

Impacts of New Plant-Based Protein Alternatives on U.S. Beef Demand

Full Project Report Prepared for the Cattlemen's Beef Promotion and Research Board (CBB)

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A. Executive Summary

This project's objective was to provide economic insights into competitive threats to U.S. beef demand posed by plant-based protein alternatives. Given the current market penetration of plant-based alternatives, this study focuses on these potential beef substitutes. Lab-based protein alternatives are not studied in this analysis as they remain in development and are not yet on the market. The project provides a multitude of insights using a series of experiments in a survey of over 3,000 U.S. residents in September of 2020. The results, weighted to be representative of the U.S. population, provide a comprehensive assessment across both retail and food service market channels.

The full project report documents procedures employed, models estimated, and results of multiple evaluations. The full report starts with a chapter focused on strategy. The strategy chapter provides a transition from a summary of main findings and recommendations to detailed presentation of methods, analyses, and conclusions underpinning this summary. A corresponding Appendix provides supplementary details. We encourage those wanting background context and related details to read the full report.

Main Findings:

1. Cattle-based beef is currently chosen in the marketplace about three times more often than plant-based protein alternatives. In prior day meals, one in six report eating a plant-based protein item while roughly one-half had beef. Among those consuming plant-based burgers or ground crumbles in the past month, beef or chicken are the two proteins consumers would have otherwise most likely purchased.
2. Beef has a good image. Consumers' perceptions of Taste, Appearance, Price, and Naturalness of beef greatly exceeds that for plant-based proteins. Average response scores for 15 meat/protein attributes indicate more consumers favor beef over plant-based protein. Overall consumer perceptions of nutrients accurately reflect information posted on nutrient contents panels of both beef and plant-based retail items. Beef compares most favorably on perceptions of Protein and Iron. And consumers perceive beef to be overall better for Farmers, Consumers, Rural Communities, and Food Prices than plant-based alternatives. The sense of "good" sentiments consumers have associated with beef are noteworthy. Good for Environment is the only item where over one-third of consumers view plant-based as superior to beef.
3. Plant-based proteins score highest on Animal Welfare, Health, Environmental Concerns, though on average these are still slightly lower scores than beef for the same attributes. Plant-based rank higher than beef on average for Cholesterol, Fat, and Dietary Fiber. These are the areas in which plant-based proteins appeal most to consumers.
4. Providing consumers information highlighting ingredient lists or nutrient panel contents does not significantly affect selection between beef burger and plant-based meals.

5. Regular meat consumers (68% of the study's full sample) are much less likely to select a plant-based item when a beef item is available.
 - The typical regular meat consumer is willing to pay \$1.87 more at a restaurant for a beef burger meal than a Beyond Meat burger meal. Conversely, those declaring an alternative diet (Vegan, Vegetarian, Flexitarian, or other) are willing to pay \$1.48 more for a Beyond Meat than beef burger meal. Likewise, in retail settings the typical regular meat consumer is willing to pay \$0.29/lb more for store-brand, 80% lean ground beef than Beyond Meat while those with an alternative diet would pay \$2.32/lb more for Beyond Meat than beef.
 - In a food service setting at contemporary prices, about 5% of regular meat consumers would select a Beyond Meat burger meal (the combined market share for beef and bacon beef burgers is 11 times larger at 55%); 23% of consumers declaring an alternative diet would choose the Beyond Meat burger (the combined market share for beef and bacon beef burgers is 1.5 times larger).
 - In a retail grocery setting at contemporary prices, about 2% of regular meat consumers would select a Beyond Meat or Impossible burger (the combined market share for ground beef is about 14 times higher); 25% of consumers declaring an alternative diet would choose the Beyond Meat or Impossible burger (the combined market share for ground beef was roughly the same).
6. Characteristics of consumers most likely to select plant-based proteins include younger, those with children under the age of 12, having higher household income, residing in a Western state, and affiliating with the Democratic party. Consumers who select plant-based proteins place greater importance on environmental and animal welfare concerns when making food choices than consumers predicted to choose traditional animal proteins.
7. Replacing a chicken wrap with a new plant-based protein offering on a food service menu has a small (less than 3%) impact on frequency of selecting beef burger meals.
8. Changes in the price of beef have a much larger impact on consumer decisions to buy beef than the impact of changes in the price of plant-based offerings. This means plant-based burgers are relatively weak substitutes for beef.
 - In food service, a 1% increase in beef burger meal price reduces overall probability of selecting beef by 2.5%; by contrast, a 1% decrease in Beyond Meat burger meal price reduces the probability of selecting beef by only 0.21%.
 - In a retail grocery setting, a 1% increase in store brand 80% lean ground beef prices reduces overall probability of selecting the same product by 1.73%; by contrast, a 1% decrease in Beyond Beef prices reduces the probability of choosing 80% lean ground beef by only 0.18%.
 - Using an experiment allowing multiple pounds and products to be selected in a retail grocery setting, a 1% increase in store brand 80% lean ground beef prices reduces stated purchase volume by 2.80% while a 1% decrease in Beyond Beef prices reduces beef volume by 0.65%.

9. Plant-based burgers have more elastic demands than hamburger and chicken breast for regular meat eaters. This suggests those who eat meat regularly will be more responsive to adjusting consumption to plant-based proteins as their prices change.

Key Recommendations:

1. Regular meat consumers are not the core market segment for plant-based protein items. Conversely those declaring an alternative diet, primarily flexitarian, largely comprise the majority of the current plant-based protein market. Therefore, sustaining and promoting core aspects unique to beef attractive to regular meat consumers is recommended. Furthermore, finding ways for beef to be attractive to flexitarians is also important. When plant-based items are purchased they often are made by consumers who also purchased beef or chicken. This points to an ongoing opportunity for appealing to consumers who may not have traditional, meat protein-centric diets.
2. Given beef price has a much larger impact than plant-based prices on beef purchases the industry will be well-served to persistently seek supply-side gains that enhance beef's competitiveness. However, these efforts must not compromise core beef demand drivers of Taste, Food Safety, and Freshness that have repeatedly been identified as key demand determinants.
3. Be aware that if plant-based protein prices decline, regular beef eaters will likely incorporate more plant-based protein in their consumption choices. Since the share of plant-based protein is still small this is not currently a large threat to the beef industry. However, it suggests keeping the valued attributes of beef in front of consumers who regularly eat meat will remain important (these include Taste, Nutrition, Safety, Naturalness, Iron, Protein, as well aesthetic attributes consumers currently value about the beef industry).
4. With plant-based protein products being perceived by consumers as lower in Fat and Cholesterol, and higher in Fiber, the beef industry may wish to consider strategies to boost beef product images around these areas. Continued information on lean beef products available for those who are concerned with these health aspects can better position beef relative to plant-based proteins. But realize this is for a small portion of the overall beef sector demand opportunity. Don't over invest in this strategy to enhance a small segment of the overall beef consumption pie.
5. Changes in chicken breast prices have a larger impact on beef demand than plant-based price adjustments. Given the heavy importance of chicken in U.S. diets indicates priority should be given to continuing to track chicken's impact on beef demand, monitoring chicken industry dynamics, and continually seeking to improve beef's relative position to chicken with consumers.

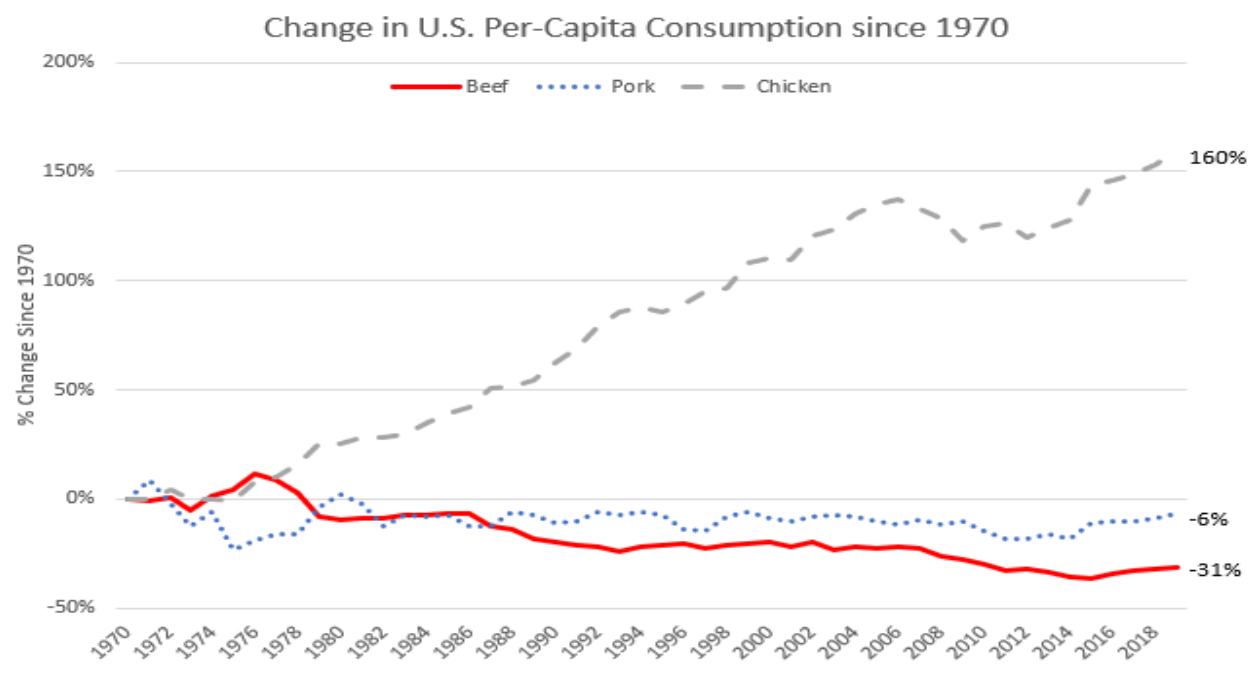
6. The overall greatest threat from plant-based protein to the beef industry is small at this time. However, the main traction the plant-based sector has is it currently appeals to the younger generation that tends to have greater concerns about health (e.g., fat content), environmental concerns, likely to have young children at home, likely to have college education, and has growing income. All aspects associated with more favorable demand for plant-based protein. If plant-based protein price declines and the product is viewed more favorably by consumers in taste and appearance, it could become a stronger substitute for beef. However, that is likely some ways into the future. However, it provides key attributes of the plant-based product for the beef industry to monitor (see the Strategy and Recommendations section for more discussion here).
7. Finally, although it is worthwhile to track the share of the protein market beef is able to garner, it is even more important to focus on strategies that can grow the overall size of the market and strategies that ultimately improve profitability of beef producers.

B. Strategy, Summary, and Extended Recommendations

Livestock producers have a rather obvious and direct interest in the rise of new plant-based protein substitutes. However, it is important to also note the significance of animal protein production to the health of the agricultural economy more generally. In 2019, USDA Economic Research Service data indicate cash receipts in U.S. agriculture totaled \$370 billion (USDA ERS, 2021). Almost half of that (47.6%) accrued from the sale of animal products. Another 16% was from feed grains that either directly go to animal feed or consumed in the form of distillers grains. Another 9.7% of total receipts were accounted for by oil crops (mainly soybeans), which also primarily go toward feeding livestock and poultry. As these data clearly indicate, the economic health of U.S. agriculture is heavily tied to demand for animal products, and as such factors which have the potential to adversely affect animal product demand have far-reaching consequences.

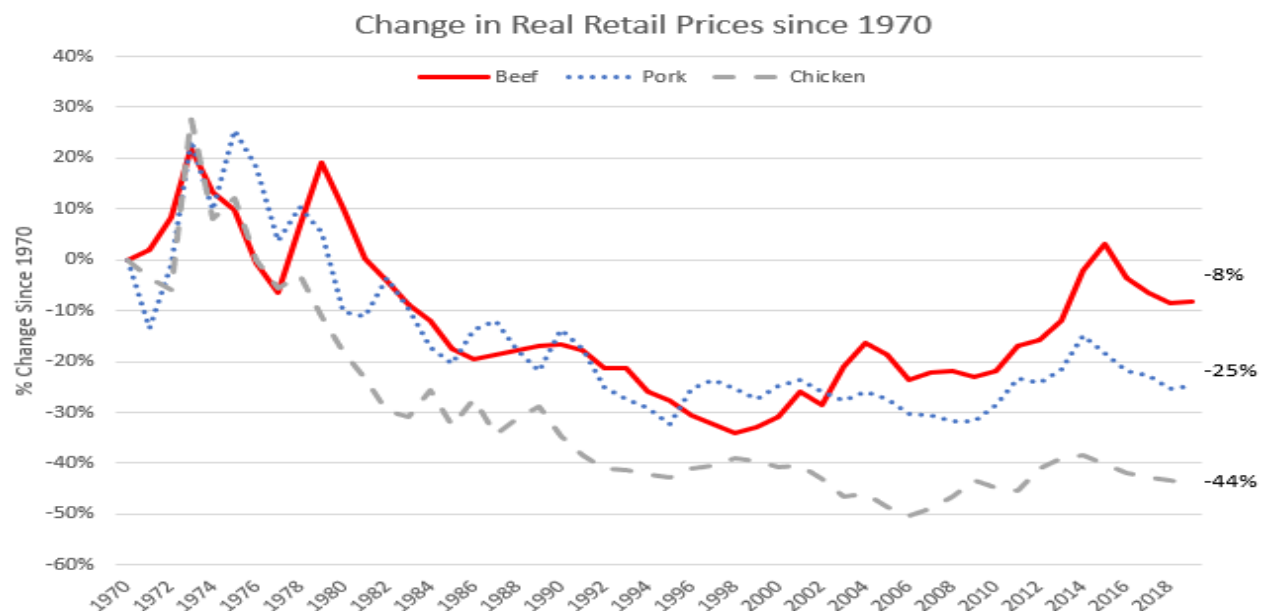
Looking specifically at the beef sector, some historical perspective may be useful. The following figures show changes in real retail prices and domestic per capita consumption since 1970 for beef and two competing animal proteins, pork and chicken. Relative to 1970, per capita consumption of beef has fallen 31%, while per capita consumption of chicken has increased 160%.¹ Some of these consumption changes are explained by relative price changes. While beef is more affordable today (in inflation adjusted terms) than in 1970, chicken and pork have become much more affordable still. Compared to 1970, real retail pork and chicken prices are today 25% and 44% lower, respectively.

Figure I. Change in U.S. Per-Capita Consumption, 1970-2019



¹ While per-capita consumption of beef has fallen, it should be noted some of this is a result of rising population. It is also the case that for all three proteins, exports have taken on an increasingly prominent role in the overall demand picture. Compared to 1970, exports of beef, pork, and chicken are up 7474%, 9195%, and 7480% in 2019.

Figure II. Change in U.S. Real Retail Prices, 1970-2019



Using an approach like the one outlined in Lusk and Tonsor (2020), the aforementioned price and quantity changes can be used to determine the extent to which demand has fallen and determine how much of any decline is due to changes in prices of substitute proteins. Data indicate per-capita U.S. quantity of beef demanded is 36.3% lower in 2019 as compared to 1970. Roughly a third of this demand decline is explained by falling prices of pork and chicken.² However, even if chicken and pork prices were the same in 2019 as in 1970, we would still predict the quantity of beef demanded to be roughly 26% lower in 2019 than in 1970. Thus, the other two-thirds of the demand decline is explained by non-price factors. A driver throughout the 1980s and 1990s was increased concerns about fat and cholesterol, which adversely effected beef demand (Kinnucan et al., 1997; Tonsor, Mintert, and Schroeder, 2010). The emergence of Atkins and high protein diets, among other factors, in the 2000's helped reverse the slide in beef demand (Tonsor, Mintert, and Schroeder, 2010).

These historical changes potentially have implications for anticipated impacts of plant-based protein on U.S. beef demand. At present, plant-based meat alternatives represent a very small share of the market. What might cause this to change? As was the case for chicken over the past six decades, increased affordability and product development aligned with consumer interest of the alternatives would adversely affect beef demand. However, our rough estimates suggest associated with falling chicken and pork prices since the 1970s, and the analysis presented from the survey, that while falling prices of plant-based alternatives would adversely affect beef demand, other factors associated with health and safety perceptions and changes in demographics are more decisive factors. Data from our survey indicate that at present, consumers' perceptions of health and quality of beef remains quite favorable related to plant-

² These calculations assume an own-price elasticity of demand for beef of -0.6 and cross price elasticities of 0.15.

based alternatives. The extent to which plant-based alternatives significantly affect beef demand depend on the extent to which they come to be seen as tasty and healthy alternatives, and the extent to which consumers' preferences for issues such as animal welfare and the environment shift. In general, rising incomes tend to be associated with heightened preferences for health as well as environmental and animal welfare impacts of food production. Meanwhile, rising incomes are also associated with overall increased demand for protein presenting both domestic and export opportunities as consumer incomes improve.

A key question relates to the ultimate market share of plant-based products. The various survey-based experiments all showed, that if pitted with a binary choice between a plant-based alternative and traditional beef, around 25% of consumers select a plant-based alternative. However, a few caveats are worth mentioning. Some of the individuals who choose the plant-based alternative are unlikely to consume much (if any) beef. In this sense, growth in the market share of plant-based alternative is not entirely coming at the cost of reduced beef demand, and indeed if a plant-based alternative simply replaces a substitute competitor (like a chicken sandwich) or reflects overall growth in protein demand, the impacts on beef demand are likely to be negligible. Nonetheless, the fact that roughly a quarter of consumers indicate they'd choose a plant-based alternative suggests there is ample room for this market to grow relative to its current position of under 1% market share. Stated differently, our estimates suggest we will likely continue to witness significant growth in the plant-based alternative market even if all that changes is increased availability (and prices remain fixed at the status quo and consumer preferences and beliefs remain unchanged).

Despite the anticipated growth in plant-based alternatives relative to the present, some of the dire, or optimistic depending on one's perspective, predictions seem unlikely. For example, Impossible Foods CEO Patrick Brown has been regularly quoted as indicating his goal is to eliminate animal agriculture within the next 15 to 20 years. This outcome seems unlikely for a number of reasons. First, as our analysis shows, consumer perceptions and preferences are currently not at a place that would support such a demand shift. Second, virtually all the production innovation that has entered the market has focused on ground products, but of course consumers also enjoy many whole muscle cuts from T-bones to briskets – products currently uniquely sourced from cattle. While lab-based cellular products have the potential to replicate whole muscle cut products, it will likely be many years before products will hit the market, and it remains to be seen whether the science will advance to a point that these products will truly replicate the eating experience of animal-based products. Finally, cattle make use of range and grass lands that are unlikely to find high valued alternative uses. With the opportunity cost of such land relatively low implies cattle are likely to continue to be reared in such settings for some time to come.

It is also important to note strong growth rates could occur for plant-based items yet a smaller market share resulting. In fact, early in the COVID19 pandemic this occurred as retail sales of plant-based items jumped; but so did many other protein items. Accordingly, plant-based item retail market share declined despite growth of overall sales – an observation that conveys caution on using market-share measures.

What factors might accelerate consumer purchases of alternative plant-based proteins? There continues to be high level of [venture capital and investment money](#) funneled into this sector. These funds are likely to be spent on science which improves the taste and functionality

while reducing the cost of plant-based alternatives. Moreover, such investments are likely to aid promotional activities that aim to improve consumers' perceptions of these products. Changes in the policy environment might influence relative costs of animal agriculture vs. plant-based alternatives. Because cattle are ruminants and emit methane, they are responsible for [a sizeable share](#) of the greenhouse gas emissions associated with U.S. agriculture. Policies which aim to curb climate emissions would increase the cost of cattle production and would tend to favor (in a relative sense) plant-based alternatives. There is also more informal "retailer regulation." As has been seen in other animal protein sectors like pork and egg production, large retailers often make commitments to source (or sell) certain products, and these strategic decisions on the part of retailers can often have much bigger impacts on markets than aggregation of individual consumers.

