans. When promoted as healthier, more nutritious, and environmentally benign than conventionally produced grain-fed beef, grass-fed beef gains increasing interest in the U.S. beef market. Due to the different feeding practices used, however, grass-fed beef presents distinct quality and sensory attributes from conventional grain-fed beef. As the U.S. bases its beef production primarily on feedlots and high-energy grain feeding, the distinct visual appearance and taste of grass-fed beef have led to mixed acceptance by mainstream consumers who are accustomed to conventional grain-fed beef. In contrast, beef production systems in many Hispanic/ Latin countries are known as typically grass-based and people in these countries traditionally consume grass-fed beef products. As heavy beef eaters with potential preferences for grass-fed beef, the fast-growing Hispanic population in the U.S is hypothesized to constitute a promising potential market for grass-fed beef. Nevertheless, existing studies on the demand for grass-fed beef have been largely focused on mainstream consumers, and no known research has been done to explore the potential Hispanic market for grass-fed beef. This dissertation aims to contribute to literature in this regard.

The study presented in this dissertation used experimental economics methods to address this research gap. The overall objective was to evaluate Hispanics' preferences and WTP for grass-fed beef and assess the potential market in Virginia given its ethnically diverse population and fast-growing Hispanic group. The research may provide industry with insights

and knowledge into Hispanic consumers' purchase and consumption decision-making processes and aid in the development of practical marketing strategies to the Hispanic market for grass-fed beef.

In order to fulfill these research objectives, laboratory economics experiments were conducted in Galax, Roanoke, Richmond, and Blacksburg, VA, from September to November 2008. Laboratory experiments consisted of written surveys, sensory evaluation, and MPL experiments. A total of 231 consumers participated in a laboratory experiment procedure. The written surveys were used to collect information on subjects' socio-demographic characteristics, beef consumption behavior, ethnic background, and health status and attitude. Through blind sensory evaluations, subjects assessed the appearance and taste of paired grass-fed and conventional grain-fed beef steak samples and rated visual and taste attributes for each sample. The MPL experiment was conducted immediately after sensory evaluations and was designed to elicit subjects' WTP for grass-fed beef. Data collected from the experiment procedure was used to estimate empirical models for analyzing Hispanic consumers' preferences and WTP for grass-fed beef.

One general conclusion is that grass-fed beef was preferred over conventional grain-fed beef by 50% of Hispanic consumers. Most of them were willing to pay a price premium for it. In particular, more than 50% of grass-fed preferring subjects were willing to pay a premium of at least $3.00/lb for grass-fed beef. This suggests a potential promising market for grass-fed beef existing among the Hispanic population in Virginia.

Our results indicate that Hispanic subjects were able to distinguish the appearance and taste differences between the grass-fed and conventional grain-fed beef. Beef sensory attributes significantly affected subjects' visual expectations and taste experience. The bivariate Probit estimations revealed a significant and positive relationship between consumers' visual and taste preferences, which conformed to the PQB model developed by

Wierenga (1982) (see Chapter II). Except sensory attributes, the importance of marbling in beef purchase decisions was a significant and positive predictor of consumers' visual preferences; on the contrary, although insignificant, it adversely affected consumers' taste preferences. The variables that influenced visual and taste preferences were not the same. Visually grass-fed preferring consumers were more likely to be Mexican or Colombian and higher acculturated, and eat beef less frequently at home. Consumers who had fewer children at home, liked less-cooked beef, and consumed beef less frequently away from home more consistently preferred the taste of grass-fed beef.

The examination of the determinants of WTP for grass-fed beef reveals difference in the results between the standard Tobit model, Heckman's sample selection model, and Cragg's double-hurdle model. The three kinds of models were developed to deal with the censored WTP dependent variable. In this study, WTP was defined as the price premium for grass-fed beef. It was a censored variable because for the 50% of subjects who preferred conventional grain-fed beef and did not participate in the MPL experiments, their WTP was reported as zero. The Tobit model didn't separate consumer participation decisions from their WTP decisions; therefore its estimation results represented a mixed effect on the participation decision and their WTP. In contrast, the Heckman's sample selection and Cragg's double-hurdle model separated the two decisions; therefore, the estimates of the two models could show the pure marginal effects on the magnitude of WTP given participation. The main differences between Heckman's sample selection and Cragg's double-hurdle model rest in that the former considers all zero premiums to be a result of self-selection and the latter takes into account other sources of zero premiums than self-selection. The theoretical differences between the three models may lead to different estimation results.