How can the beef industry position itself to mitigate against the potential adverse impacts of plant-based protein? The "natural" and "unprocessed" aspects of animal protein, aspects which consumers desire, are key competitive advantages that are unlikely to be impeached by plant-based alternatives. There have been several efforts in recent years to increase integration and/or information transmission from retailer-to-packer-to-farmer, and vice-versa. These efforts are likely to help improve price and quality signals across the supply chain, but more subtly might be beneficial in tying retailers' profitability more closely to the fate of beef and cattle production, which might have advantages in mitigating against activist and policy pressures to alter their mix of product offerings.

A question that is unclear at this stage of development of the plant-based protein sector is whether it can or will target a cheap protein market segment or a higher quality segment. We anticipate the larger initial market opportunity for plant-based protein is a low-cost protein market. This is because likely the costs of getting the product to higher quality markets with a product that is comparable or better than beef is a stretch at this time. Furthermore, modifying plant-based products to strive to mimic high quality beef would require even more product manufacturing making it less natural, an important attribute to consumers of beef. As such, the market opportunity that may be most fruitful for plant-based protein could end up being lower-quality, lower-cost products for those unable to afford high-quality grain-fed beef. In other words, the larger threat may end up being for lower-cost, lower-quality beef producing regions exporting beef products to developing countries.

It is also important to consider how the industry may benefit from possible positive impacts from plant-based proteins. Notably, we find here that most purchases of plant-based items are coupled with and purchased by the same consumer of beef or chicken items. This is consistent with a quote by Anne-Marie Roerink, principal of 210 Analytics, LLC and author of the annual Power of Meat report: "(plant-based) alternatives and meat are often compared using 'versus' but in reality it's more of an 'and' behavior". "Almost all households who buy alternatives also buy meat, usually in the same basket." Given this, there likely are opportunities to leverage new and strengthening consumer interest in the role of protein in their diet and advances in plant-based offerings may be a new source of this interest that could be leveraged by the beef industry.

I. Objectives, Process, and Project Overview

A perpetual industry priority is to better understand and monitor beef demand, as well as to inform stakeholders because demand directly influences overall industry profitability. Given this priority, this project has five main steps.

1. First, we assessed currently published literature related to consumer demand for new plant-based protein offerings in the U.S. This initial step helped identify knowledge gaps. Completion of Step 1 occurred upon project launch and was shared during an in-person presentation with the CBB Evaluation Committee in February 2020 at the Annual Cattle Industry Convention in San Antonio, TX.
2. At the 2020 Cattle Industry Convention, the CBB Evaluation Committee was presented the literature review and initial findings from a supplemental survey conducted in December 2019. The Evaluation Committee provided feedback and offered suggestions guiding the remainder of the project.
3. After an unexpected delay due to the COVID19 pandemic, in September 2020 a nationally-representative survey was conducted. The over-arching purpose was documenting current prevalence of plant-based protein consumption, perceptions of plant-based vs. animal-based protein, and preferences for plant-based and animal-based protein under various experimental settings. We built upon information gathered in Steps 1 and 2, and a long history of our team with consumer assessment using multiple economic methods.
4. In addition to reporting results of the survey, we offer expert opinion on related economic effects of the emergence of plant-based protein. Here we provide opinions on other economic factors worthy of consideration. The goal of Step 4 is to document current “best guess” assessments the team has formed on points not directly assessed in Steps 1-3 to help the industry prioritize future work in this evolving area.
5. Lastly, starting with a presentation at the abbreviated 2021 Cattle Industry Annual Convention held virtually due to the pandemic, we will collaborate with CBB staff to disseminate findings and implications to industry stakeholders.

II. National Survey and Analyses

A central aspect of this project was a large consumer survey effort where information was collected from U.S. residents. Initially the survey was targeted for March 2020. However, with the pandemic's onset and guidance from the Evaluation Committee, data collection was delayed. The survey was conducted between August 24th and September 30th 2020 yielding 4,894 (at least partially completed) survey responses. Our analyses utilize 3,225 observations after omitting responses failing to pass four data-quality filters. Respondents were omitted if they did not grocery shop, had reported age below 18 or above 120 years, failed a question testing attentiveness, or revealed in a self-assessment their responses were not truthful. Respondent characteristics are summarized in Table 1. Each variable in Table 1 is a dummy variable equal to 1 if the characteristic applies, and 0 otherwise (presented values are percentages).

The survey included the following question designed to identify the self-declared diet of each participant: *"Which of the following statements best describes your personal diet?"*

- Vegan (do not eat meat, fish, dairy, eggs, honey or any food derived from animals)
- Vegetarian (do not eat meat or fish, but do eat dairy and eggs)
- Flexitarian/Semi-Vegetarian (mostly follow a vegetarian diet, but occasionally eat meat or fish)
- Regularly consume meat, fish/seafood, or products derived from animals
- None of the above"

As noted in table 1, 68% indicate they regularly consume meat, fish/seafood, or products derived from animals. Throughout this report, we use "Regular Meat Consumer" to describe this population segment. Consistent with this project's focus, ideally, we would compare characteristics, perceptions and consumption patterns across a number of alternative self-reported diets. However, there are insufficient observations for all breakouts. Accordingly, we group together flexitarians, vegans, vegetarians, and none into a "non-regular meat consumer" or "alternative diet" category. We use this to encompass respondents who do not regularly eat meat yet recognize it does contain a mix spanning from Flexitarians who do still consume meat to those who truly consume no meat protein. Where feasible we report results both for the total sample and specifically for those self-declaring to regularly consume meat products but never for instance breakout flexitarians separate from vegans or vegetarians. Consistent with this, Table 1 reports percentages for our full sample as well as separately for those self-reporting to regularly consume meat products vs. an alternative diet.

Table 1. Respondent Summary Statistics, Percentages (n=3,225)

Variable	Full Sample	Regular Meat Consumer	Other Diet	p-Value
Number of Respondents	3,225	2,186	1,039	
Age				
- Under 35 Years of Age	29.8%	23.1%	43.6%	0.000
- 35 to 55 Years of Age	33.0%	31.8%	35.5%	0.036
- Base Case: Over 55 years of age				
Gender				
- Male	48.4%	48.0%	49.3%	0.496
- Base Case: Female				
Census Regions				
- Northeast	17.2%	17.1%	17.4%	0.843
- Midwest	20.9%	23.0%	16.5%	0.000
- South	38.1%	37.9%	38.4%	0.777
- Base Case: West				
Education				
- College, 4 Year Degree	32.3%	30.8%	35.2%	0.014
- Base Case: No 4 Year College Degree				
Income				
- Below \$60,000	52.4%	52.5%	52.3%	0.931
- Above \$100,000	30.0%	28.5%	33.1%	0.007
- Base Case: Income \$60,000 to \$100,000				
Race/Ethnicity				
- Hispanic/Latino	13.2%	9.8%	20.4%	0.000
- Base Case: Not Hispanic/Latino				
- White	76.5%	80.9%	67.5%	0.000
- Black/African American	13.4%	10.6%	19.2%	0.000
- Base Case: Neither White nor Black/African American				
Marriage				
- Married	51.5%	53.2%	48.2%	0.011
- Base Case: Not Currently Married				
Children Under Age of 12				
- Yes	23.9%	20.0%	32.2%	0.000
- Base Case: No children under age of 12				
Home Description				
- One Family, Detached	61.4%	63.8%	56.6%	0.000

- Base Case: Other type of home

Political Party Affiliation

- Democratic	37.2%	34.1%	43.7%	0.000
- Republican	34.1%	35.8%	30.4%	0.003
- Base Case: Libertarian, Constitution, Green, Tea Party, Independent or Other				

Diet

- Regularly Consume Meat, Fish/Seafood, or Products Derived from Animals	67.8%
- Vegan	7.4%
- Vegetarian	3.7%
- Flexitarian/Semi-Vegetarian	12.3%
- None of the above	8.9%

Note: Census Regions are: Northeast (ME, NH, VT, MA, CT, RI, NJ, NY, PA), Midwest (ND, SD, NE, KS, MO, IA, MN, WI, IL, IN, OH, MI), South (TX, OK, AR, LA, MS, AL, TN, KY, WV, MD, DE, DC, VA, NC, SC, GA, FL), and West (AK, HI, WA, OR, CA, NV, ID, MT, WY, UT, CO, AZ, NM). *p-values* are from Chi-square tests for equivalence between Regular Meat Consumers and Other Diet sub-groups.

Regular meat consumers are less likely to be under 35 years old, have a 4-year college degree, have household incomes above \$100,000, be Hispanic/Latino or Black/African American, to have children under the age of 12, and to be affiliated with the Democratic party. Conversely, regular meat consumers are more likely to reside in the Midwest region, be married and be affiliated with the Republican party. Taken broadly, the alignment of these characteristics with self-reported diet is consistent with our expectations.

Data was collected attempting to match targeted percentages for age, education, gender, income, region of residence, and race to reflect US census prevalence rates. Subsequently, we conducted all analyses using sample weights so the sample represents the U.S. population in terms of the distributions of six characteristics. As we proceed to conduct refined assessments using only subsets of this full data set, the exact match with the national population varies, and sampling errors may increase, given reduced sample sizes despite intentional random allocation of respondents across treatments.

The following sections outline consumer stated history of plant-based protein consumption, perceptions of how beef and plant-based offerings compare, and a description of the experimental approach taken yielding novel insights on specific areas of focus regarding beef demand impacts.

a. History of Plant-Based Protein Consumption

The survey began by providing the following statement:

“We are going to ask you some questions about the types of protein you may consume. Please read the following category descriptions before continuing the survey.”

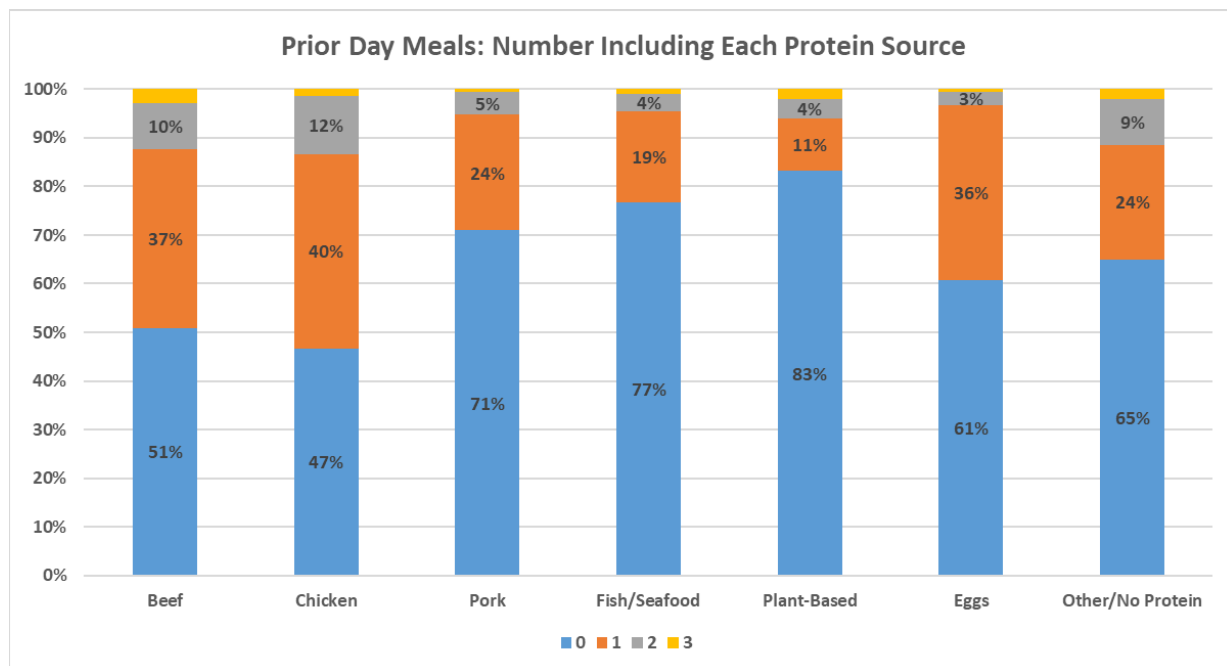
- “Beef” refers to foods such as beef steak, hamburger, ground beef, beef roast, beef sandwiches and other beef-based meals.

- “Pork” refers to foods such as ham, ham sandwiches, bacon, pork chops, pork ribs, pork roast, ground pork, and other pork-based meals.
- “Chicken” refers to foods such as chicken breasts, chicken legs/thighs, chicken wings, ground chicken, chicken nuggets, fried chicken, chicken sandwiches and other chicken-based meals.
- “Fish/Seafood” refers to foods such as fish sticks, fish sandwiches, tuna, salmon, shrimp, trout, catfish and other fish-based meals.
- “Plant-Based Proteins” refers to plant-based foods, not derived from animals, such as patties and ground crumbles”

It should be noted these descriptions were not specific to any particular company or brand, and rather were intended for respondents to appreciate what terms including “beef” and “plant-based” referred to.

All respondents were asked questions about their plant-based protein consumption. Our first insights follow from a sequence of recall questions asking about the respondent’s prior-day meals. Considering the standard three-meal approach of breakfast, lunch, and dinner this provides a 0-3 count for each respondent of how many prior-day meals included various proteins. Figure 1 summarizes findings.

Figure 1. Recall Data, Prior Day Meals (n=3,225)



Considering prior-day’s food consumption, the vast majority (83%) did not have a plant-based protein item, 11% had plant-based proteins in one meal, 4% had plant-based proteins in two meals, and 2% had plant-based proteins in all three meals. This differs notably from the pattern for beef where 49% had beef in at least one meal. Specifically, 37% had beef in one

meal, 10% had beef in two meals, and 3% had beef in all three meals. This documents the much higher prevalence of beef over plant-based proteins currently in U.S. diets.

It is further important to recognize that often, multiple sources of protein are contained in the typical resident's prior day meals. For instance, of the 17% who reported a plant-based protein in at least one prior day meal, 36% also reported having beef in at least one meal. Meanwhile, of the 49% who had beef in at least one meal, 12% also reported having a plant-based protein the prior day. A key point here is that beef and plant-based protein consumption are not entirely exclusive.

To better appreciate related drivers of purchasing decisions, we proceed to consider how each respondent falls into one of four situations considering prior day meals. They could have consumed both beef and plant-based (6%), consumed beef but not plant-based (43%), consumed neither beef nor plant-based (40%), or consumed plant-based but not beef (11%). Beyond appreciating the relative size of these four groupings, it is instructive to see what socio-economic characteristics align with underlying beef and plant-based protein consumption decisions. Accordingly, we estimate a multinomial logit model to provide these insights and table 2 reports the resulting marginal effects.³

Table 2. Modeling Probability of Beef & Plant-Based Protein Inclusion in Prior Day Meals, Marginal Effects (n=3,225)

Parameter	Beef & Plant-Based (6% of sample)	Beef & No Plant-Based (43% of sample)	Neither Beef nor Plant-Based (40% of sample)	Plant-Based & No Beef (11% of sample)
Age, Under 35	0.016	0.072	-0.108	0.020
Age, 35 to 55	0.016	0.025	-0.034	-0.007
Male	0.026	0.062	-0.094	0.006
College, 4 Years or More	0.028	-0.075	0.028	0.020
Household Size	0.000	0.000	0.000	0.000
Income, Above \$100,000	0.023	-0.044	0.001	0.021
Region, Northeast	-0.013	-0.022	0.072	-0.038
Region, Midwest	-0.004	0.062	-0.006	-0.051
Region, South	0.003	0.010	-0.005	-0.009

Note: The values reported are changes in probability of someone in each parameter category, accounting for other attributes, indicating they consumed each respective combination of products the previous day. For example, Males had a 2.6% greater probability of consuming both beef and plant-based, 6.2% beef alone, 9.4% less likely to have consumed neither, and 0.6% more likely to have consumed plant-based only. The probabilities in each row sum to 0 (e.g., for males, $2.6 + 6.2 - 9.4 + 0.6 = 0$).

As one interprets results in table 2, the base categories noted in table 1 can be referenced. For instance, consider the impact of gender. Male respondents are 6.2% more likely than females to have beef and not any plant-based proteins yesterday. Meanwhile, female respondents are 9.4% more likely than males to have consumed neither beef nor plant-based proteins yesterday.

³ Note tables are included in the Appendix overviewing results of this and other models. We focus here on marginal effects and other intuitive measures that are derived from parameter estimates.

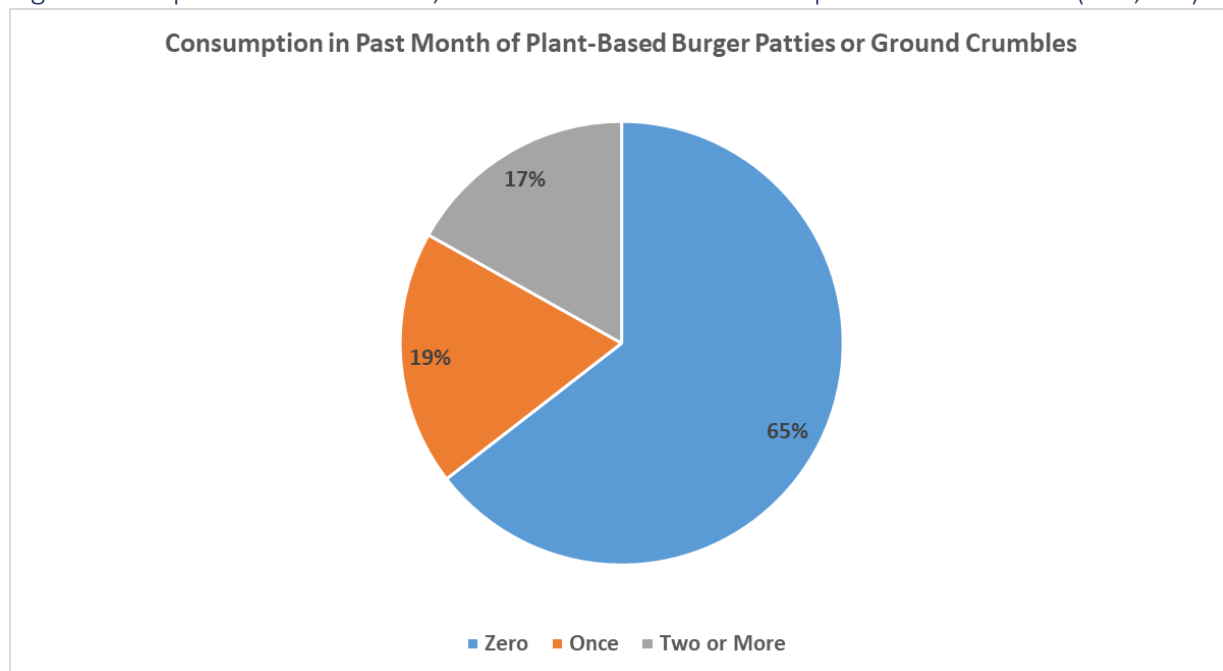
Also note the marginal effect of each variable has a net-zero effect across the four possible combinations of inclusion/omission of beef and plant-based proteins (i.e., rows in table 2 sum to zero). The largest effects correspond to age and gender. Respondents who are under 35 are 10.8% less likely to have consumed neither beef nor plant-based proteins in the prior day and 7.2% more likely to have had beef and not plant-based, 2.0% more likely to have eaten plant-based and not beef, and 1.6% more likely to have had both protein sources. As noted, males are less likely to have neither product and more likely to have beef without a plant-based item. Combined this indicates that males under the age of 35 remain important segments of current beef consumers.

Characteristics aligning with having a plant-based protein and no beef yesterday include higher education and income. Specifically, those with 4 years or more of college and household incomes over \$100,000 are 2.0% and 2.1% more likely to make this choice, respectively. It is important to further note, these consumers are also more likely to select both beef and plant-based proteins than to have beef and no plant-based items. This suggests higher educated and income households remain important consumers of beef items, even if they may also be incorporating plant-based items – recall there are three meals in the prior day enabling such outcomes.

Finally, it is worth noting region of residence patterns where we utilized US Census regions, with an omitted base case of the Western region. Northeastern residents are most likely to have neither beef nor plant-based proteins. Midwestern and Southern residents are most likely to have beef and not a plant-based item.

A second insight into prevalence of plant-based protein consumption comes from a broader question focused on past consumption history. Specifically, we asked: *“Over the past month, what best describes your consumption of plant-based burger patties or ground crumbles (for instance Beyond Meat, Impossible Burger, etc.)?”* Answer options of “zero,” “once,” and “two or more” were provided with results summarized in figure 2.

Figure 2. Respondent Recall Data, Plant-Based Protein Consumption in Past Month (n=3,187)



Consistent with the previous results, the majority (65%) of residents have not consumed plant-based proteins in the past month and only 17% have done so more than once. As compared to the Power of Meat survey, which found 56% of Americans had prepared a plant-based meat alternative, we find a smaller share of respondents (35%=18.60%+16.88%) indicating they've consumed plant-based burgers or crumbles. Similar to the 2020 Power of Meat Survey we find of those who have tried alternatives, most only tried them once or prepared them every few months at most.⁴

We subsequently asked respondents an open-ended follow-up question. Those stating they had not consumed plant-based proteins in the past month were asked: *"In your own words, please describe why you have not consumed plant-based burger patties or ground crumbles in the past month."* Similarly, those indicating they had consumed plant-based proteins were asked why. Using these open-ended text responses, we build Word Clouds to highlight tendencies in thoughts shared by participants as shown in figures 3-5.

While interpreting word clouds can be subjective, it is useful to note the most commonly used words to "get in the mind" of most respondents. Among those commenting on reasons for not consuming plant-based proteins many indicated they like the taste of real meat. This reflects "like," "taste," "real," and "meat" being four of the five most commonly shared words (figure 3). The terms "try" and "wanted" are the two most expressed by those who tried plant-based proteins only once (figure 4). This may suggest these consumers were curious, but some aspect of their plant-based eating experience was disappointing or unsatisfactory leading them to not make follow-up consumption decisions. Among those commenting on why they consumed plant-based proteins multiple times the terms "like" and "healthier" are among the

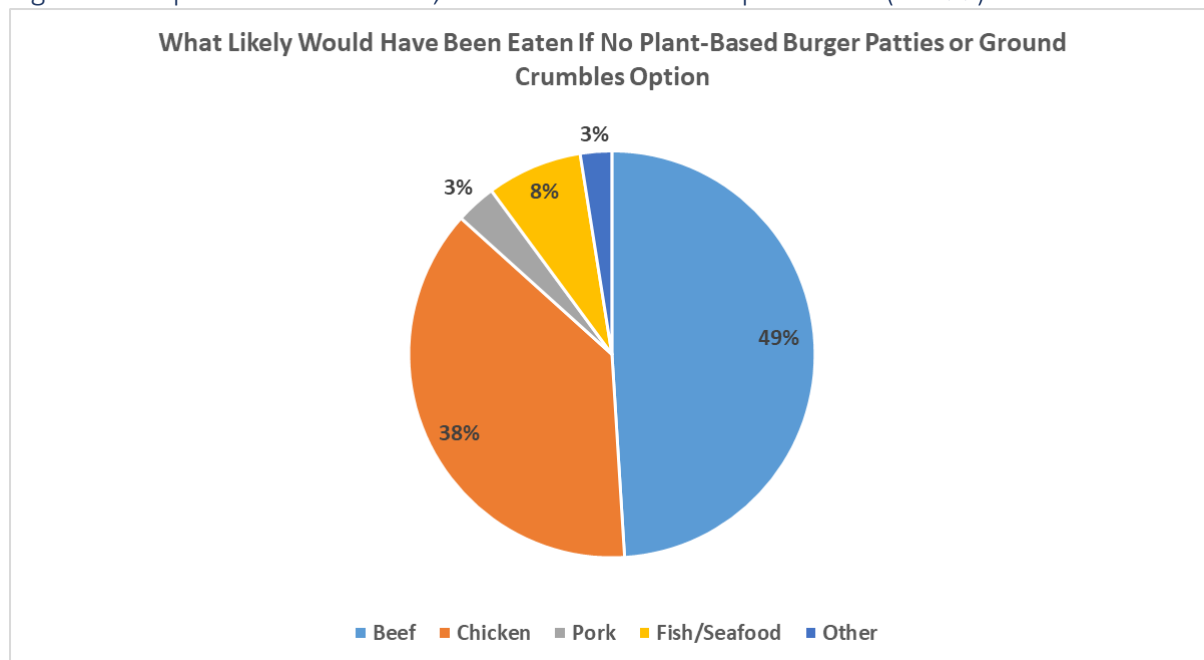
⁴ "Analogue dish" available online:

<http://library.meatingplace.com/publication/frame.php?i=676576&p=&pn=&ver=html5>

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of plant-based protein may have displaced beef and chicken much more than pork, fish/seafood, or other proteins.

Figure 6. Respondent Recall Data, Plant-Based Protein Replacement (n=477)



b. Beef vs. Plant-Based Protein Perceptions

The preceding section summarized base consumption patterns as background to our ensuing insights on determinants of beef vs. plant-based protein demand. To begin that assessment, we included a series of 5-point Likert scale questions to capture consumer perceptions on how beef and plant-based protein products compare on multiple dimensions.

One-half of survey respondents were asked to compare beef steak with plant-based while the other half compared beef hamburger (ground beef) with plant-based alternatives. The aim is to determine whether there are perception differences within the beef category. Tables 3 and 4 summarize results from comparisons over a list of 15 items. These 15 items encompass the 12 “Protein Values” regularly assessed in the beef and pork checkoff-supported Meat Demand Monitor project in addition to “Sustainability,” “Ingredient List,” and “Naturalness.” These three items were added following dialogue with the Evaluation Committee early in this project.

Overall, the areas where beef is viewed most favorably is consistent across steak and hamburger. Taste, Appearance, and Price are the top-3 traits in beef steak’s favor and Taste, Price, and Ingredient List top ground beef values. Conversely, plant-based fares best regarding Environmental Impact, Animal Welfare, and Health though even these score slightly below both steak and hamburger. Both Steak and Hamburger, on the other extreme, score relatively lower on Environmental Impact, Health, and Sustainability with hamburger also scoring relatively low on Safety. Plant-based score poorly on Taste, Price, Ingredient List, Appearance, Freshness, Convenience, and Naturalness. However, it is important to appreciate that average scores for

all items are below 3.0 (a score of 3.0 would indicate beef and plant-based are the same, above 3.0, plant-based is better, and below 3.0 beef is preferred). This indicates more favorable responses for beef, on all 15 items, than for plant-based.

Figures 7 and 8 show the percentage indicating “Better” or “Much Better” providing a simplified summary of these rankings. Now, the relative advantage that both beef steak and hamburger have over plant-based on several dimensions becomes readily clear. There is at least 30% more of consumers suggesting beef is superior regarding Taste, Appearance, Price, Naturalness, Ingredient List, Freshness, and Convenience.

Table 3. Beef Steak vs Plant-Based, Protein Values (n=1,566)

Statement	Beef Steak (from animals) is Much Better	Beef Steak (from animals) is Better	Beef Steak (from animals) & Plant-Based Are Somewhat the Same	Plant-Based is Better	Plant-Based is Much Better
Price (the price you pay for the product)	33%	29%	23%	9%	5%
Freshness (if product is fresh as indicated by expiration date and visual perception)	31%	22%	28%	10%	9%
Environmental Impact (if production and marketing of the product impacts the environment)	22%	17%	22%	21%	17%
Sustainability (if product is produced in a sustainable manner)	25%	18%	22%	22%	14%
Nutrition (if product provides essential nutrients such as protein, carbohydrates, vitamins, and minerals)	29%	24%	24%	14%	10%
Safety (if consuming the product will not cause illness)	25%	19%	27%	16%	14%
Appearance (if product looks appealing and appetizing)	37%	27%	24%	7%	6%
Health (if product positively contributes to long term health; including amount and type of fat and cholesterol in the product)	25%	17%	22%	22%	14%
Convenience (if product can be prepared and consumed easily or quickly)	31%	20%	30%	11%	8%
Taste (if product is appealing to the senses including flavor, smell, and texture)	42%	27%	19%	7%	6%
Origin/Traceability (if locations and source identities are known)	26%	22%	30%	13%	9%
Animal Welfare (if source of the product was raised using animal friendly means)	24%	20%	15%	18%	22%
Hormone-Free/Antibiotic-Free (if source of the product used added hormones or antibiotics)	26%	19%	21%	20%	15%
Ingredient List (length of ingredients in the product)	32%	23%	21%	14%	10%
Naturalness (made without modern food technologies and ingredients)	29%	28%	20%	12%	10%

Table 4. Beef Hamburger vs Plant-Based, Protein Values (n=1,631)

Statement	Beef Hamburger (from animals) is Much Better	Beef Hamburger (from animals) is Better	Beef Hamburger (from animals) & Plant-Based Are Somewhat the Same	Plant-Based is Better	Plant-Based is Much Better
Price (the price you pay for the product)	35%	30%	22%	7%	6%
Freshness (if product is fresh as indicated by expiration date and visual perception)	29%	20%	33%	11%	6%
Environmental Impact (if production and marketing of the product impacts the environment)	23%	17%	24%	22%	15%
Sustainability (if product is produced in a sustainable manner)	24%	18%	25%	19%	13%
Nutrition (if product provides essential nutrients such as protein, carbohydrates, vitamins, and minerals)	28%	21%	27%	15%	9%
Safety (if consuming the product will not cause illness)	23%	19%	31%	17%	11%
Appearance (if product looks appealing and appetizing)	33%	24%	29%	8%	6%
Health (if product positively contributes to long term health; including amount and type of fat and cholesterol in the product)	24%	18%	23%	22%	13%
Convenience (if product can be prepared and consumed easily or quickly)	28%	23%	35%	8%	7%
Taste (if product is appealing to the senses including flavor, smell, and texture)	42%	26%	20%	7%	5%
Origin/Traceability (if locations and source identities are known)	25%	22%	30%	13%	9%
Animal Welfare (if source of the product was raised using animal friendly means)	24%	20%	17%	19%	21%
Hormone-Free/Antibiotic-Free (if source of the product used added hormones or antibiotics)	24%	19%	21%	21%	14%
Ingredient List (length of ingredients in the product)	34%	25%	20%	14%	8%
Naturalness (made without modern food technologies and ingredients)	31%	23%	23%	14%	9%

Figure 7. Beef Steak vs. Plant-Based, Protein Value Perceptions (% Better or Much Better; n=1,566)

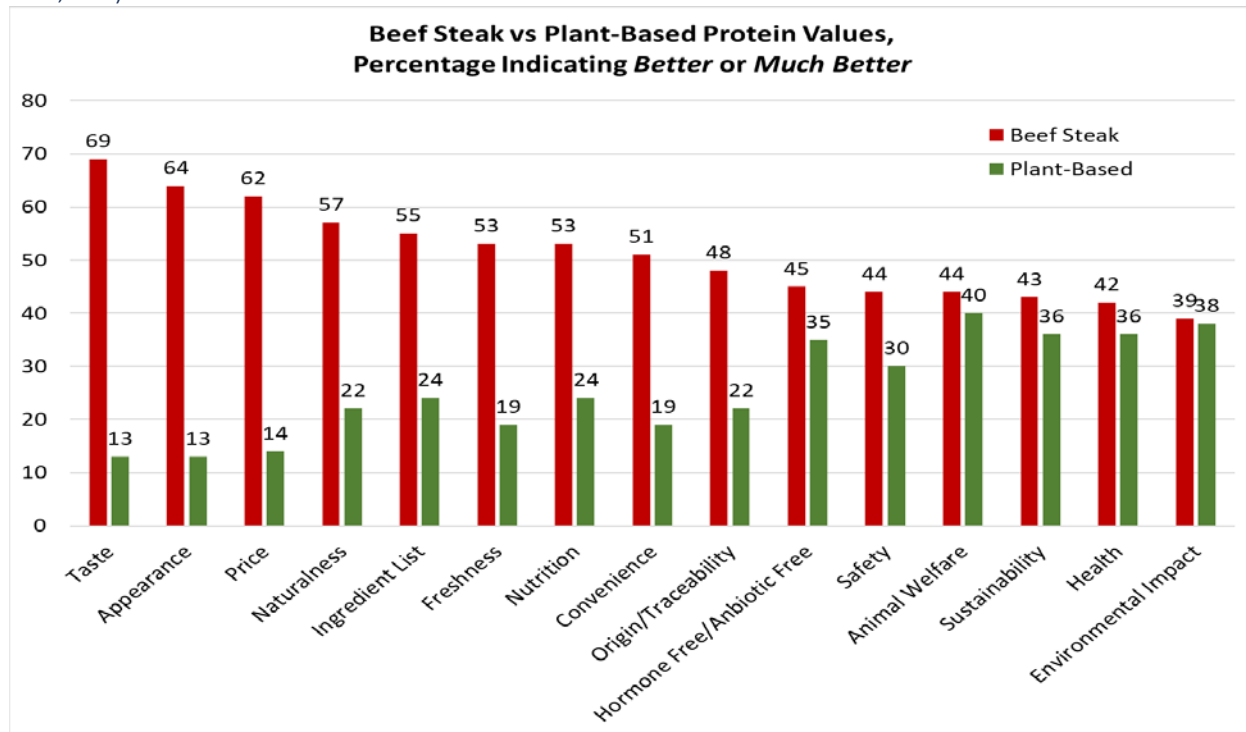
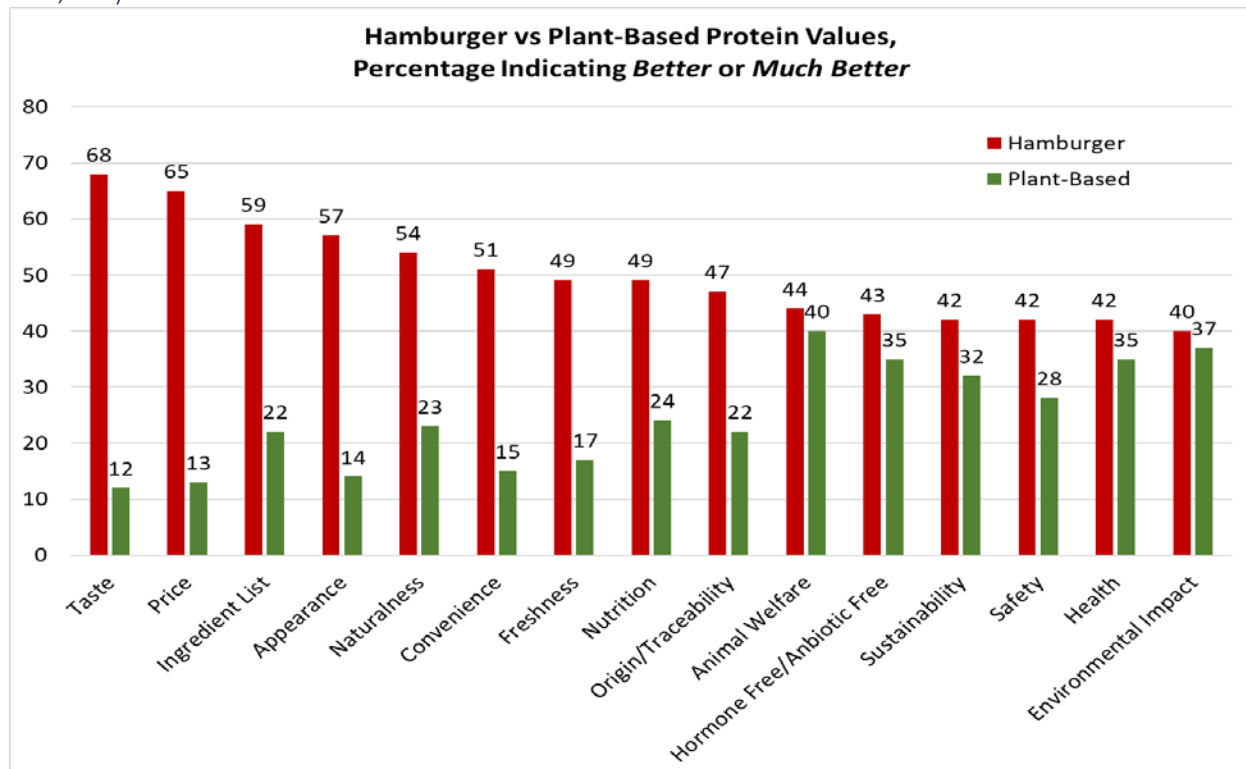


Figure 8. Hamburger vs. Plant-Based, Protein Value Perceptions (% Better or Much Better; n=1,631)



Given elevated interest in how nutrient content panels vary between beef and plant-based products we included an additional set of Likert-scale perception questions. Here a list of 15 nutrients was developed encompassing the major items appearing on product labels. Overall, the areas where beef is viewed most favorably is again consistent across steak and hamburger (tables 5 and 6). Protein and Iron are the top traits for steak and hamburger, with Preservatives and Carbohydrates also ranking highly for both. Conversely, Plant-Based is perceived better regarding Cholesterol, Dietary Fiber, Total Fat, and Saturated Fat. Average relative scores are near, or slightly greater than 3.0 which is a point of neutrality (above 3.0 are for plant-based being better than beef). Hence, while plant-based has higher relative scores for Cholesterol, Dietary Fiber, Total Fat, and Saturated Fat these scores do not convey a strong view for the majority of consumers.

Generally, beef does not score well for perceptions of Total Fat, Saturated Fat, Cholesterol, and Dietary Fiber relative to plant-based. For instance, 16% (Cholesterol in beef steak assessment and both Saturated Fat and Cholesterol in hamburger assessment) is the highest frequency for a “plant-based is much better” response.

Figures 9 and 10 show the percentage indicating “Better” or “Much Better.” At least 30% more consumers suggest beef is superior regarding Protein and Iron. Meanwhile, at least 5% of consumers view beef as inferior regarding Dietary Fiber, and Cholesterol. While specific contents vary by product both for beef and plant-based items, given nutrient contents panels appear on retail items sold it is feasible to further assess consumer perceptions against posted nutrient information. As a general statement, beef nutrient facts panels indicate beef has higher protein, total fat, and saturated fat content while plant-based has higher sodium and total carbohydrate content. This aligns with perceptions consumers shared in our survey. That said, for each nutrient there are segments who hold inaccurate perceptions and hence could be targets for strategic, educational efforts.⁵

⁵ Although, as discussed further below in our experiment the overall impact of providing nutritional information had little impact on consumer choices.