With respect to model selection, the LR test indicates that Cragg's double hurdle model is a better specification than the standard Tobit model for the estimation of WTP for grass-fed

beef. Rejection of the standard Tobit model suggests that the participation decisions (i.e. overall preference for grass-fed vs. conventional grain-fed beef) is separate from decisions of WTP level; the results suggest that zero premiums for grass-fed beef may occur not only due to a corner solution, but also due to consumers' self-selection to conventional grain-fed beef.

Heckman's sample selection model and Cragg's double hurdle model have different estimation results. Post-test results such as AIC and BIC indicate the superiority of Cragg's double-hurdle model as it accounts for the many zero observations of WTP by grass-fed preferring subjects. It is evident that the different sources of zero WTP need to be considered for model selection.

Distinguishing between the determinants of participation choices (overall preference) and the magnitude of WTP given participation (i.e. preference for grass-fed beef) helps industry better understand the different respects of consumer purchase process. The examination of the determinants of participation gives producers and marketers insights into who could be the potential consumers and what they prefer. The investigation of the determinants of magnitude of WTP given participation sheds light on the market potential and appropriate pricing strategies for grass-fed beef.

According to Cragg's model, visual and taste satisfactions were most important factors in determining Hispanic subjects' overall preferences. Moreover, subjects who were male, had households with more children but fewer adults, and more frequently ate beef away from home preferred grass-fed beef. Younger, less-educated subjects who had households with fewer adult family members were willing to pay more for grass-fed beef given preferences for it.

An interesting finding is about the interaction terms of country of origin and peer effects (the levels of same-country neighbors). Specifically, the effects of country of origin on WTP varied with the different levels of peer effects. Given participation, Colombian

origin promoted peer effects while origins from Mexico, Salvador/Honduras, or "other" Hispanic countries weakened this effect. Nevertheless, only the interaction between Mexico and peer effects significantly influenced consumers' WTP. That is, Mexican or Mexican-American subjects who lived with more Mexican neighbors were less willing to pay for grass-fed beef. To our surprise, the interaction terms had no significant influences on subjects' overall preferences. Rather, the pure positive effects of Mexico and Colombia origins were detected in subjects' visual preferences.

Another important finding is about the potential heath attitudes of grass-fed preferring subjects. Some health-related factors significantly affected subjects' sensory preferences and WTP. For example, grass-fed preferring subjects read food health/nutrition labels more frequently, were more concerned about the presence of marbling, and had more prior experience with specialty meat products.

8.2. Limitations and Future Research

The WTP measured by different elicitation techniques is not always equivalent. For example, the second-price auctions may lead to over-bidding, and its bids are greater than English auction and the random nth-price auction in iterative bidding (Kagel and Roth 1995; Lusk and Hudson 2004). In this study, MPL was used to investigate consumers' WTP for grass-fed beef. Although, theoretically, non-hypothetical MPL experiments could elicit consumers' true valuations, it is not known if the results are comparable and consistent to those by other incentive-compatible non-hypothetical elicitation methods such as experimental auctions. Conjoint valuation such as choice experiments is a method that facilitates the examination of the impacts of product attributes or combinations of attributes on consumers' WTP. Further studies could use these valuation mechanisms. In addition, laboratory experiments might increase bias due to inconvenience for participation and an

unfamiliar experiment environment to subjects. Similar studies could be conducted in stores to make experiments in a natural shopping setting.