Table 5. Beef Steak vs Plant-Based, Nutrient Contents (n=1,566)

Statement	Beef Steak (from animals) is Much Better	Beef Steak (from animals) is Better	Beef Steak (from animals) & Plant-Based Are Somewhat the Same	Plant-Based is Better	Plant-Based is Much Better
Calories	21%	18%	26%	24%	12%
Total Fat	20%	18%	23%	25%	14%
Saturated Fat	20%	16%	22%	27%	15%
Cholesterol	19%	16%	22%	27%	16%
Sodium	23%	20%	30%	17%	10%
Potassium	19%	17%	38%	17%	9%
Total Carbohydrates	22%	19%	30%	18%	11%
Dietary Fiber	18%	17%	25%	27%	14%
Sugars	22%	20%	33%	16%	9%
Protein	31%	25%	27%	9%	8%
Iron	28%	25%	28%	11%	8%
Zinc	20%	20%	37%	15%	9%
Vitamin B12	21%	19%	35%	16%	9%
Preservatives	22%	20%	29%	18%	11%

Table 6. Beef Hamburger vs Plant-Based, Nutrient Contents (n=1,631)

Statement	Beef Hamburger (from animals) is Much Better	Beef Hamburger (from animals) is Better	Beef Hamburger (from animals) & Plant-Based Are Somewhat the Same	Plant-Based is Better	Plant- Based is Much Better
Calories	20%	17%	27%	23%	13%
Total Fat	19%	19%	21%	26%	15%
Saturated Fat	19%	18%	22%	25%	16%
Cholesterol	19%	16%	22%	27%	16%
Sodium	21%	19%	32%	18%	10%
Potassium	20%	18%	36%	17%	9%
Total Carbohydrates	22%	21%	29%	18%	11%
Dietary Fiber	18%	14%	28%	26%	14%
Sugars	21%	19%	33%	16%	11%
Protein	30%	26%	27%	9%	8%
Iron	27%	27%	28%	10%	8%
Zinc	20%	18%	38%	15%	9%
Vitamin B12	21%	20%	34%	15%	9%
Preservatives	23%	21%	28%	18%	11%

Figure 9. Beef Steak vs Plant-Based Perceptions (% Better or Much Better; n=1,566)

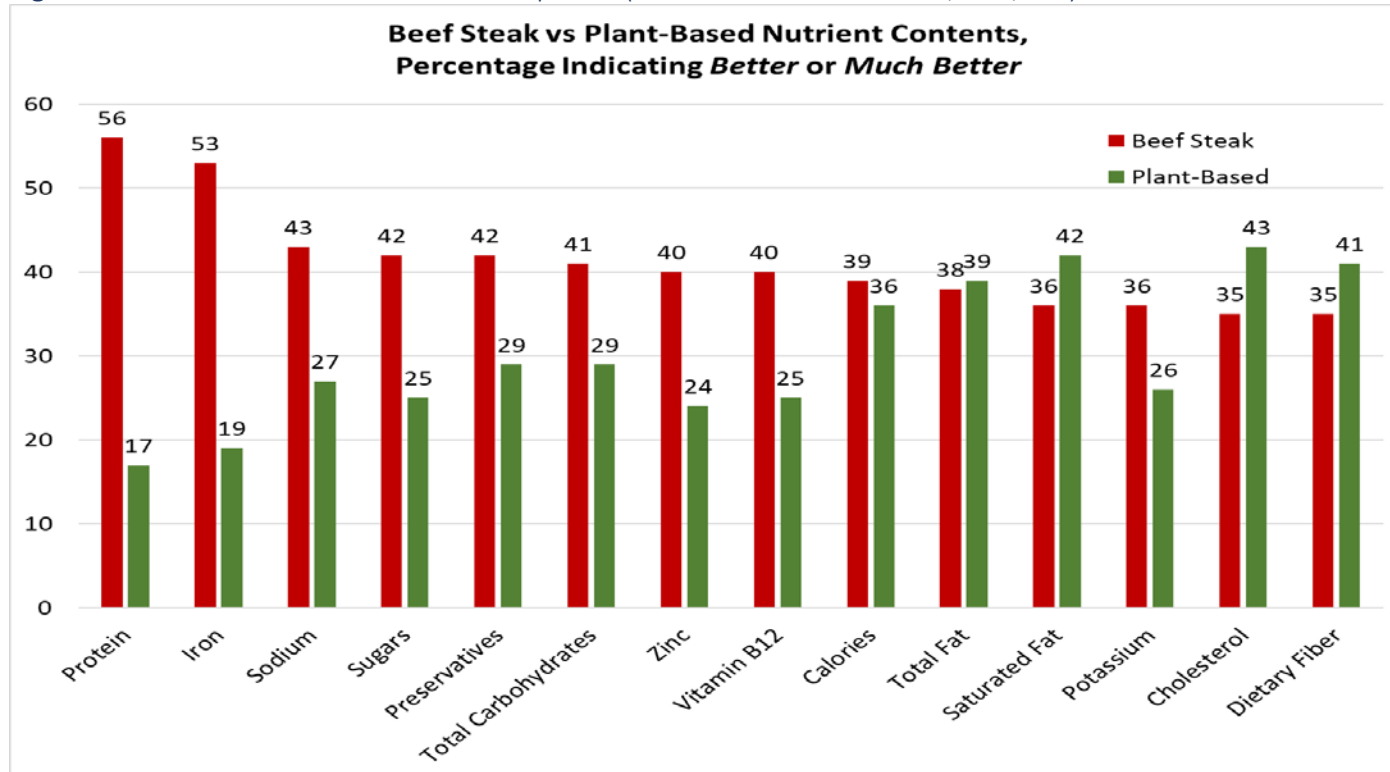
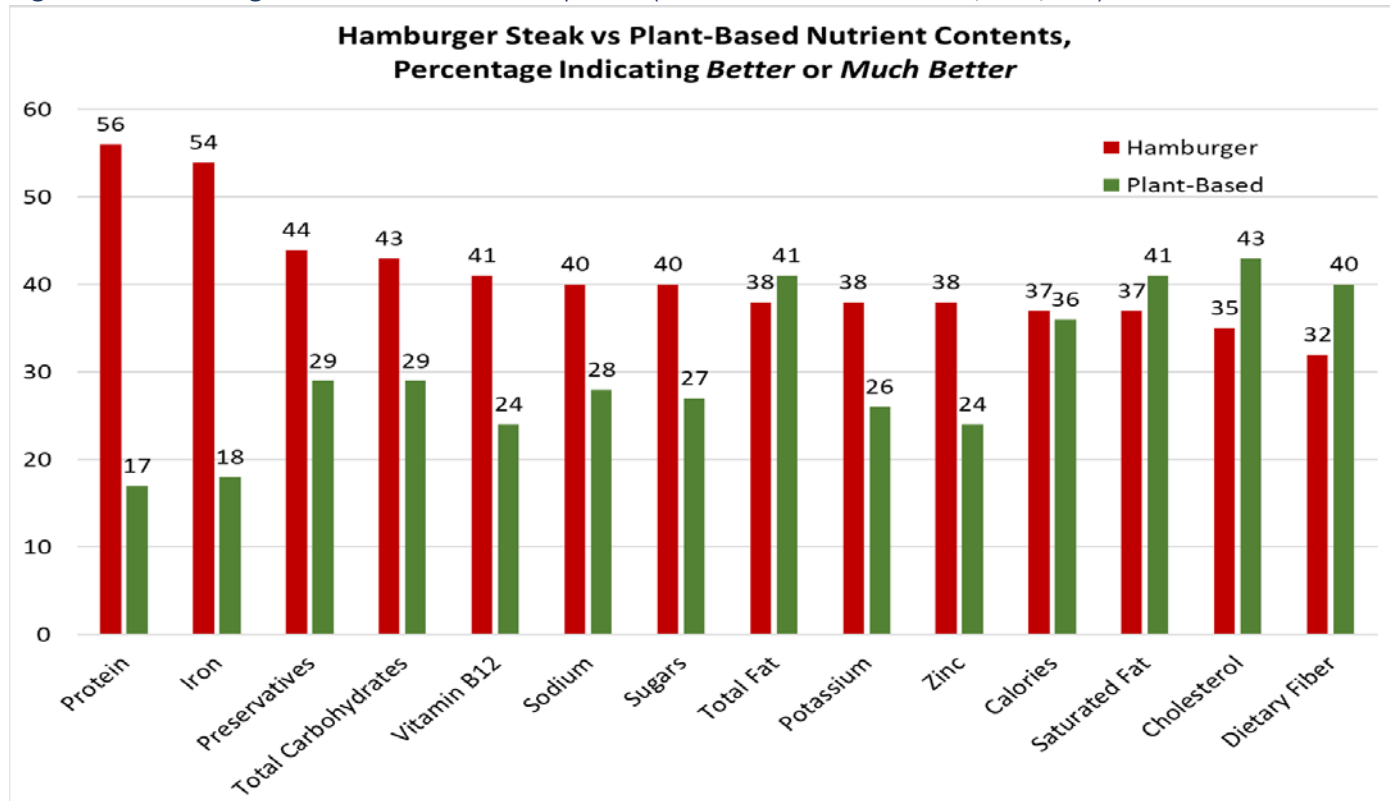


Figure 10. Hamburger vs Plant-Based Perceptions (% Better or Much Better; n=1,631)

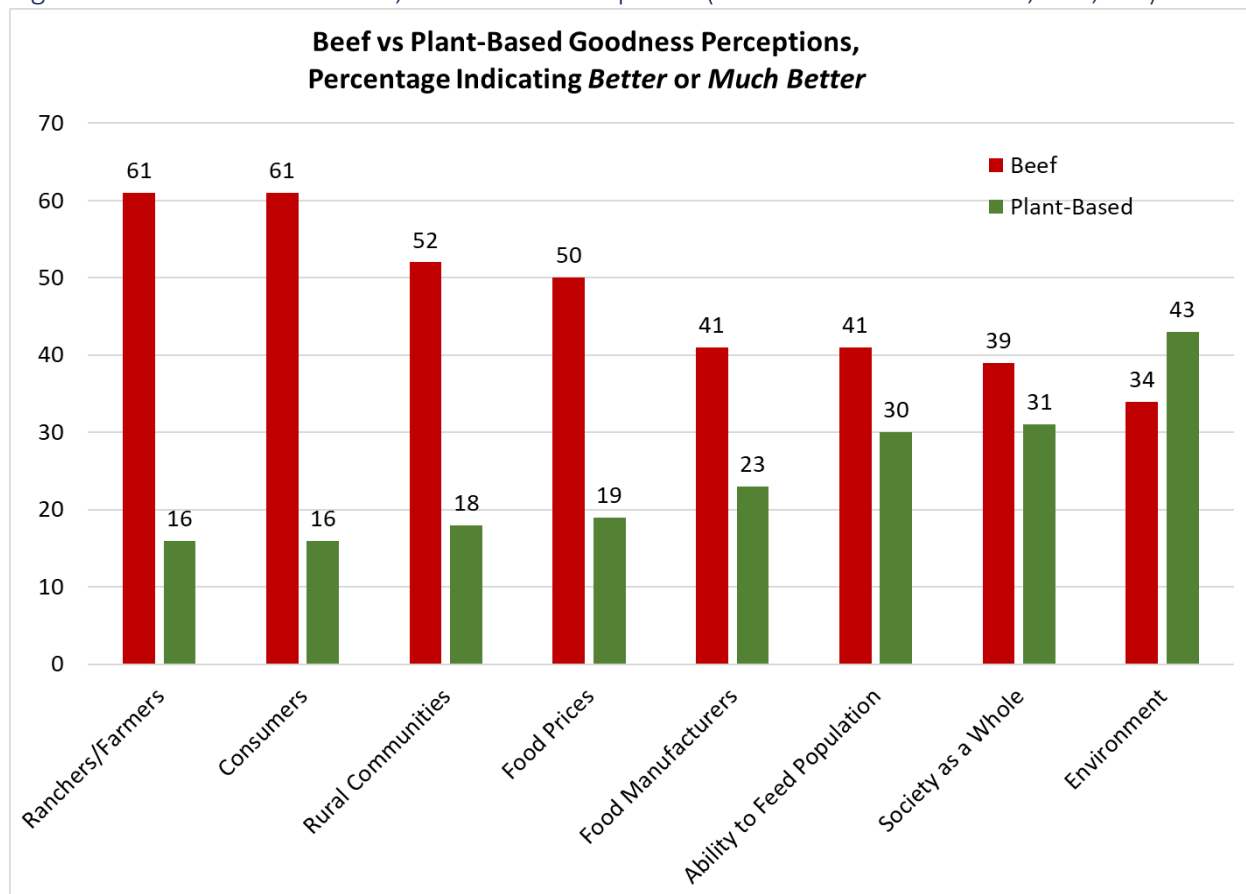


The final direct assessment of perceptions was framed broadly around how “Good for ____” beef and plant-based items are with table 7 reporting our findings. The areas where beef is viewed most favorable include being good for Ranchers/Farmers, Consumers, Rural Communities, and Food Prices. Plant-based items rank higher in terms of Environment (which is where beef scores lowest), and though scoring worse than beef are considered relatively strong for Society as a Whole, and Ability to Feed Population. Here, only the statement *Good for Environment* favors Plant-Based with an average score (marginally) above 3.0. This can also be seen in Figure 11 showing *Good for Environment* is the only item where more than one-third of respondents suggests plant-based is superior.

Table 7. Beef vs Plant-Based, Goodness Perceptions (n=3,211)

Statement: <i>Good For</i> _____	Beef Steak (from animals) is Much Better	Beef Steak (from animals) is Better	Beef Steak (from animals) & Plant-Based Are Somewhat the Same	Plant- Based is Better	Plant-Based is Much Better
Ranchers/Farmers	38%	23%	22%	9%	7%
Consumers	38%	23%	22%	9%	7%
Food Manufacturers	23%	18%	36%	14%	9%
Society as a Whole	22%	17%	30%	17%	14%
Rural Communities	30%	22%	31%	10%	8%
Food Prices	26%	24%	31%	11%	8%
Ability to Feed Population	24%	17%	29%	17%	13%
Environment	21%	13%	24%	24%	19%

Figure 11. Beef vs Plant-Based, Goodness Perceptions (% Better or Much Better; n=3,211)



c. Experimental Design

The above sections document past consumption patterns and perceptions over multiple dimensions. To further understand impacts on beef demand from plant-based protein offerings we designed four separate experiments. In each experiment, participants made purchasing decisions in simulated shopping scenarios. Our goal was to ascertain economic insights from behavior in these situations. We designed two experiments focused on consumer decisions made in food service and restaurant settings and two experiments centered on decisions made in retail settings involving at-home preparation and consumption. Each participant was randomly assigned to one of these four experimental treatments documented sequentially below, with data from approximately 800 respondents in each treatment used here.

1. Food Service, Pairwise Treatment (N=793)

The first food service treatment involved a single pairwise comparison of two meal options. Each participant was presented an option containing a Beef Burger meal versus a Beyond Meat Burger meal where both are available for the same price of \$7.99. Here each respondent was simply asked:

“Imagine you are at a restaurant selecting a meal for yourself.

Each option can be customized with cheese, condiments, and toppings as you desire.

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*Each meal comes with one medium-sized drink and side included.
Which of the following would you purchase?"*

This treatment was intended to measure how consumers substitute between beef and Beyond Meat burgers in a fast-food environment under alternative product labels and information settings. We randomly allocated respondents to one of four treatments intended to discern whether respondent preferences for Beyond Meat Burgers changed when presented with alternative hamburgers or label information. In particular, the Beyond Meat Burger preferences were compared across treatments with: 1) a regular "Beef Burger"; 2) an "Organic Beef" burger; 3): a regular burger including ingredient list information; or 4) a regular burger including nutrient contents. The following four figures are the images respondents were presented; we include these on separate pages to display them as respondents viewed them.

Figure 12. Food Service, Pair-Wise Base Treatment

Which of the following would you purchase?

	 <u>Beef Burger</u> Price: \$7.99/meal	 <u>Beyond Meat Burger</u> Price: \$7.99/meal	If these were the only options, I would buy something else.
I would choose:	☐	☐	

Figure 13. Food Service, Pair-Wise Organic Treatment

Which of the following would you purchase?

	 <u>Organic Beef Burger</u> Price: \$7.99/meal	 <u>Beyond Meat Burger</u> Price: \$7.99/meal	If these were the only options, I would buy something else.
I would choose:	☐	☐	☐

Figure 14. Food Service, Pair-Wise Ingredient List Treatment

Which of the following would you purchase?

	 <u>Beyond Meat Burger</u> <i>Patty Ingredients:</i> water, pea protein isolate, expeller-pressed canola oil, refined coconut oil, rice protein, mung bean protein, natural flavors, methylcellulose, potato starch, sunflower oil, salt, potassium chloride, apple extract, vinegar, lemon juice concentrate, color blend (vegetable glycerine, maltodextrin, ascorbic acid, beet juice extract), sunflower lecithin, pomegranate fruit powder, lycopene (for color), vitamins and minerals (dried yeast, niacin [vitamin b3], pyridoxine hydrochloride [vitamin b6], thiamin hydrochloride [vitamin b1], riboflavin [vitamin b2], folic acid [vitamin b9], cyanocobalamin [vitamin b12], d-calcium pantothenate, pyridoxine hydrochloride, biotin, zinc sulfate). May contain soy.		
	 <u>Beef Burger</u> <i>Patty Ingredients:</i> 100% Beef Price: \$7.99/meal	Price: \$7.99/meal If these were the only options, I would buy something else.	
I would choose:	☐	☐	☐

Figure 15. Food Service, Pair-Wise Nutrient Content Treatment

Which of the following would you purchase?

			
	<u>Beef Burger</u> Nutrient Contents Calories: 540 Fat: 32g Protein: 23g Sugar: 11g Carbohydrates: 40g Trans Fat: 1g Saturated Fat: 11g Cholesterol: 60mg Fiber: 2g Sodium: 760mg Calcium: 10% Daily value Iron: 25% Daily value Vitamin A: 8% Daily value Vitamin C: 6% Daily value Price: \$7.99/meal	<u>Beyond Meat Burger</u> Nutrient Contents Calories: 500 Fat: 29g Protein: 22g Sugar: 8g Carbohydrates: 40g Trans Fat: 0g Saturated Fat: 5g Cholesterol: 5mg Fiber: 3g Sodium: 1,110mg Calcium: 6% Daily value Iron: 45% Daily value Vitamin A: 0% Daily value Vitamin C: 4% Daily value Price: \$7.99/meal	If these were the only options, I would buy something else.
I would choose:	☐	☐	☐

2. Food Service, Beyond Meat Burger Introduction Treatment (N=839)

The second food service treatment also put respondents in the frame of selecting a restaurant meal. Here each respondent saw nine choice scenarios, each of which included four meal options of Beef Burger, Bacon Beef Burger, Chicken Sandwich, and Chicken Wrap with prices varying across the nine scenarios. Then the situation was followed by a repeat of these nine scenarios where a Beyond Meat Burger meal was included instead of the Chicken Wrap meal included in the initial nine scenarios. Combined, each respondent answered 18 choice questions. Varying meal prices across these scenarios enabled us to estimate consumer demand.

The intent here was to directly identify impacts from a plant-based offering being introduced onto food service menus. This is timely as *Meatingplace* reported in November

2020 that 9% of food service menus offered plant-based burgers and general expectations are for availability to increase.⁶

The specific question asked was:

“Imagine you are at a restaurant selecting a meal for yourself.

Each option can be customized with cheese, condiments, and toppings as you desire.

Each meal comes with one medium-sized drink and side included.

For each of the following 9 questions, please indicate which meal you would most likely buy.

The only difference across these 9 questions is the price (\$/meal) of each option.”

For instance, here is one of these initial questions:

Figure 16. Food Service, Chicken Wrap Question Example

Which of the following would you purchase?

				If these were the only options, I would buy something else.	
<u>Beef Burger</u>	<u>Bacon Beef Burger</u>	<u>Chicken Sandwich</u>	<u>Chicken Wrap</u>		
Price: \$10.29/meal	Price: \$10.49/meal	Price: \$8.09/meal	Price: \$9.19/meal		
I would choose:	☐	☐	☐	☐	☐

After completing nine of these scenarios containing a Chicken Wrap option, respondents were informed:

“Now imagine one month passes and you again are at this same restaurant selecting a meal for yourself.