The descriptive and estimation results suggest possible effects of consumers' potential health attitudes on their preferences and WTP for grass-fed beef. In the study, however, visual evaluations and taste tests were blind and no information about grass-fed beef's health/nutrition values was revealed during the experiment procedure. Future research may address these issues by investigating the influences of the revelation of qualitative information about the health and nutrition benefits of grass-fed beef and Hispanic consumers' health knowledge on their WTP for grass-fed beef. Likewise, research may be extended to investigate Hispanic consumers' WTP for other attributes of grass-fed beef, such as its environment and animal welfare benefits.

It should be noted that the characteristics of sample in this study is not entirely representative to the Hispanic population in Virginia. Especially, 90% of subjects are foreign-born (the first generation), which is much higher than the percentage of the Hispanic population in Virginia (approximately 50%). Another limitation is that the subjects primarily originated from Mexico, El Salvador, Honduras, and Colombia. Future research could recruit participants from more diverse Hispanic/Latin countries and including more US-born citizens. Furthermore, there may exist selection bias in our sample. Due to time and budget constraints and accessibility limitations, a big proportion of the sample was recruited from a university and from the members of a Hispanic organization. In order for better sampling, future laboratory experiments could consider to recruit more participants from direct consumers. For example, getting customer lists from supermarkets or retail grocery stores and recruiting subjects from them.

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Appendix A: Consumer Survey

Please read and answer all the questions carefully. Please place "×" on only **ONE** answer for each question unless "*Please choose all that apply*" is indicated. If there is no answer that completely represents your own opinion or you are not sure about the answer, please mark the answer that you think is closest. You may also ask your interviewer if you need any help.

Section 1: Consumer beef eating habits & purchase pattern

1.1 Are you the primary *food buyer* in your household?

- ☐ Yes
- ☐ Joint decision maker
- ☐ No

1.2 Are you the primary *food preparer* in your household?

- ☐ Yes
- ☐ Joint decision maker
- ☐ No

1.3 Are you the primary person who *decides what to eat* in your household?

- ☐ Yes
- ☐ Joint decision maker
- ☐ No

1.4 How often do you eat the following products?

	Three or more times a week	Once to two times a week	One to three times a month	Less than once a month	Never
Beef	☐	☐	☐	☐	☐
Pork	☐	☐	☐	☐	☐
Poultry	☐	☐	☐	☐	☐
Fish	☐	☐	☐	☐	☐
Lamb	☐	☐	☐	☐	☐

1.5 How often do you eat beef *prepared at home*?

☐ Three times or more per week
☐ Once or twice a week
☐ A few times a month
☐ Less than once a month
☐ Never

How often do you eat beef *prepared away from home*, such as at restaurants, cafeterias, or purchased ready-to-eat from supermarkets or delicatessens?

☐ Three times or more per week
☐ Once or twice a week
☐ A few times a month
☐ Less than once a month
☐ Never

1.6 Approximately how much does your household spend on **food** during a typical week or month? $_____ ☐ per week ☐ per month

1.7 Approximately how much does your household spend on **meat** during a typical week or month?

$ _____ ☐ per week ☐ per month

Approximately how much does your household spend on **beef** during a typical week or month?

$ _____ ☐ per week ☐ per month

1.8 How often do you purchase **beef** from the following places?

	Never	Occasionally	Sometimes	Frequently
Supermarket/retail grocery store	☐	☐	☐	☐
International /ethnic foods store	☐	☐	☐	☐
Health/Natural foods store	☐	☐	☐	☐
Farmers' market	☐	☐	☐	☐
Directly from producer	☐	☐	☐	☐
Internet or Direct mail order	☐	☐	☐	☐
Other, _____ (*please specify*)	☐	☐	☐	☐

1.9 When you buy beef, which type do you most often purchase?

☐ Bone-in
☐ Boneless

1.10 How frequently do you typically purchase each of the following types of beef?

	Three or more times a week	Once to two times a week	One to three times a month	Less than once a month	Never
Ground beef	☐	☐	☐	☐	☐
Steak	☐	☐	☐	☐	☐
Roast	☐	☐	☐	☐	☐

1.11 When you purchase beef, how many pounds of the following types of beef do you typically purchase at a time?

Ground beef	_____lbs/each time	☐ Do not purchase
Steak	_____lbs/each time	☐ Do not purchase
Roast	_____lbs/each time	☐ Do not purchase

1.12 What fat content do you most often purchase when you buy ground beef/burger?

☐ 70-79% lean
☐ 80-90% lean
☐ More than 90% lean
☐ Do not know

1.13 When purchasing beef steaks, which grade do you most often buy?

☐ USDA Select
☐ USDA Choice
☐ USDA Prime
☐ Not graded
☐ Do not know

1.14 What cuts do you most often purchase when you buy beef steaks for consumption at home?

☐ Ribeye
☐ T-bone
☐ Tenderloin
☐ Sirloin
☐ Porterhouse
☐ Other, _____ (please specify)
☐ Do not know

1.15 How well done do you like beef steak?

Cooking degree
☐ **Rare or less**-- the outside is gray-brown, and the middle of the steak is red and slightly warm, or rawer.
☐ **Medium rare**-- the steak will have a fully red, warm center. Unless specified otherwise, upscale steakhouses will generally cook to at least this level.
☐ **Medium**-- the middle of the steak is hot and red with pink surrounding the center. The outside is gray-brown.
☐ **Medium well**-- the meat is light pink with gray-brown surrounding the center.
☐ **Well-done or more**-- the meat is gray-brown throughout and slightly blackened or charred
☐ **It varies by cut**

1.16 How do you usually cook **beef steak**? (*Please check **all** that apply*)

☐ **Grilling** --- a quick dry-heat cooking method in which beef is heated directly on the cooking grid over charcoal, wood, gas flames, or other heat sources.

☐ **Broiling** --- a quick dry-heat cooking method in which beef is cooked on a broiler rack in the oven that is set to a "broil" setting and with the heat source above the beef.

☐ **Pan Frying** --- a dry-heat cooking method in which beef is cooked in an uncovered pan on the stove with enough oil to come halfway or two thirds up its side.

☐ **Stir-Frying** --- a quick dry-heat cooking method in which small uniform pieces of beef are cooked in a small amount of oil over high heat by continuously tossing.

☐ **Roasting** --- a dry-heat cooking method in which beef is placed an uncovered pan and heated in the oven without water, usually used for cooking bigger cuts of beef.

☐ **Braising** --- a slow moist-heat cooking method in which beef is first browned in a pan on the stove and then simmered in a small amount of liquid with a tight-fitting lid.

☐ **Cooking in liquid** --- a slow moist-heat cooking method in which beef is simmered in a covered pan over low heat with a large amount of liquid.

☐ **Other**,_____ (Please specify. *Other cooking methods* includes pan-broiling, deep-frying, and so on.)

☐ **Don't cook**

1.17 How important are the following factors in your beef purchase decisions?

	Not important	Somewhat important	Important	Very important	Extremely important
Price	☐	☐	☐	☐	☐
Ingredients on label	☐	☐	☐	☐	☐
Health/nutrition content	☐	☐	☐	☐	☐
Production practice on label (*for example, "Organic" or "Natural"*)	☐	☐	☐	☐	☐
Convenience of preparation and/or consumption	☐	☐	☐	☐	☐
Brand	☐	☐	☐	☐	☐
USDA Quality Grade (*for example, "Select" , "Choice", or " Prime"*)	☐	☐	☐	☐	☐

1.18 How much do the following attributes affect your beef purchases?

	Not important	Somewhat important	Important	Very important	Extremely important
Meat color	☐	☐	☐	☐	☐
Fat color	☐	☐	☐	☐	☐
Presence of marbling *(white flecks of fat within beef muscle)*	☐	☐	☐	☐	☐
Tenderness	☐	☐	☐	☐	☐
Juiciness	☐	☐	☐	☐	☐
Type of cuts	☐	☐	☐	☐	☐
Leanness	☐	☐	☐	☐	☐
Anticipated taste or flavor	☐	☐	☐	☐	☐