Now the available meal options have changed.

The Chicken Wrap is no longer available. A Beyond Meat, plant-based patty is now available.

As before, each option can be customized with cheese, condiments, and toppings as you desire.

Each meal comes with one medium-sized drink and side included.

For each of the following 9 questions, please indicate which meal you would most likely buy.

The only difference across these 9 questions is the price (\$/meal) of each option.”

For instance, here is one of these questions:

⁶ “Plant-Based Sprouts” article available online:

<http://library.meatingplace.com/publication/frame.php?i=679158&p=90&pn=&ver=html5>

Impacts of New Plant-Based Protein Alternatives on U.S. Beef Demand (Tonsor, Lusk, and Schroeder, 2021)

Figure 17. Food Service, Beyond Meat Wrap Question Example

Which of the following would you purchase?

					If these were the only options, I would buy something else.
	<u>Beef Burger</u>	<u>Bacon Beef Burger</u>	<u>Chicken Sandwich</u>	<u>Beyond Meat Burger</u>	
	Price: \$10.29/meal	Price: \$10.49/meal	Price: \$8.09/meal	Price: \$9.19/meal	
I would choose:	☐	☐	☐	☐	☐

3. Retail, Choose One Item Treatment (N=813)

The first retail treatment focused on purchasing decisions for at-home preparation and consumption. Here we included two beef, two plant-based, and one chicken option in each question. The specific question asked was:

"Imagine you are selecting protein products for at-home preparation and consumption.

Suppose there are five products available:

- Beyond Meat's Beyond Beef (from plants)*
- Impossible Food's Impossible Burger (from plants)*
- Tyson's Boneless, Skinless Chicken Breast (from animals)*
- Laura's Lean, All-Natural, 92% Lean Ground Beef (from animals)*
- Store Brand 80% Lean Ground Beef (from animals).*

For each of the following 11 questions, please indicate which product (or none) you would most likely buy. The only difference across these 11 questions is the price (\$/lb) of each option."

Across these 11 questions the only thing that varied were the presented prices (\$/lb), enabling us to estimate measures of interest such as willingness-to-pay. Here is an example question asked:

Figure 18. Retail, Choose One Item Question Example

Which of the following would you purchase?

						If these were the only options, I would buy something else.
	<u>Beyond Beef</u>	<u>Impossible Burger</u>	<u>Chicken Breast</u>	<u>Laura's Lean Natural Ground Beef</u>	<u>Store Brand, 80% Lean Ground Beef</u>	
	Price: \$12.49/lb	Price: \$14.49/lb	Price: \$1.99/lb	Price: \$4.49/lb	Price: \$7.99/lb	
I would choose:	☐	☐	☐	☐	☐	☐

4. Retail, Choose How Many Treatment (N=782)

The second retail treatment was nearly identical to the first retail treatment. The only adjustment was we now allowed multiple pounds of each presented product to be selected. The specific question asked was:

"Imagine you are selecting protein products for at-home preparation and consumption.

Suppose there are five products available:

- Beyond Meat's Beyond Beef (from plants)*
- Impossible Food's Impossible Burger (from plants)*
- Tyson's Boneless, Skinless Chicken Breast (from animals)*
- Laura's Lean, All-Natural, 92% Lean Ground Beef (from animals)*
- Store Brand 80% Lean Ground Beef (from animals).*

*For each of the following 11 questions, please indicate **how many pounds of each product** you would most likely buy. The only difference across these 11 questions is the price (\$/lb) of each option."*

Here (but not in surveys respondents received) we have added, bold underline text to highlight in this report the difference from the first retail treatment. For each product respondents could select from an 11-item dropdown menu spanning from "0 (None)" to "10 or more." Here is an example question asked:

Figure 19. Retail, Choose How Many Items Question Example

How many pounds of each product would you purchase?

				
<u>Beyond Beef</u>	<u>Impossible Burger</u>	<u>Chicken Breast</u>	<u>Laura's Lean Natural Ground Beef</u>	<u>Store Brand, 80% Lean Ground Beef</u>
Price: \$12.49/lb	Price: \$14.49/lb	Price: \$1.99/lb	Price: \$4.49/lb	Price: \$7.99/lb

d. Experimental Results

Given the above documentation of how each experiment was designed, we now sequentially document findings from each experiment.

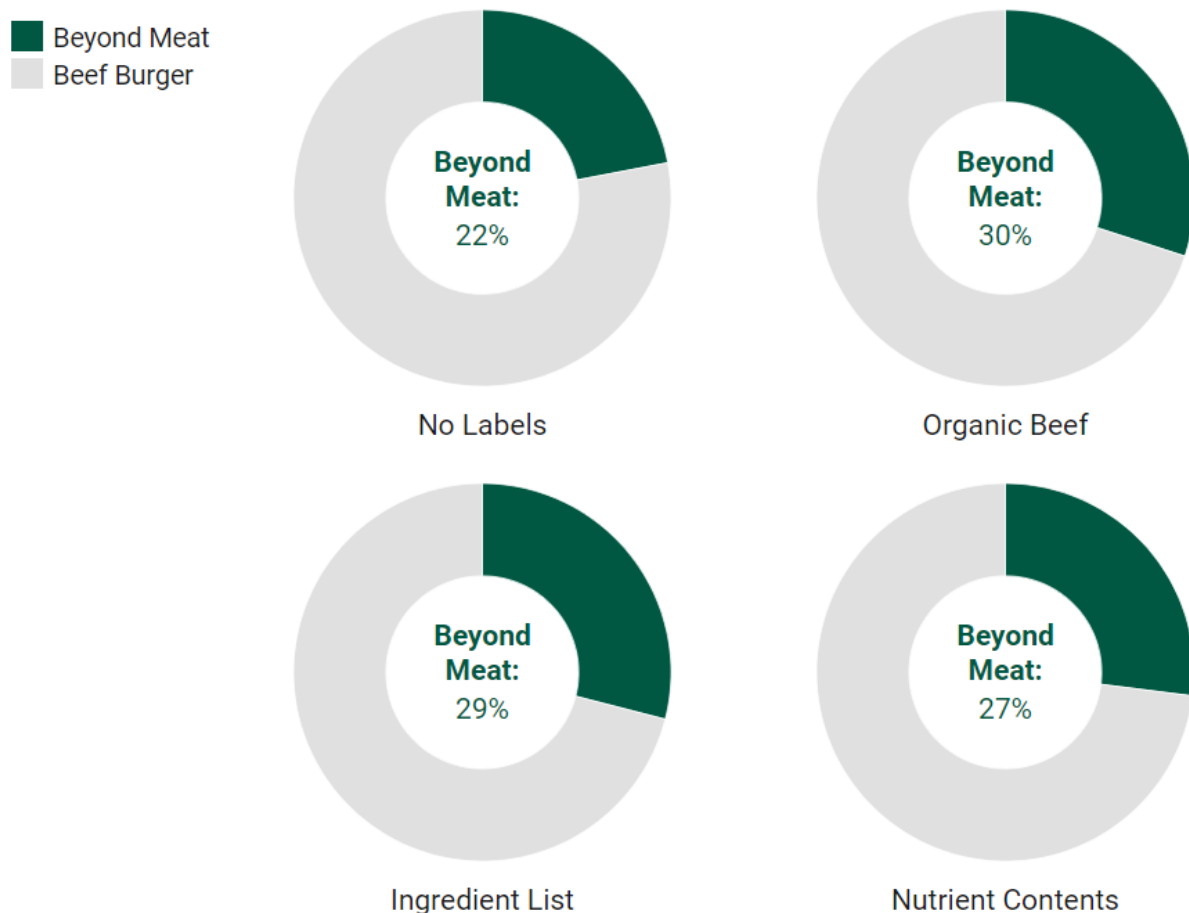
1. Food Service, Pairwise Treatment

A total of 793 respondents completed a question from the food service, pairwise experiment. Accordingly, there was about 200 participants in each of the four versions.

The choice frequency for each of the four versions of this food service pairwise treatment is summarized in figure 20.

Figure 20. Food Service, Pairwise Treatment Results (n=793)

Choice of Beyond Meat in Four Conditions



Examining these frequency statistics, it may be surprising to find the unlabeled Base treatment (upper left circle) to have the lowest frequency of Beyond Meat Burger being selected at 22%. We anticipated a decline in Beyond Meat Burger selections when Ingredient Lists were provided. This expectation reflects the longer list of ingredients included on Beyond Meat Burger labels. To gain additional insights, we explore selection rates using binary logit models (where 1 reflects selection of Beyond Meat Burger meal and 0 reflects selection of the

beef burger meal) both for the full sample and separately by diet with marginal effects reported in table 8.

Table 8. Selection of Beyond Meat Burger Meal, Binary Logit Model Marginal Effect Estimates (n=793)

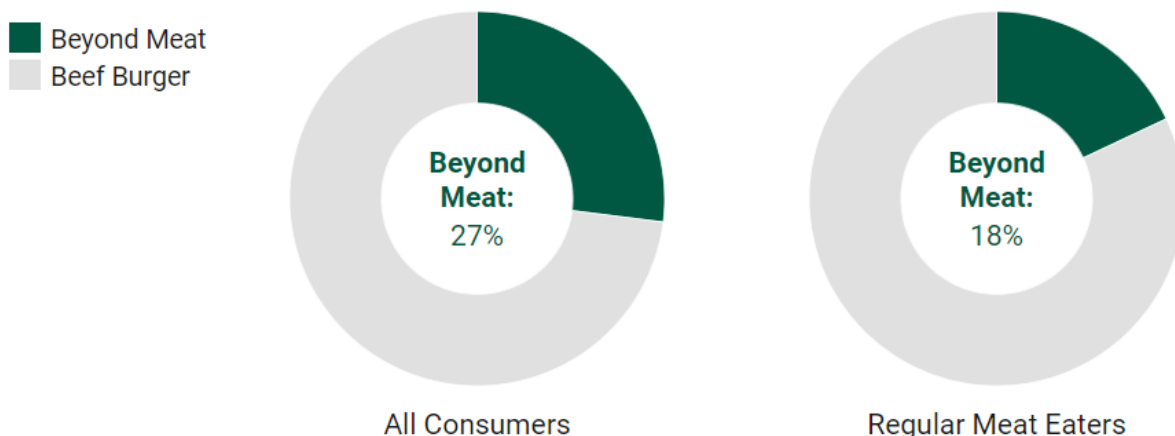
	<i>Full Sample</i>		<i>Regular Meat Consumer</i>		<i>Not a Regular Meat Consumer</i>	
	Marginal Effects	p-value	Marginal Effects	p-value	Marginal Effects	p-value
Parameter						
Constant						
Treatment, Organic	0.054	0.145	0.025	0.454	0.108	0.242
Treatment, Ingredient List	0.067	0.086	0.011	0.750	0.225	0.014
Treatment, Nutrient Contents	0.063	0.117	0.013	0.719	0.173	0.064
Age, Under 35	0.222	0.000	0.190	0.000	0.126	0.143
Age, 35 to 55	0.094	0.008	0.048	0.163	0.068	0.454
Male	0.052	0.039	0.080	0.001	0.023	0.729
Children Under Age of 12	0.086	0.002	0.080	0.003	0.070	0.347
Income above \$100,000	0.080	0.008	0.020	0.470	0.182	0.016
Region, Northeast	-0.071	0.020	-0.055	0.068	-0.135	0.094
Region, Midwest	-0.109	0.000	-0.025	0.474	-0.294	0.000
Region, South	-0.073	0.010	-0.013	0.646	-0.210	0.005
Political Party, Democratic	0.034	0.022	0.041	0.201	0.048	0.240
Political Party, Republican	-0.035	0.018	-0.012	0.705	-0.049	0.229
Number of Observations	793		590		202	

This model indicates differences across treatment are not statistically significant - we fail to reject at 0.05 level the hypothesis that frequency selection in the Organic, Ingredient List, and Nutrient Content treatments was the same as in the Base treatment. Younger males, those with children under the age of 12, Western residents, and those reporting affiliation with the Democratic party are more likely to select a Beyond Meat Burger meal. While marginal effect magnitudes vary, these directional conclusions hold for the full sample and regular meat consumers.

Across all the treatments, about 27% of choices went toward the Beyond Meat option and the other 73% went for the beef option. One question of interest is the extent to which the 27% of choices for Beyond Meat are a result of “new” entrants into the ground beef market that might not have bought ground beef otherwise. If we focus in on just the regular meat eaters, data indicate across all treatments, only about 18% chose Beyond Meat.

Figure 21. Food Service, Pairwise Treatment Results: All Consumers vs. Regular Meat Eaters (n=793)

Choice of Beyond Meat among Regular Meat Eaters



2. Food Service, Beyond Meat Burger Introduction Treatment

A total of 839 respondents completed questions in the food service experiment. The intermediate prices used reflect Burger King prices in Manhattan, KS on August 4, 2020 (\$8.29 for Whopper, \$8.49 for Whopper with Bacon, \$8.09 for Chicken Sandwich, and \$9.19 for Impossible Whopper)⁷. It is useful to begin by comparing the frequency of product selections in the first 9 scenarios where Chicken Wrap is included and Beyond Meat Burger is excluded with the final 9 scenarios when the Chicken Wrap option is removed and Beyond Meat Burger is added. The following two figures provide these frequency values.

Figure 22. Food Service, Beyond Meat Burger Introduction Treatment Results: (n=839)

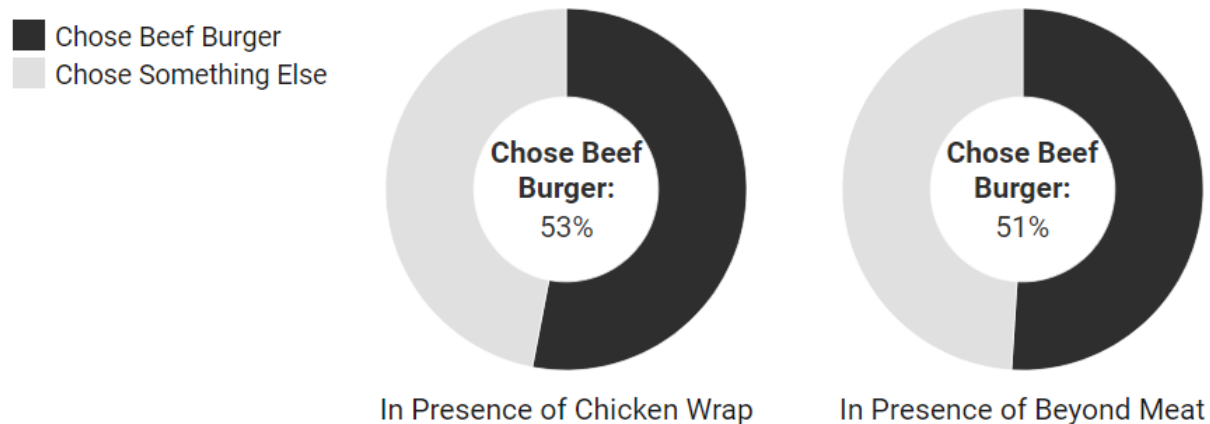
Choice of Chicken Wrap vs. Beyond Meat



⁷ Across food service choice experiment scenarios, higher and lower prices were set as \$2/meal adjustments from these base prices.

Figure 23. Food Service, Beyond Meat Burger Introduction Treatment Results: Beef Burger Selection In Presence of Chicken Wrap vs Beyond Meat (n=839)

Choice of Beef in Presence of Chicken Wrap vs. Beyond Meat



A main conclusion is the presence of the Beyond Meat Burger meal on beef demand has roughly the same impact as the presence of a Chicken Wrap meal on beef demand and these impacts are small on choice frequency overall. In both cases, at least 58% chose the Beef Burger meal at least once and at least 64% chose the Bacon Beef Burger meal at least once.⁸

To gain insight on the impacts of consumer price-sensitivity, recall prices vary over the presented scenarios. Hence it is useful to directly estimate consumer demand models. Here we estimate random parameter logit models to derive parameter estimates both on how price-sensitive participants are and on their preferences for the presented meal options. These models reflect consumer preference heterogeneity and have results with expected signs.

We proceed to report median willingness-to-pay (WTP, \$/meal) estimates from these models as individual coefficients are not overly useful on their own. Table 9 summarizes these median WTP estimates.

⁸ Histograms summarizing choice frequencies are included in the Appendix.

Table 9. Food Service Beyond Meat Introduction Treatment Results, Median Willingness-to-Pay (\$/meal; n=839)

	Chicken Wrap Block	Beyond Meat Block	Difference (\$)	Difference (%)
ALL RESPONDENTS				
Beef Burger	\$ 9.03	\$ 8.85	\$ (0.17)	-1.92%
Bacon Beef Burger	\$ 9.76	\$ 9.90	\$ 0.14	1.45%
Chicken Sandwich	\$ 8.96	\$ 8.87	\$ (0.09)	-0.98%
Chicken Wrap	\$ 6.29	---	---	---
Beyond Meat Burger	---	\$ 7.74	---	---
REGULAR MEAT CONSUMERS				
Beef Burger	\$ 9.84	\$ 9.66	\$ (0.18)	-1.79%
Bacon Beef Burger	\$ 10.19	\$ 9.94	\$ (0.25)	-2.43%
Chicken Sandwich	\$ 8.68	\$ 8.82	\$ 0.14	1.57%
Chicken Wrap	\$ 6.06	---	---	---
Beyond Meat Burger	---	\$ 7.79	---	---
NOT REGULAR MEAT CONSUMERS				
Beef Burger	\$ 6.74	\$ 7.26	\$ 0.52	7.72%
Bacon Beef Burger	\$ 7.51	\$ 8.89	\$ 1.37	18.28%
Chicken Sandwich	\$ 8.28	\$ 8.41	\$ 0.13	1.57%
Chicken Wrap	\$ 5.73	---	---	---
Beyond Meat Burger	---	\$ 8.74	---	---

First consider the results from our full set of respondents to reflect a situation where information regarding diets would not be available. A key finding is the small (under \$0.20/meal & 2%) overall impact on beef demand which follows from a Beyond Meat Burger meal being added as a meal option in place of a Chicken Wrap meal. As an example, the median values suggest a “typical” consumer would be indifferent to having a Beef Burger meal for \$8.85 and choosing something besides the four presented options when a Beyond Meat meal was available. This \$8.85 is \$0.17 less than when a Chicken Wrap meal is available instead of Beyond Meat.⁹ Similarly, this person would be WTP \$1.05/meal more to have bacon included for a Bacon Beef Burger meal. Perhaps most noteworthy is this typical consumer would prefer either of the beef burger meals over a Beyond Meat option. Going further, the median WTP of \$7.74 for a Beyond Meat Burger meal indicates the typical person would pay \$1.11 more for a Beef Burger meal. Hence the typical person is not a likely Beyond Meat Burger meal buyer. Stated differently, the price of a Beyond Meat Burger meal would need to decline \$1.11, without other factors changing, for typical consumers to be equally likely to buy a Beef Burger and a Beyond Meat Burger meal.

To further appreciate these findings, consider the situation with availability of the Beyond Meat Burger meal. Median WTP values for the Beef Burger, Bacon Beef Burger, and Chicken

⁹ These are median values, one-half the population would be WTP more and one-half would be WTP less than the estimates reported here.

Sandwich meals exceed intermediate prices in our experiment. Conversely, the median value for the Beyond Meat Burger meal is well below the \$9.19/meal Impossible Whopper price offering. This indicates the majority of consumers would be willing to buy the Beef Burger, Bacon Beef Burger, and Chicken Sandwich meals but a minority would buy a plant-based option at available prices.