Section 2: Consumer Information and Knowledge of Pasture-Fed Beef

2.1 Have you ever taken a health or nutrition class?

☐ Yes

☐ No

2.2 Have you ever purchased meat products with any of the following labels?

Natural	☐ Yes	☐ No	☐ Don't know
Organic	☐ Yes	☐ No	☐ Don't know
Free Range	☐ Yes	☐ No	☐ Don't know
Grass-fed/Pasture-fed	☐ Yes	☐ No	☐ Don't know

2.3 What is your experience with "natural" beef? (Such as Coleman's, Laura's Lean, etc.)

☐ I have never heard of it.

☐ I have heard of it, but never purchased it.

☐ I have purchased it, but do not regularly purchase it.

☐ I purchase it regularly.

2.4 What is your experience with "organic" beef?

☐ I have never heard of it.

☐ I have heard of it, but never purchased it.

☐ I have purchased it, but do not regularly purchase it.

☐ I purchase it regularly.

2.5 What is your experience with "pasture-fed (PFB)," "grass-fed (GFB)," or "pasture-raised" beef
(PRB)?

☐ I have never heard of it.

☐ I have heard of it, but never purchased it.

☐ I have purchased it, but do not regularly purchase it.

☐ I purchase it regularly.

Note: If you have never heard of PFB/GFB/PRB (referred to in Q. 2.5), please continue to Q.2.7

2.6 What is your impression of pasture-fed beef's

... impact on human health? ☐ Negative ☐ Neutral ☐ Positive ☐ No expectation

... impact on the environment? ☐ Negative ☐ Neutral ☐ Positive ☐ No expectation

... impact on animal welfare? ☐ Negative ☐ Neutral ☐ Positive ☐ No expectation

... taste compared with conventional beef? ☐Worse ☐Indifferent ☐Better ☐No expectation

2.7 What kind of beef did you eat when you were growing up?

☐ Pasture-fed/grass-fed beef

☐ Grain-fed beef

☐ Other, _____

☐ Do not know

Section 3: Exercise and Health

3.1 How frequently do you undertake moderate or vigorous physical activities (including any activities that cause an increase in your heart or breathing rate so that you can talk but not sing, such as brisk walking, bicycling, vacuuming or other forms of exercise)?

☐ Less than once a week

☐ One or two times a week

☐ Three or more times a week

3.2 Have you ever been diagnosed with any of the following? (*Please check all that apply*)

☐ Diabetes

☐ Heart disease

☐ High blood pressure

☐ High Cholesterol

☐ Obesity

☐ None of the above

3.3 Have any of your family members for whom you cook ever been diagnosed with any of the following? (*Please check all that apply*)

☐ Diabetes

☐ Heart disease

☐ High blood pressure

☐ High Cholesterol

☐ Obesity

☐ None of the above

3.4 How often do you read nutrition labels when deciding to buy a food product?

☐ Always

☐ Most of the time

☐ Sometimes

☐ Rarely

☐ Never

☐ Don’t know

3.5 How often do you read health claims on packages when deciding to buy a food product?

☐ Always

☐ Most of the time

☐ Sometimes

☐ Rarely

☐ Never

☐ Don’t know

Section 4: Ethnic Background

4.1 Were you born in the U.S.?

☐ Yes ☐ No

If **No**, i) at around what age did you arrive in the U.S. for the first time?

_____

ii) how many years have you been living in the U.S.? _____

If **Yes**, i) was your mother born outside of the U.S.?

☐ Yes

At around what age did your mother arrive in the U.S.? _____

☐ No

ii) was your father born outside of the U.S.?