Proceeding to compare median WTP values by diet sheds additional insights. Regular Meat consumers have preferences altered minimally with Beyond Meat Burger being added to the menu as median values change by \$0.25/meal or less. Conversely those self-declaring an alternative diet appear to be less price sensitive following introduction of the Beyond Meat Burger as median WTP values increase by 8 and 18% for a Beef Burger and Bacon Beef Burger meal respectively. Further note the median premium for adding bacon to a beef burger meal is \$0.28 for Regular Meat consumers and \$1.63 for those with alternative diets. This later point suggests the beef industry may be able to garner higher sales prices on premium offerings made to those not declaring to be regular meat consumers – perhaps as a way to sustain their interest in beef burger meals.

We can also project market shares under different conditions. Specifically, we can utilize parameters of our estimated models, which reflect heterogeneous product preferences and sensitivity to prices, to estimate the probability of any given meal being selected under different market conditions. These choice probability estimates can be used to approximate market share of food service meal selections with results in table 10.

First, we derive estimates given all four presented meals are available at the intermediate price levels used in our experiment. Considering all respondents, combined the Beef Burger and Bacon Beef Burger meals comprise over one-fourth of meal selections and the impact of Beyond Meat being displacing the Chicken Wrap option is minimal (28.45% vs. 27.15%). The decline is larger for Bacon Beef Burger meals than Beef Burger meals – potentially suggesting some are less willing to pay a premium to add bacon when the Beyond Meat Burger meal is available.

We then consider four possible price decline situations. Specifically, we estimate choice frequencies given a \$1/meal decline in the price of Beyond Meat, Chicken Sandwich, Beef Burger, and both Beef Burger and Bacon Beef Burger meals. A \$1 decline in the price of Beyond Meat (Chicken Sandwich) meals reduces the share of Beef Burger meals by 0.47% (0.97%) and Bacon Beef Burger meals by 0.56% (1.15%). Meanwhile, a \$1 decline in Beef Burger meals increases selection by 3.88% - an impact that is more than 8 times larger than a \$1 decline in Beyond Meat meals. Across these scenarios we see Beyond Meat Burger meals represent 7% or less of projected selections while the Beef Burger and Bacon Beef Burger meals combine to 25% or more. A key conclusion here is that selection of Beef Burger meals are much more impacted by beef prices than prices of Beyond Meat meals.

Table 10. Food Service Beyond Meat Introduction Treatment Results, Projected Meal Choice Frequencies (All Respondents, n=839)

Meal	Intermediate Price Level, All 4 Meals	Chicken Wrap/Beyond Meat Burger Meal, \$1 Decline	Chicken Sandwich Meal, \$1 Decline	Beef Burger Meal, \$1 Decline	Beef Burger & Bacon Beef Burger Meals, \$1 Decline
Chicken Wrap Block					
Beef Burger	12.85%	12.51%	11.87%	16.58%	15.31%
Bacon Beef Burger	15.61%	15.23%	14.54%	14.51%	18.15%
Chicken Sandwich	11.72%	11.37%	15.52%	10.76%	9.86%
Chicken Wrap	3.61%	5.18%	3.29%	3.30%	3.02%
Beyond Meat Burger	---	---	---	---	---
Beyond Meat Block					
Beef Burger	12.36%	11.89%	11.40%	16.24%	14.86%
Bacon Beef Burger	14.79%	14.23%	13.65%	13.63%	17.60%
Chicken Sandwich	11.89%	11.41%	15.78%	10.92%	9.94%
Chicken Wrap	---	---	---	---	---
Beyond Meat Burger	4.67%	6.79%	4.24%	4.24%	3.81%

Note: The presented frequencies do not sum to 100% as the balance of selections are for the opt-out, would buy something else option.

We then proceed to repeat this scenario assessment using models ran separately for Regular Meat Consumers and those declaring an alternative diet with results presented in the following two tables. This clearly reveals large differences in meal selections across the two groups. At the intermediate price levels for all available meals, just over 5% of Regular Meat Consumers would select the available plant-based meal while over 22% of those declaring an alternative diet would. Across the four price decline scenarios considered, Regular Meat Consumers select one of the beef burger meals over 50% of the time while those with an alternative diet do so at lower frequencies (32-45% of the time).

Table 11. Food Service Beyond Meat Introduction Treatment Results, Projected Meal Choice Frequencies (Regular Meat Consumers, n=638)

Meal	Intermediate Price Level, All 4 Meals	Chicken Wrap/Beyond Meat Burger Meal, \$1 Decline	Chicken Sandwich Meal, \$1 Decline	Beef Burger Meal, \$1 Decline	Beef Burger & Bacon Beef Burger Meals, \$1 Decline
Chicken Wrap Block					
Beef Burger	25.51%	24.82%	23.52%	33.80%	30.21%
Bacon Beef Burger	31.56%	30.73%	29.18%	28.48%	36.88%
Chicken Sandwich	21.70%	21.15%	28.68%	19.71%	17.73%
Chicken Wrap	6.72%	9.44%	6.20%	6.06%	5.42%
Beyond Meat Burger	---	---	---	---	---

Beyond Meat Block					
Beef Burger	25.95%	24.88%	23.60%	35.34%	31.54%
Bacon Beef Burger	29.17%	27.98%	26.61%	25.97%	35.00%
Chicken Sandwich	23.68%	22.81%	31.80%	21.31%	19.18%
Chicken Wrap	---	---	---	---	---
Beyond Meat Burger	5.36%	9.50%	4.67%	4.49%	3.73%

Note: The presented frequencies do not sum to 100% as the balance of selections are for the opt-out, would buy something else option.

Table 12. Food Service Beyond Meat Introduction Treatment Results, Projected Meal Choice Frequencies (Not Regular Meat Consumers, n=203)

Meal	Intermediate Price Level, All 4 Meals	Chicken	Chicken	Beef Burger	Beef Burger &
		Wrap/Beyond Meat Burger Meal, \$1 Decline	Sandwich Meal, \$1 Decline	Meal, \$1 Decline	Bacon Beef Burger Meals, \$1 Decline
Chicken Wrap Block					
Beef Burger	19.23%	18.71%	18.01%	23.51%	22.50%
Bacon Beef Burger	19.19%	18.59%	17.83%	18.33%	22.86%
Chicken Sandwich	27.21%	26.37%	33.24%	25.98%	24.69%
Chicken Wrap	12.03%	15.08%	11.22%	11.52%	10.97%
Beyond Meat Burger	---	---	---	---	---
Beyond Meat Block					
Beef Burger	14.20%	13.46%	13.37%	17.97%	16.97%
Bacon Beef Burger	19.34%	18.32%	18.20%	18.48%	23.05%
Chicken Sandwich	28.01%	26.89%	32.61%	27.13%	26.01%
Chicken Wrap	---	---	---	---	---
Beyond Meat Burger	22.62%	26.82%	21.53%	21.85%	20.87%

Note: The presented frequencies do not sum to 100% as the balance of selections are for the opt-out, would buy something else option.

The final set of results we include are elasticity measures summarized in table 13. These are estimates of how 1% changes in meal prices impact the probability of each meal being selected. These estimates can be useful in other economic applications such as projecting the possible impact of alternative changes in meal prices.

As an example interpretation, a 1% increase in the price of a Beef Burger meal is projected to reduce the probability of a Regular Meat Consumer selecting a Beef Burger meal by 3.17%. This impact is larger than the 2.06% impact for those indicating an alternative diet. In fact, Regular Meat Consumers are identified broadly to generally be more price sensitive indicating their meal selections will adjust more to changes in menu prices. It is also important to note that own-meal price effects are much larger than cross-meal, substitution effects. For instance, for Regular Meat Consumers a 1% decline in the Beyond Meat Burger meal has about

1/10th the impact of changes in Beef Burger meal prices (0.33% decrease in Beef Burger meal selection probability from Beyond's price decline vs 3.17% own-price impact). Furthermore, for Regular Meat Consumers the impact of price changes for Chicken Sandwich meals on beef burger meal selections is much larger than the impact of plant-based offering prices.

Table 13. Food Service Beyond Meat Introduction Treatment Results, Meal Selection Elasticities (n=839)

Price	Beef Burger	Bacon Beef Burger	Chicken Sandwich	Beyond Meat Burger	Other
ALL RESPONDENTS					
Beef Burger	-2.474	0.379	0.399	0.435	0.554
Bacon Beef Burger	0.458	-2.387	0.468	0.508	0.647
Chicken Sandwich	0.376	0.364	-2.492	0.417	0.545
Beyond Meat Burger	0.211	0.203	0.214	-2.952	0.227
REGULAR MEAT CONSUMERS					
Beef Burger	-3.174	0.925	0.831	1.306	1.426
Bacon Beef Burger	1.089	-2.930	0.916	1.379	1.484
Chicken Sandwich	0.728	0.682	-2.873	0.883	1.084
Beyond Meat Burger	0.329	0.290	0.247	-5.029	0.349
NOT REGULAR MEAT CONSUMERS					
Beef Burger	-2.062	0.334	0.227	0.247	0.555
Bacon Beef Burger	0.472	-1.970	0.320	0.351	0.776
Chicken Sandwich	0.447	0.448	-1.329	0.362	0.730
Beyond Meat Burger	0.452	0.453	0.334	-1.648	0.692

Note: The presented values are how a 1% change in the price of a row's meal impacts the probability of each meal being selected.

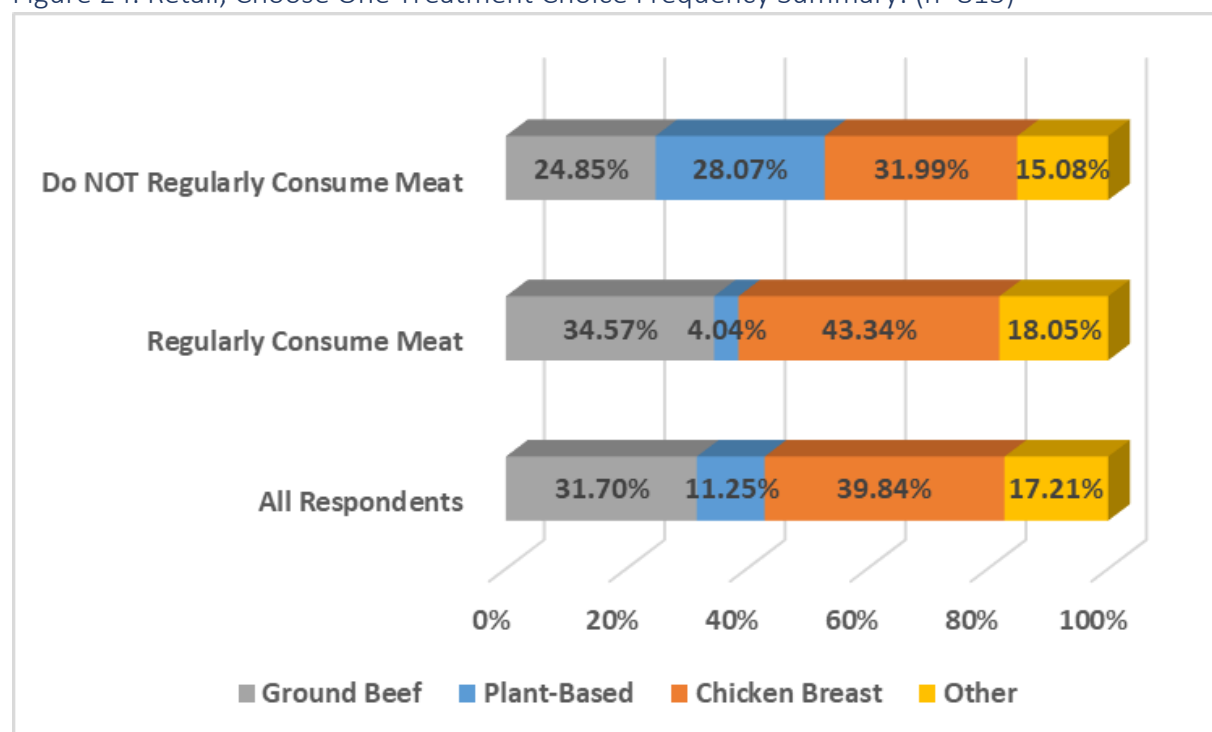
3. Retail, Choose One Item Treatment

A total of 813 respondents completed questions in this retail experiment. Recall an intentional point of this retail experiment was to incorporate multiple plant-based and beef options to further refine insights. Inclusion of both Beyond Meat and Impossible Burger expands upon earlier insights from Food Service treatments only using Beyond Meat. Meanwhile, including Laura's Lean Natural Ground beef as a contrast to Store Brand, 80% Lean Ground Beef enables insights on branded vs store-brand and natural vs. base 80% lean offerings. The intermediate price offerings for Beyond Meat, Impossible Burger, Tyson's Chicken Breast, Laura's Lean, and Store-Brand ground beef reflect what was recorded in Manhattan KS on August 11, 2020 at \$9.99, \$11.99, \$4.49, \$6.99, and \$5.49, respectively.¹⁰

¹⁰ Across retail choice experiment scenarios, higher and lower prices were set as \$2.50/lb adjustments from these base prices.

It is useful to start by assessing the raw choice frequency both for all respondents, and separately by self-reported diet. The Appendix contains complete details and figure 24 provides a convenient summary. In each case, the total share of selections is largest for Tyson's Chicken Breast which is not surprising given presented prices and outside of this work, USDA's consumption statistics. Important insights arise immediately comparing responses between Regular Meat Consumers and others. Those self-declaring to regularly consume meat (72%) select one of the two plant-based items 4% of the time, select one of the ground beef items over one-third of the time, and are most likely to select Tyson's Chicken Breast. Conversely, those declaring a diet besides regular meat consumption (28%) selected one of the two plant-based items over one-fourth of the time, select one of the ground beef items just under one-fourth of the time, and are also most likely to select Tyson's Chicken Breast. An important point follows – even consumers who self-declare to not be regular meat consumers remain important consumers of ground beef items.

Figure 24. Retail, Choose One Treatment Choice Frequency Summary: (n=813)



Consistent with the previous food service meal selection treatment, we proceed to further analyze this retail selection data using a random parameters logit model that is similarly specified. Parameters and other model fit details are tabulated in the Appendix. Table 14 shows median willingness-to-pay (WTP) estimates for each protein offering in \$/lb units derived from these estimates.

Table 14. Retail Choose One Treatment Results, Median Willingness-to-Pay (\$/lb; n=813)

	All Respondents	Regularly Consume Meat	Do NOT Regularly Consume Meat
Beyond Beef	\$ 6.69	\$ 5.73	\$ 8.18
Impossible Burger	\$ 7.41	\$ 4.78	\$ 9.16
Tyson's Chicken Breast	\$ 6.76	\$ 6.58	\$ 7.60
Laura's Lean Natural Ground Beef	\$ 5.18	\$ 4.89	\$ 4.66
Store Brand, 80% Lean Ground Beef	\$ 5.66	\$ 6.02	\$ 5.86

Regular Meat Consumers value Store Brand ground beef more than either plant-based item while the reverse is true for those declaring an alternative diet. Secondly, the valuation difference based on self-reported diet, regarding plant-based items is substantial (\$2.44 and \$4.38/lb respectively for Beyond Beef and Impossible Burger) while the difference is very small (\$0.15/lb) for Store Brand ground beef. Proceeding to compare median WTP values to the intermediate prices in our experiment reveals a consistent point across both consumer groups. Namely, both groups value Store Brand ground beef more, and each plant-based item less, than these intermediate price levels. Accordingly, the majority of consumers (including those declaring an alternative diet) would be expected to purchase Store Brand, 80% Lean Ground Beef while only a minority would be expected to buy a plant-based item. This reinforces a recurring point – even those declaring an alternative diet present a market opportunity for ground beef offerings.

Our final assessment here includes projecting choice frequencies under alternative situations, both for the full sample of respondents and separately by diet (table 15). The first situation is when all five products are available at the intermediate prices used in our experiment. Considering the entire set of respondents less than 7% share would be held by the two plant-based items combined, the two ground beef items would combine for 32%, and Tyson's Chicken Breast would lead at 45%. This pattern changes notably when dissecting by diet. Those consumers (not) regularly consuming meat products have 2% (25%), 29% (25%), and 51% (38%) for plant-based, ground beef, and chicken breast respectively. While the much larger share held by plant-based for those declaring an alternative diet stands out, it is equally important to see where this increase is sourced from. Yes, those declaring an alternative diet select ground beef items less often but the impacts on Chicken Breast and Other (Something else) selections should be appreciated. Chicken breast is selected much more often by those declaring a regular meat consuming diet while those declaring an alternative diet are much less likely (12% vs 18%) to indicate they would purchase something besides the five presented options.

We proceed to examine the impact of possible price declines on choice frequencies. First the impact from plant-based items being offered at lower prices is considered. If Beyond Meat was available for \$1/lb less, Regular Meat Consumers would slightly increase (3% vs 1%) their rate of selection with this increase coming more at the expense of Chicken Breast than

any other item while this price change for those declaring an alternative diet would increase their Beyond Beef selection a bit more (20% vs 17%) with this change also impacting Chicken Breast the most. If both Beyond Beef and Impossible Burger were available for \$1/lb less the combined plant-based share for Regular Meat Consumers would increase from 2% to nearly 5%. Those declaring an alternative diet would have a larger combined plant-based selection rate of 31% (vs a base of 25%).

If alternatively Store Brand 80% Lean Ground Beef was available for \$1/lb less than Regular Meat Consumers would substantially increase their purchases (34% vs 24%) with this change mainly reflecting a decline in Chicken Breast selections. The same price decline has similar directional, but smaller magnitude impacts for those declaring an alternative diet as Store Brand selections increase from 19% to 23%. Similar conclusions follow from the case of both Laura's Lean and Store Brand ground beef items being available for \$1/lb less.

A take-home point across these scenarios is that while price changes have expected directional impacts on consumer selections, the impact of changes in plant-based and beef prices on each other's selections is relatively minor while selection rates of Chicken Breast stand to be most impacted.

Table 15. Retail Choose One Treatment Results, Projected Choice Frequencies (n=813)

Meal	Intermediate Price Level, All 5 Items	Beyond Meat Burger, \$1 Decline	Beyond Meat & Impossible, \$1 Decline	Ground 80% Lean, \$1 Decline	Ground 80% Lean and Laura's Lean, \$1 Decline
All Respondents					
Beyond Beef	3.63%	7.04%	6.88%	4.40%	4.20%
Impossible Burger	2.65%	3.36%	4.68%	3.23%	3.07%
Tyson's Chicken Breast	45.24%	40.63%	40.20%	38.52%	37.17%
Laura's Lean Natural Ground Beef	7.58%	10.25%	10.06%	9.55%	13.61%
Store Brand, 80% Lean Ground Beef	24.10%	23.65%	23.37%	30.99%	29.82%
Other	16.82%	15.07%	14.81%	13.30%	12.13%
Regularly Consume Meat					
Beyond Beef	1.35%	3.23%	3.20%	1.79%	1.70%
Impossible Burger	0.71%	0.96%	1.38%	0.90%	0.85%
Tyson's Chicken Breast	51.43%	45.71%	45.55%	42.18%	40.60%
Laura's Lean Natural Ground Beef	5.31%	8.79%	8.73%	7.83%	12.12%
Store Brand, 80% Lean Ground Beef	23.56%	24.92%	24.82%	33.53%	32.17%
Other	17.65%	16.40%	16.32%	13.78%	12.55%
Do NOT Regularly Consume Meat					
Beyond Beef	16.68%	20.20%	19.86%	16.58%	16.28%
Impossible Burger	8.06%	8.76%	10.79%	8.64%	8.41%
Tyson's Chicken Breast	38.30%	34.92%	34.29%	34.43%	33.70%
Laura's Lean Natural Ground Beef	6.75%	7.96%	7.72%	7.76%	10.25%
Store Brand, 80% Lean Ground Beef	18.63%	17.81%	17.40%	22.81%	22.20%
Other	11.58%	10.36%	9.94%	9.78%	9.16%

The final use of this choose one retail experiment data is to derive elasticity measures. As discussed in the last food service experiment, these estimates show how the probability of each item being selected changes given a 1% change in the price of each good. Table 16 reports these estimates for the full set of respondents and for models estimated separately by diet.