☐ Yes

At around what age did your father arrive in the U.S.? _____

☐ No

4.2 Which of the following best describes your ethnicity and country of origin ? (If you do not belong to any of the specified categories or you are multiracial/mixed racial/interracial, please mark the option of "Other" and specifically indicate your ethnic origin or race composition). (*Please check all that apply*)

☐ **Hispanic/Latino**

☐ North American

☐ Mexican

☐ Mexican-American or Chicano

☐ Caribbean

☐ Puerto Rican

☐ Cuban

☐ Dominican

☐ Other Caribbean, _____

☐ Central American

☐ Salvadoran

☐ Guatemalan

☐ Honduran

☐ Nicaraguan

☐ Panamanian

☐ Other Central American, _____

☐ South American

☐ Argentinean

☐ Colombian

☐ Ecuadorian

☐ Peruvian

☐ Venezuelan

☐ Brazilian

☐ Chilean

☐ Other South American, _____

☐ Other Hispanic/Latino, _____

4.3 Is your native language English?

☐ Yes

☐ No, _____(Please indicate what your native language is)

Note: If your native language is English, please continue to Q. 4.5

4.4 If your native language is NOT English, please mark the language you use most often in the following situations:

	Native	English	Both equally
At home?	☐	☐	☐
At work or in school?	☐	☐	☐
With friends?	☐	☐	☐
When shopping?	☐	☐	☐

4.5 Please rate your English *SPEAKING* ability,

☐ Excellent
☐ Good
☐ Average
☐ Fair
☐ Minimal or none

Please rate your English *READING* ability,

☐ Excellent
☐ Good
☐ Average
☐ Fair
☐ Minimal or none

Please rate your English *WRITING* ability,

☐ Excellent
☐ Good
☐ Average
☐ Fair
☐ Minimal or none

4.6 How often do you think in English?

☐ Always or almost always
☐ Often
☐ Sometimes
☐ Rarely or never

4.7 Approximately how many people in your current neighborhood would you say are from the same ethnic group as you?

☐ All or almost all
☐ Many
☐ Some
☐ Few
☐ Almost none or none

4.8 Please indicate the ethnic backgrounds of your three **closest** friends:

Friend 1: ☐ Hispanic/Latino ☐ Non-Hispanic/Non-Latino

Friend 2: ☐ Hispanic/Latino ☐ Non-Hispanic/Non-Latino

Friend 3: ☐ Hispanic/Latino ☐ Non-Hispanic/Non-Latino

4.9 Do you prefer to go to social gatherings or parties where people are:

☐ All or almost all Hispanics/Latinos
☐ More Hispanics/Latinos than non-Hispanics/non-Latinos
☐ Equal Hispanics/Latinos and non-Hispanics/non-Latinos
☐ More non-Hispanics/non-Latinos than Hispanics/Latinos
☐ All or almost all non-Hispanics/non-Latinos
☐ No preference

4.10 How often does your family cook Hispanic foods?

☐ Always or almost always
☐ Often
☐ Sometimes
☐ Rarely or never

4.11 What type of food do you prefer?

☐ Hispanic food
☐ American food
☐ Other, _____

4.12 What music do you prefer?

☐ Only music in Spanish
☐ Mostly music in Spanish
☐ Equally music in Spanish and English
☐ Mostly music in English
☐ Only music in English
☐ Other, _____

4.13 If you have the choice, what radio programs do you prefer?

☐ Only radio programs in Spanish
☐ Mostly radio programs in Spanish
☐ Equally radio programs in Spanish and English
☐ Mostly radio programs in English
☐ Only radio programs in English
☐ Other, _____

4.14 If you have the choice, what movies do you prefer?

☐ Only movies in Spanish
☐ Mostly movies in Spanish
☐ Equally movies in Spanish and English
☐ Mostly movies in English
☐ Only movies in English
☐ Other, _____

4.15 If you have the choice, what television programs do you prefer?

☐ Only TV programs in Spanish
☐ Mostly TV programs in Spanish
☐ Equally TV programs in Spanish and English
☐ Mostly TV programs in English
☐ Only TV programs in English
☐ Other, _____

Section 5: Consumer demographics

5.1 What is your gender?

☐ Female
☐ Male

5.2 What year were you born? _____

5.3 Which of the following options best describes your living arrangement?

☐ Live alone
☐ Live with spouse / partner
☐ Live with spouse / partner and children
☐ Live with children only
☐ Live with extended family
☐ Live with unrelated people (such as friends or roommates)

5.4 What is the highest level of education that you have completed?

☐ Less than high school diploma or equivalent
☐ High school diploma or equivalent
☐ Some College/technical school
☐ Associates Degree
☐ Bachelors degree
☐ Graduate or Professional Degree

5.5 What is your current employment status out side of home?

☐ Employed part time (including students who work on campus or off campus)
☐ Employed full-time
☐ Not employed
☐ Student
☐ Retired

5.6 Do you have a spouse/partner?

☐ Yes
☐ No

If **Yes**, please indicate your spouse/partner's employment status?

☐ Employed part time (including students who work on campus or off campus)
☐ Employed full-time
☐ Not employed
☐ Student
☐ Retired
☐ Not applicable

5.7 What is your approximate annual household income before taxes?

☐ Less than $10,000
☐ $10,000 - $19,999
☐ $20,000 - $29,999
☐ $30,000 - $39,999
☐ $40,000 - $49,999
☐ $50,000 - $59,999
☐ $60,000 - $69,999
☐ $70,000 - $79,999
☐ $80,000 - $89,999
☐ $90,000 - $99,999
☐ More than $100,000

5.8 Including yourself, how many members are currently living in your household?

_____

a) How many infants (0-2 year old) are there in your current household? _____
b) How many Children (3-17 year old) are there in your current household? _____
c) How many Adults at age 18 to 65 are there in your current household?
(Including yourself) _____
d) How many seniors over the age of 65 are there in your current household?
(Including yourself) _____

5.9 Do you or any member of your household currently participate in any of the following food assistance programs? (*Please check all that apply*)

☐ Food Stamp Program (FSP)
☐ Women, Infants and Children Program (WIC)
☐ School Lunch program
☐ None

Appendix B: Taste Evaluation

Definitions of Taste Traits of Beef

Tenderness: the force required to bite through a piece of beef
Flavor: the taste of beef
Juiciness: the perception of moistness

Please evaluate the taste traits of beef samples when you taste each sample, and mark the boxes that indicate how you feel about the palatability attributes of each sample.

(1) Palatability Evaluation: Beef Sample #1

Tenderness	☐ Very tender	☐ Tender	☐ Somewhat tender	☐ Neutral	☐ Somewhat tough	☐ Tough	☐ Very tough	Don't know ○
Juiciness	☐ Very juicy	☐ Juicy	☐ Somewhat juicy	☐ Neutral	☐ Somewhat dry	☐ Dry	☐ Very dry	Don't know ○
Flavor	☐ Very intense	☐ Intense	☐ Somewhat intense	☐ Neutral	☐ Somewhat bland	☐ Bland	☐ Very bland	Don't know ○

Please cleanse your palate with a sip of water between samples.

(2) Palatability Evaluation: Beef Sample #2

Tenderness	☐ Very tender	☐ Tender	☐ Somewhat tender	☐ Neutral	☐ Somewhat tough	☐ Tough	☐ Very tough	Don't know ○
Juiciness	☐ Very juicy	☐ Juicy	☐ Somewhat juicy	☐ Neutral	☐ Somewhat dry	☐ Dry	☐ Very dry	Don't know ○
Flavor	☐ Very intense	☐ Intense	☐ Somewhat intense	☐ Neutral	☐ Somewhat bland	☐ Bland	☐ Very bland	Don't know ○

Which beef sample's taste do you prefer?

☐ Sample #1 ☐ Sample #2

Appendix C: Visual Evaluation

Definitions of Visual Traits of Beef

Lean meat color: the color of beef muscle
Fat color: the color of intramuscular and marbling fat
Meat texture: fineness or coarseness of the cut surface

Please evaluate the visual traits of beef samples when you examine each sample that is displayed in the retail cases, and mark the boxes that indicate how you feel about the visual attributes of each sample.