Table 16. Retail Choose One Treatment Results, Choice Probability Elasticities (n=813)

	Beyond Beef	Impossible Burger	Tyson's Chicken Breast	Laura's Lean Natural Ground Beef	Store Brand, 80% Lean Ground Beef	Other
All Respondents						
Beyond Beef	-3.26%	0.35%	0.14%	0.26%	0.18%	0.22%
Impossible Burger	0.35%	-3.26%	0.11%	0.22%	0.14%	0.12%
Tyson's Chicken Breast	0.49%	0.41%	-1.18%	0.53%	0.49%	0.97%
Laura's Lean Natural Ground Beef	0.28%	0.26%	0.20%	-2.56%	0.22%	0.42%
Store Brand, 80% Lean Ground Beef	0.42%	0.35%	0.34%	0.43%	-1.73%	0.72%
Regularly Consume Meat						
Beyond Beef	-3.56%	0.21%	0.08%	0.17%	0.11%	0.08%
Impossible Burger	0.14%	-3.37%	0.04%	0.08%	0.05%	0.02%
Tyson's Chicken Breast	0.69%	0.54%	-1.41%	0.74%	0.70%	1.34%
Laura's Lean Natural Ground Beef	0.30%	0.25%	0.22%	-2.89%	0.24%	0.38%
Store Brand, 80% Lean Ground Beef	0.54%	0.40%	0.46%	0.54%	-2.05%	0.87%
Do NOT Regularly Consume Meat						
Beyond Beef	-1.63%	0.31%	0.26%	0.36%	0.33%	0.49%
Impossible Burger	0.20%	-2.39%	0.19%	0.34%	0.26%	0.37%
Tyson's Chicken Breast	0.24%	0.27%	-0.78%	0.36%	0.34%	0.63%
Laura's Lean Natural Ground Beef	0.10%	0.15%	0.12%	-2.02%	0.16%	0.33%
Store Brand, 80% Lean Ground Beef	0.18%	0.23%	0.20%	0.30%	-1.38%	0.53%

Comparing across diet-delineated groups we observe more price sensitivity for those declaring to regularly consume meat. As an example interpretation, a 1% increase (decrease) in the price of Store Brand, 80% Lean Ground is projected to decrease (increase) the probability of selection by 2.05% for Regular Meat Consumers and 1.38% for those declaring an alternative diet. These estimates can also be used for cross-product impact assessments. For instance, a 10% decline in offering price for Beyond Beef to Regular Meat Consumers would be projected to increase the probability of Beyond Beef being selected by 35.6% and decrease the probability of Store Brand, 80% Lean Ground Beef being selected by 1.1%. This differs from the case of alternative diet declaring consumers where the 10% Beyond Beef price decline would increase the probability of Beyond Beef being selected by 16.3% and decrease the probability of Store Brand, 80% Lean Ground Beef being selected by 3.3%.

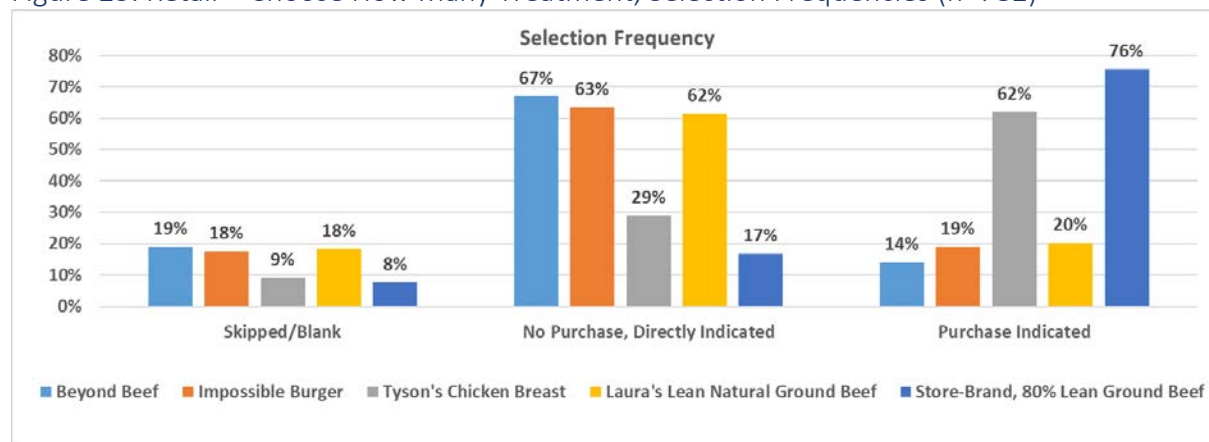
4. Retail, Choose How Many Treatment

A total of 782 respondents completed questions in this retail experiment. Recall the product offerings and price scenarios presented were exactly the same as in the first retail experiment. The only difference is rather than forcing a selection of a single item, here we allow multiple

pounds to be selected for each available protein offering. This may better match the setting consumers face and enables us to extend demand pattern insights accordingly.

It is useful to first look at frequencies of the raw data from participants across the 11 shopping scenarios presented. Given use of drop-down menus in this question, it is possible that cases where a respondent skipped or didn't change the default blank response may differ from where a respondent directly selected the "0 (None)" presented option. Accordingly, we first report the frequency of skipped/blank, directly indicated No Purchase, and indicated Purchase responses in figure 25.

Figure 25. Retail – Choose How Many Treatment, Selection Frequencies (n=782)



An immediate take-away is several differences across products exist. First, for both plant-based options and Laura's Lean Natural Ground Beef, there is both a higher tendency for respondents to skip or leave a selection blank and to directly indicate they would not purchase any. Overall in 20%, or fewer, of situations (11 shopping scenarios across all participants) would any of these three options be purchased. Conversely, in less than 10% of situations were questions on Chicken Breast and Store Brand, 80% Lean Ground Beef skipped. Furthermore, in the majority of situations (62% and 76% respectively), at least one pound of Chicken Breast and Store Brand, 80% Lean Ground Beef would be purchased. This likely reflects the higher predominance of store-branded ground beef and boneless chicken breast products in the purchased basket of goods for many consumers.

The varied frequency of product bundles is summarized in table 17. This table shows the frequency of situations for each product where an item was not selected, solely that item was selected, or that item and at least one other item was selected. This quickly affirms the prevalence of Store-Brand Ground Beef to be the item most likely selected when only one package is chosen. Further, Store-Brand Ground Beef, as with Tyson's Chicken Breast, is fairly likely to be selected in a bundle of multiple items. Conversely, both plant-based items are most frequently not selected and when selected these items are nearly always selected in tandem with an additional protein item. This highlights another key point: plant-based items indeed may often be purchased by consumers also selecting chicken or ground beef items.

Table 17. Retail – Choose How Many Treatment, None/Alone/Bundle Frequencies (n=782)

	None	Alone	With At Least One Other Item
Beyond Beef	85.93%	0.26%	13.81%
Impossible Burger	80.95%	1.53%	17.52%
Tyson's Chicken Breast	38.11%	7.29%	54.60%
Laura's Lean Natural Ground Beef	79.79%	0.90%	19.31%
Store-Brand, 80% Lean Ground Beef	24.42%	23.66%	51.92%

It is also useful to look beyond simple inclusion of a product, but to examine the volume of packages participants indicate they would purchase. Accordingly, we document the mean volumes by product. Table 18 reports these mean volumes. The unconditional mean volumes include cases (prevalent per the prior table for plant-based items) where zero-volume applies. Accordingly, the mean unconditional volume is less than one pound for the plant-based offerings and exceeds 2 pounds for Store Brand ground beef. The conditional mean volume reflects the average number of pounds for situations where at least one pound was selected – hence all values exceed 1.0. These values indicate 2-3 pounds are purchased (on average) when a consumer elects to make a purchase. Finally, additional details are provided in the Appendix as histograms document the frequency of specific-volumes being selected.

Table 18. Retail – Choose How Many Treatment, Unconditional and Conditional Mean Volume (lbs; n=782)

	Beyond Beef	Impossible Burger	Tyson's Chicken Breast	Laura's Lean Natural Ground Beef	Store-Brand, 80% Lean Ground Beef
Unconditional Mean Volume	0.352	0.425	1.485	0.476	2.326
Conditional Mean Volume	2.500	2.228	2.399	2.354	3.078

A unique opportunity presented by the “choose how many” approach of this retail treatment is to derive refined price-sensitivity estimates. Specifically, we can leverage the variation in price over 11 scenarios and the stated purchase quantities to identify price-quantity relationships. We estimated Tobit models given high tendency for zero volume purchases with model results provided in the Appendix. Here we focus on price-sensitivity conclusions as Table 19 presents elasticity estimates.

As an example interpretation, the own-price elasticity estimate of -2.37 indicates that considering all respondents we expect a 2.37% decline in purchase volume following a 1% increase in Beyond Beef price. As noted in earlier treatments we observe regular meat consumers to generally be more price sensitive than those declaring an alternative diet. These estimates also suggest Beyond Beef, Tyson’s Chicken Breast, and Laura’s Lean are substitutes (positive cross-price effects) for Store-Brand ground beef. That said, ground beef’s own-price effects remain much larger than demand impacts from changes in price of plant-based which is also consistent with results discussed above.

Table 19. Retail – Choose How Many Treatment, Elasticities

	Beyond Beef	Impossible Burger	Tyson's Chicken Breast	Laura's Lean Natural Ground Beef	Store-Brand, 80% Lean Ground Beef
All Respondents					
Beyond Beef	-2.368	-0.358	0.047	0.542	0.647
Impossible Burger	-1.761	-4.664	-0.534	-1.988	-1.121
Tyson's Chicken Breast	0.306	0.813	-1.296	0.225	0.123
Laura's Lean Natural Ground Beef	-0.429	-0.644	-0.152	-2.909	0.286
Store-Brand, 80% Lean Ground Beef	-0.596	-0.718	-0.319	-0.243	-2.797
Regular Meat Consumers					
Beyond Beef	-8.578	0.062	0.120	0.873	0.730
Impossible Burger	-3.386	-11.967	-0.417	-2.974	-1.005
Tyson's Chicken Breast	0.277	0.919	-1.813	0.325	0.118
Laura's Lean Natural Ground Beef	0.090	-1.403	-0.153	-6.449	0.623
Store-Brand, 80% Lean Ground Beef	-1.505	-1.362	-0.245	0.078	-3.840
Not Regular Meat Consumers					
Beyond Beef	-0.888	-0.285	-0.053	0.185	0.418
Impossible Burger	-1.053	-2.218	-0.725	-1.187	-1.244
Tyson's Chicken Breast	0.236	0.514	-0.404	0.155	0.153
Laura's Lean Natural Ground Beef	-0.425	-0.383	-0.115	-0.774	-0.172
Store-Brand, 80% Lean Ground Beef	-0.333	-0.420	-0.436	-0.381	-1.335

Note: These elasticity estimates were derived from double-censored Tobit models estimated separately for each product. The number of observations accordingly varies by model as noted in the Appendix.

Our final assessment is to examine how demand varies over various socio-economic groups, beyond just by self-declared diet. We use marginal effects derived from each Tobit model to understand how stated purchase intent varies across characteristics considering those outlined in Table 1 for our full sample. The Appendix contains these estimates and here we highlight take-home points. In general, these findings from our retail, choose how many experiment align well with the prior-day's meals, recall data discussed earlier (table 2).

Store-brand ground beef demand is estimated to be strongest in the Midwest for responding households who are younger, male, married, have children at home, and are Hispanic. There are several common trends across all five products. Younger, male, married households with children at home are heavier purchaser of each product. This statement holds across both regular meat consumers and those declaring an alternative diet. As an example interpretation, regular meat consuming respondents under the age of 35 would be expected to purchase 0.54 more pounds of Store-Brand ground beef, and those declaring an alternative diet would purchase 0.44 more pounds, then respondents over 55 years of age.

III. Expert Opinions

Given the emergence of plant-based proteins, there are a multitude of economic factors key for the beef industry to consider and the preceding sections examine several, but far from all of them. As the fourth step in this project's 5-step process we include a brief commentary on items outside the scope of our empirical assessment here yet worthy of thought and consideration. Here we provide opinion on some of these additional factors, in hope they provide a resource for the industry in prioritizing future work in this evolving area.

First it is important to appreciate that the entire consumer protein space has long been dynamic. This can be documented several ways, but perhaps most easily by considering annual consumption trends. Beef's share of total red meat and poultry consumption in the U.S. on a retail per capita basis peaked in 1976 at 48% (94.6 lbs) and hit a low of 26% (54.0 lbs) in 2015. Over this time, perhaps the biggest change was the growth in per capita chicken consumption and with it a notable increase in the share of total red meat and poultry consumption. Beef was not alone, as lamb peaked at 3% (4.5 lbs) in 1962 and turkey peaked at 8.9% (17.9 lbs) in 1991. The point is the beef industry has long operated in an environment where "competing protein" shares have been evolving. As another example, a key point made in our last beef demand determinants report was that the cross-price effects of pork on beef demand have been declining. With the notable increase in prevalence of bacon-burgers and even bacon-wrapped beef filets over the last couple of decades, more pork and beef products are consumed together as complements rather than substitutes than perhaps ever before. This dynamic history with other protein sources seem likely to continue and the recent arrival of plant-based proteins is just the latest.

Second, it is important to appreciate exactly how the U.S. beef-cattle industry operates in a global marketplace (Tonsor, 2020). Recent years have included notable increase in the economic importance of beef exports. Meanwhile ongoing dialogue continues on the role of beef imports. Here it is key to appreciate the majority of beef imported into the U.S. is for inputs into a broader effort at producing ground beef products for U.S. consumers. Historically the U.S. has imported highly lean items to blend with trimmings and less lean, domestically sourced beef yielding desired ground beef products. This is important to appreciate regarding plant-based proteins as several companies have offered consumer products that blend beef and plant-based ingredients. The exact future of these products and their economic impact is beyond the scope of this project but warrants monitoring. This comment is included not just for direct impacts on traditional beef demand domestically, but also for possible adjustments in the broader role of imports if the domestic ground beef production system changes.

Finally, perhaps now more than ever it is essential for the industry collectively to accurately identify its comparative advantage and leverage that in subsequent strategic efforts. In many ways we do not believe existence of plant-based proteins alters the industry's global comparative advantage as a major, grain-finished beef industry. Nonetheless, this and other foundations of the industry's comparative advantage must underpin future industry efforts.

IV. Appendix

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Past History of Beef & Plant-Based Protein Consumption

Table A1. Multinomial Logit Model: Beef & Plant-Based Protein in Prior Day Meals (n=3,225)

Parameter	Beef, No Plant-Based		Neither Beef nor Plant-Based		Plant-Based & No Beef	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	2.741	0.000	2.921	0.000	1.435	0.000
Age, Under 35	-0.147	0.459	-0.579	0.004	-0.131	0.563
Age, 35 to 55	-0.251	0.184	-0.392	0.038	-0.377	0.087
Male	-0.354	0.030	-0.730	0.000	-0.443	0.018
College, 4 Years or More	-0.739	0.000	-0.489	0.010	-0.360	0.099
Household Size	0.003	0.043	0.001	0.401	0.001	0.345
Region, Northeast	-0.552	0.004	-0.442	0.020	-0.240	0.275
Region, Midwest	0.198	0.437	0.423	0.095	-0.119	0.684
Region, South	0.242	0.304	0.076	0.747	-0.410	0.141

Note: The base, omitted category is consuming both Beef and Plant-Based proteins the prior day.

Food Service, Pairwise Treatment

Table A2. Binary Logit Model: Food Service Pairwise Treatment, Selection of Beyond Meat Burger Meal (n=793)

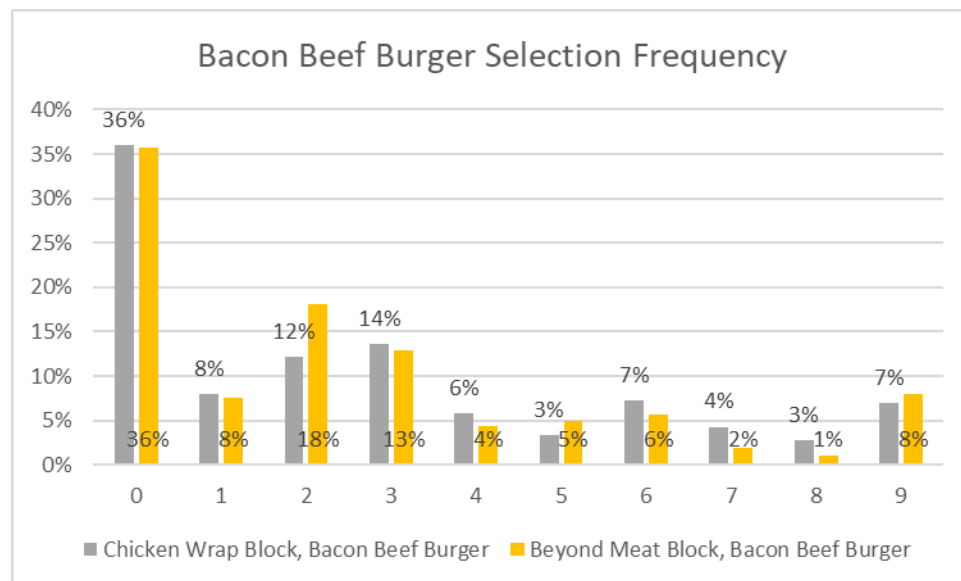
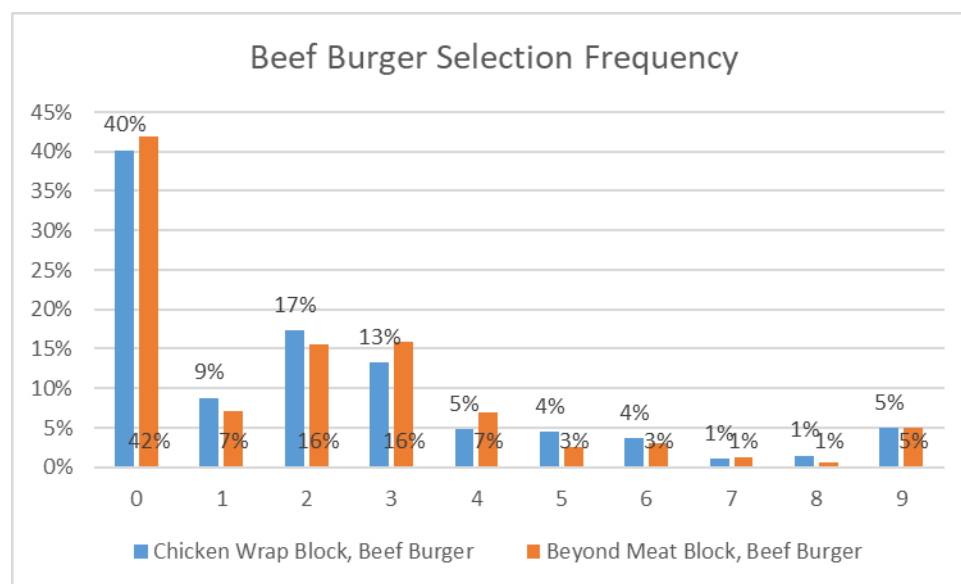
Parameter	Full Sample		Regular Meat Consumer		Not a Regular Meat Consumer	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	-2.105	0.000	-2.936	0.000	-0.838	0.108
Treatment, Organic	0.373	0.130	0.248	0.438	0.521	0.246
Treatment, Ingredient List	0.454	0.073	0.108	0.746	1.079	0.020
Treatment, Nutrient Contents	0.431	0.101	0.130	0.713	0.835	0.072
Age, Under 35	1.272	0.000	1.383	0.000	0.595	0.150
Age, 35 to 55	0.628	0.008	0.459	0.152	0.326	0.457
Male	0.367	0.039	0.804	0.001	0.112	0.730
Children Under Age of 12	0.616	0.002	0.822	0.003	0.332	0.344
Income above \$100,000	0.527	0.005	0.197	0.457	0.845	0.017
Region, Northeast	-0.555	0.034	-0.642	0.111	-0.699	0.126
Region, Midwest	-0.912	0.002	-0.264	0.496	-1.640	0.003
Region, South	-0.536	0.013	-0.134	0.649	-1.034	0.010
Political Party, Democratic	0.246	0.021	0.402	0.186	0.233	0.240