(1) Visual Evaluation: Beef Sample A

Lean Meat Color	☐ Very pale ☐ Pale ☐ Pink ☐ Neutral ☐ Red ☐ Dark ☐ Very dark	Don't know ○
Fat color	☐ Very white ☐ White ☐ Somewhat white ☐ Neutral ☐ Somewhat yellow ☐ Yellow ☐ Very yellow	Don't know ○
Meat Texture	☐ Very fine ☐ Fine ☐ Somewhat fine ☐ Neutral ☐ Somewhat tough ☐ Tough ☐ Very tough	Don't know ○

(2) Visual Evaluation: Beef Sample B

Lean Meat Color	☐ Very pale ☐ Pale ☐ Pink ☐ Neutral ☐ Red ☐ Dark ☐ Very dark	Don't know ○
Fat color	☐ Very white ☐ White ☐ Somewhat white ☐ Neutral ☐ Somewhat yellow ☐ Yellow ☐ Very yellow	Don't know ○
Meat Texture	☐ Very fine ☐ Fine ☐ Somewhat fine ☐ Neutral ☐ Somewhat tough ☐ Tough ☐ Very tough	Don't know ○

Which beef sample do you prefer visually?

☐ Sample A ☐ Sample B

Appendix D: Overall Preference Evaluation

Please indicate which beef sample did you prefer overall?

☐ Sample #1 / A

☐ Sample # 2 / B

☐ Indifferent/ No preference

Appendix E: Consumer's Willingness-to-Pay (WTP) Survey

Beef sample: # 2

If a pound of supermarket beef steak costs about $8.00, would you be willing to pay **more than $8.00** for a pound of beef from sample #2?

☐ Yes
☐ No

If yes,

1). would you be willing to pay an additional $1.00 for a pound of beef steak from sample # 2 instead? ☐ Yes ☐ No ☐ Indifferent

2) ... $2.00? ☐ Yes ☐ No ☐ Indifferent

3) ... $3.00? ☐ Yes ☐ No ☐ Indifferent

4) ... $4.00? ☐ Yes ☐ No ☐ Indifferent

5) ... $5.00? ☐ Yes ☐ No ☐ Indifferent

6) ... $6.00? ☐ Yes ☐ No ☐ Indifferent

7) ... $7.00? ☐ Yes ☐ No ☐ Indifferent

8) ... $8.00? ☐ Yes ☐ No ☐ Indifferent

9) ... $9.00? ☐ Yes ☐ No ☐ Indifferent

10) ... $10.00? ☐ Yes ☐ No ☐ Indifferent

11) ... $11.00? ☐ Yes ☐ No ☐ Indifferent

12) ... $12.00? ☐ Yes ☐ No ☐ Indifferent

13) ... $13.00? ☐ Yes ☐ No ☐ Indifferent

14) ... $14.00? ☐ Yes ☐ No ☐ Indifferent

15) ... $15.00? ☐ Yes ☐ No ☐ Indifferent

What is the most additional money you would be willing to pay for one pound of beef sample #2? $_____

Note: If you answer "**indifferent**" in any of the questions above, or you answer **"yes" to all the questions**, you **do not** need to fill out the second page.

What is the most additional money you indicated in the first page that you would be willing to pay for a pound of beef sample #2? $_____

1) are you willing to pay **$.10 more** for it?
☐ Yes ☐ No ☐ Indifferent

2) are you willing to pay **$.20 more** for it?
☐ Yes ☐ No ☐ Indifferent

3) are you willing to pay **$.30 more** for it?
☐ Yes ☐ No ☐ Indifferent

4) are you willing to pay **$.40 more** for it?
☐ Yes ☐ No ☐ Indifferent

5) are you willing to pay **$.50 more** for it?
☐ Yes ☐ No ☐ Indifferent

6) are you willing to pay **$.60 more** for it?
☐ Yes ☐ No ☐ Indifferent

7) are you willing to pay **$.70 more** for it?
☐ Yes ☐ No ☐ Indifferent

8) are you willing to pay **$.80 more** for it?
☐ Yes ☐ No ☐ Indifferent

9) are you willing to pay **$.90 more** for it?
☐ Yes ☐ No ☐ Indifferent