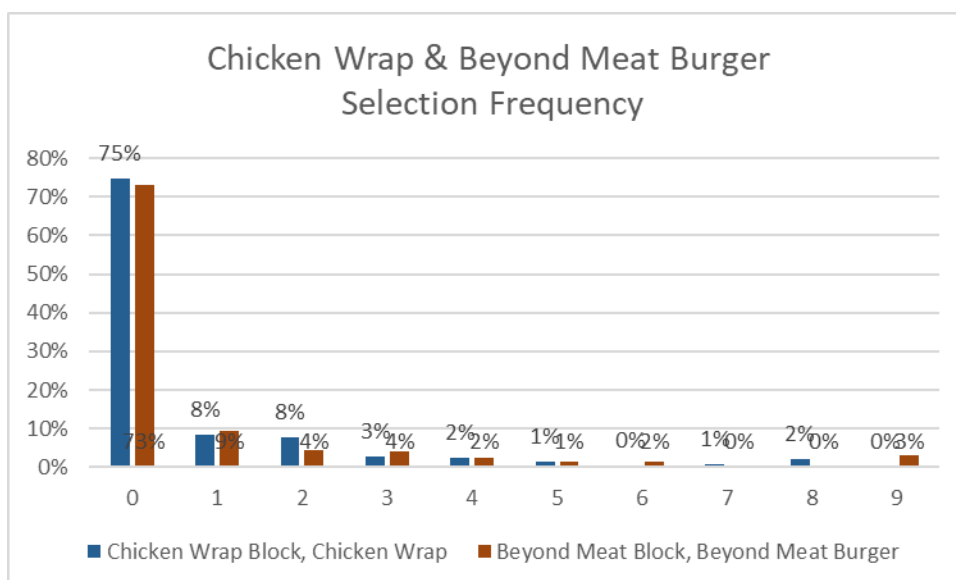
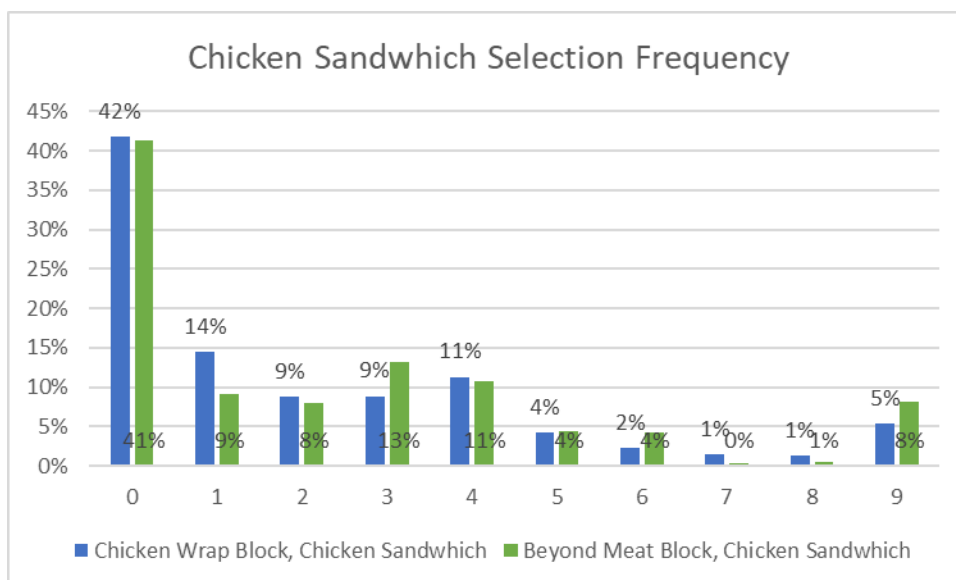
Impacts of New Plant-Based Protein Alternatives on U.S. Beef Demand (Tonsor, Lusk, and Schroeder, 2021)

Political Party, Republican	-0.253	0.018	-0.126	0.709	-0.239	0.228
Number of Observations	793		590		202	
Log-Likelihood	-406.307		-239.711		-122.709	
AIC	840.600		507.400		273.400	

Food Service, Beyond Meat Burger Introduction Treatment

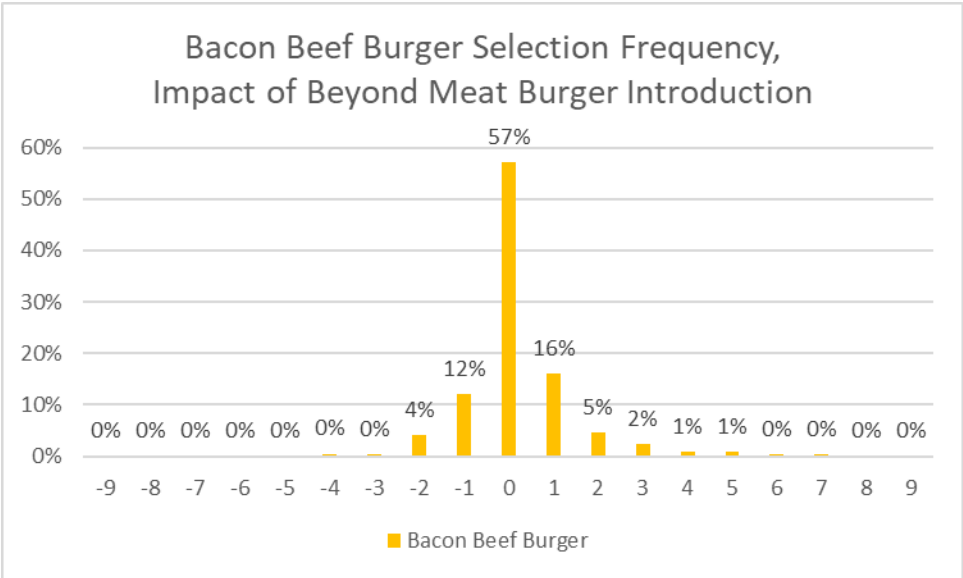
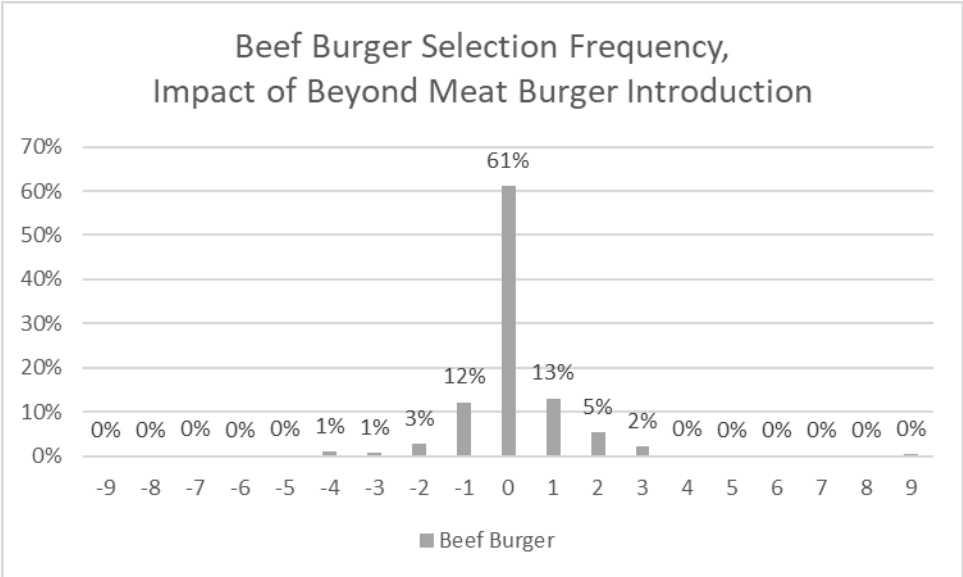
Figure A1. Food Service Beyond Meat Introduction Treatment, Selection Frequency Histograms (n=839)





It is a bit easier to see the direct impacts on choice frequency by plotting the difference in selections – specifically the difference between the first 9 scenarios where a Chicken Wrap is available and the last 9 scenarios where a Beyond Meat Burger meal is available. Here a value of 0 conveys no change in total choice frequency, a positive value means a meal was selected more frequently when the Chicken Wrap was available, and a negative value indicates a meal was selected more often when the Beyond Meat Burger was available.

Considering the Beef Burger meal, we see 61% made no change in choice frequency. There was a slightly higher (21% vs 18%) combined frequency of when the Chicken Wrap was available than when the Beyond Meat Burger was available. Similarly, for the Bacon Beef Burger meal 57% made no change. Here a larger impact from the Beyond Meat Burger introduction is observed (25% vs 17% combined).



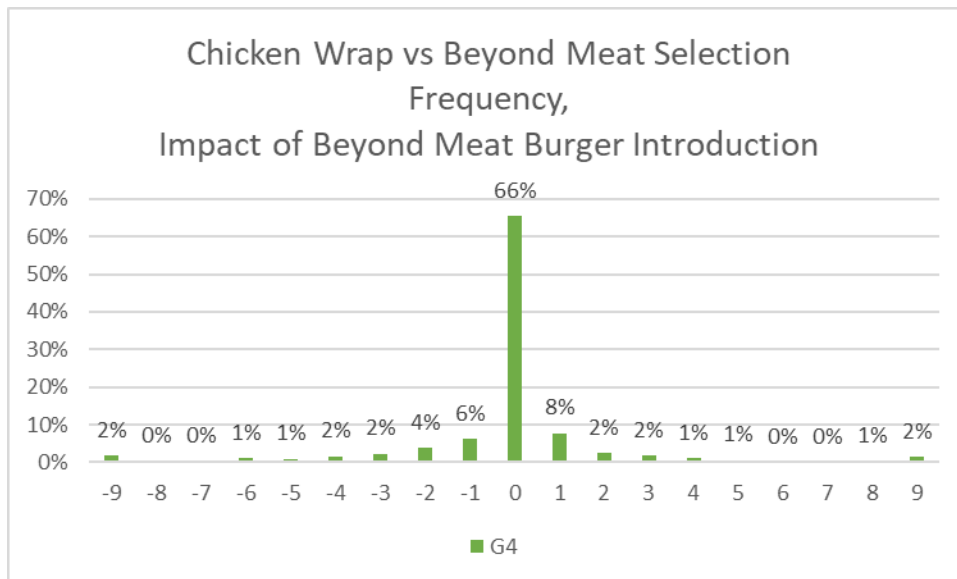
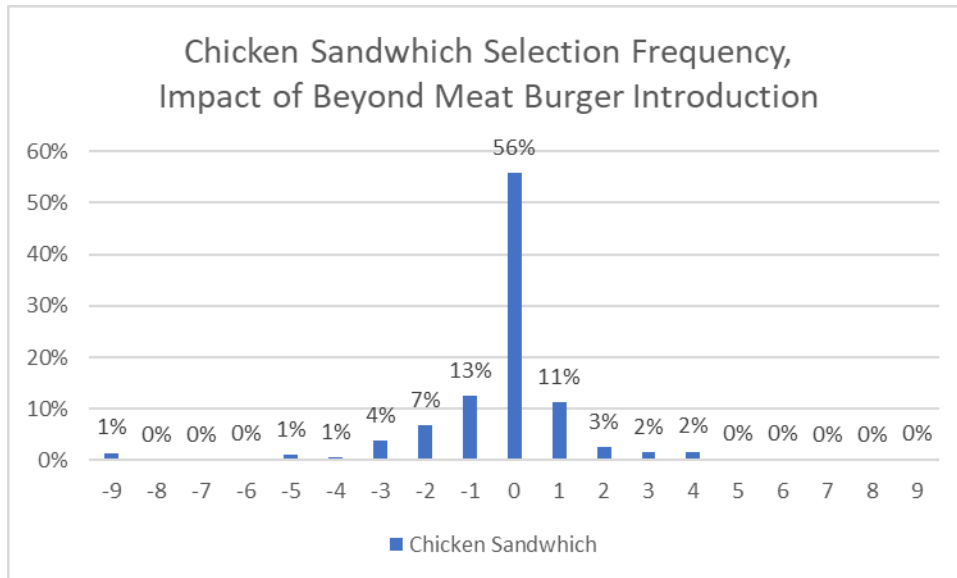


Table A3. Random Parameters Logit Model: Food Service Beyond Meat Introduction Treatment, All Respondents (n=839)

	Chicken Wrap Block		Beyond Meat Block	
Parameter	Coefficient	p-Value	Coefficient	p-Value
<i>Mean</i>				
Beef Burger	8.684	0.000	10.174	0.000
Bacon Beef Burger	9.240	0.000	10.931	0.000
Chicken Sandwich	8.404	0.000	9.877	0.000
Chicken Wrap	6.166	0.000		
Beyond Meat Burger			8.573	0.000

Price	-0.958	0.000	-1.112	0.000
<i>Standard Deviation</i>				
Beef Burger	2.925	0.000	3.207	0.000
Bacon Beef Burger	3.391	0.000	3.198	0.000
Chicken Sandwich	2.600	0.000	3.158	0.000
Chicken Wrap	3.198	0.000		
Beyond Meat Burger			3.223	0.000
Price	0.958	0.000	1.112	0.000
Number of Observations	839		839	
Log-likelihood	-6,936.991		-6,582.004	
AIC	13,892		13,182	

Note: This model was estimated with alternative-specific constants for each meal option specified to varying normally against an omitted based case of the opt-out, none of these option. The price parameter was specified to vary following a triangular distribution assuring a globally negative impact.

Table A4. Random Parameters Logit Model: Food Service Beyond Meat Introduction Treatment, Respondents Regularly Consuming Meat, Fish/Seafood, or Products Derived from Animals (n=638)

Parameter	Chicken Wrap Block		Beyond Meat Block	
	Coefficient	p-Value	Coefficient	p-Value
<i>Mean</i>				
Beef Burger	11.419	0.000	16.336	0.000
Bacon Beef Burger	12.207	0.000	16.995	0.000
Chicken Sandwich	10.313	0.000	15.132	0.000
Chicken Wrap	7.079	0.000		
Beyond Meat Burger			13.704	0.000
Price	-1.182	0.000	-1.717	0.000
<i>Standard Deviation</i>				
Beef Burger	2.825	0.000	3.576	0.000
Bacon Beef Burger	2.930	0.000	3.840	0.000
Chicken Sandwich	3.726	0.000	4.828	0.000
Chicken Wrap	4.872	0.000		
Beyond Meat Burger			3.108	0.000
Price	1.182	0.000	1.717	0.000
Number of Observations	638		638	
Log-likelihood	-4,457.471		-4,074.217	
AIC	8,933		8,166	

Note: This model was estimated with alternative-specific constants for each meal option specified to varying normally against an omitted based case of the opt-out, none of these option. The price parameter was specified to vary following a triangular distribution assuring a globally negative impact.

Table A5. Random Parameters Logit Model: Food Service Beyond Meat Introduction Treatment, Respondents Not Regularly Consuming Meat, Fish/Seafood, or Products Derived from Animals (n=203)

Parameter	Chicken Wrap Block		Beyond Meat Block	
	Coefficient	p-Value	Coefficient	p-Value
<i>Mean</i>				
Beef Burger	3.714	0.000	4.058	0.000
Bacon Beef Burger	4.130	0.000	4.903	0.000
Chicken Sandwich	4.717	0.000	4.874	0.000
Chicken Wrap	3.204	0.000		
Beyond Meat Burger			5.049	0.000
Price	-0.558	0.000	-0.566	0.000
<i>Standard Deviation</i>				
Beef Burger	2.710	0.000	2.340	0.000
Bacon Beef Burger	2.208	0.000	2.091	0.000
Chicken Sandwich	1.907	0.000	3.358	0.000
Chicken Wrap	2.740	0.000		
Beyond Meat Burger			3.106	0.000
Price	0.558	0.000	0.566	0.000
Number of Observations	203		203	
Log-likelihood	-2,410.700		-2,270.621	
AIC	4,839		4,559	

Note: This model was estimated with alternative-specific constants for each meal option specified to varying normally against an omitted based case of the opt-out, none of these option. The price parameter was specified to vary following a triangular distribution assuring a globally negative impact.

Retail, Choose One Item Treatment

Table A6. Retail Choose One Treatment, Choice Frequencies (n=813)

	All Respondents	Regularly Consume Meat	Do NOT Regularly Consume Meat
Beyond Beef	5.45%	2.26%	12.87%
Impossible Burger	5.79%	1.78%	15.20%
Tyson's Chicken Breast	39.84%	43.34%	31.99%
Laura's Lean Natural Ground Beef	9.45%	9.78%	8.62%
Store Brand, 80% Lean Ground Beef	22.25%	24.79%	16.23%
Other	17.21%	18.05%	15.08%
Number of Observations	813	586	229

Table A7. Retail Choose One Treatment Random Parameters Logit Model Results (n=813)

Parameter	All Respondents		Regularly Consume Meat		Do NOT Regularly Consume Meat	
	Coefficient	p-Value	Coefficient	p-Value	Coefficient	p-Value
<i>Mean</i>						
Beyond Beef	5.674	0.000	6.039	0.000	4.467	0.000
Impossible Burger	6.315	0.000	4.873	0.000	4.931	0.000
Tyson's Chicken Breast	5.607	0.000	7.019	0.000	4.029	0.000
Laura's Lean Natural Ground Beef	4.337	0.000	5.251	0.000	2.530	0.000
Store Brand, 80% Lean Ground Beef	5.040	0.000	6.375	0.000	3.273	0.000
Price	-0.854	0.000	-1.072	0.000	-0.550	0.000
<i>Standard Deviation</i>						
Beyond Beef	1.621	0.000	1.488	0.000	3.606	0.000
Impossible Burger	1.464	0.000	2.532	0.000	2.332	0.000
Tyson's Chicken Breast	2.643	0.000	2.242	0.000	2.937	0.000
Laura's Lean Natural Ground Beef	2.240	0.000	2.199	0.000	2.159	0.000
Store Brand, 80% Lean Ground Beef	2.582	0.000	2.335	0.000	2.366	0.000
Price	0.854	0.000	1.072	0.000	0.550	0.000
Number of Observations	813		586		229	
Log-likelihood	-9,264.89		-5,107.48		-3,935.54	
AIC	18,551.80		10,237.00		7,893.10	

Note: This model was estimated with alternative-specific constants for each meal option specified to varying normally against an omitted based case of the opt-out, none of these option. The price parameter was specified to vary following a triangular distribution assuring a globally negative impact.

Retail, Choose How Many Treatment

We also summarize response data via histograms. First the frequency of volume selections for those indicating they would buy one or more pounds is documented as “conditional quantity” information. As shown in the following figure, among situations where participants are intent on buying the most common response for Store-Brand, 80% Lean is two packages (26% of cases) where the most common for the other four items is one pound.

Figure A2. Retail Choose How Many Treatment, Conditional Quantity Histogram

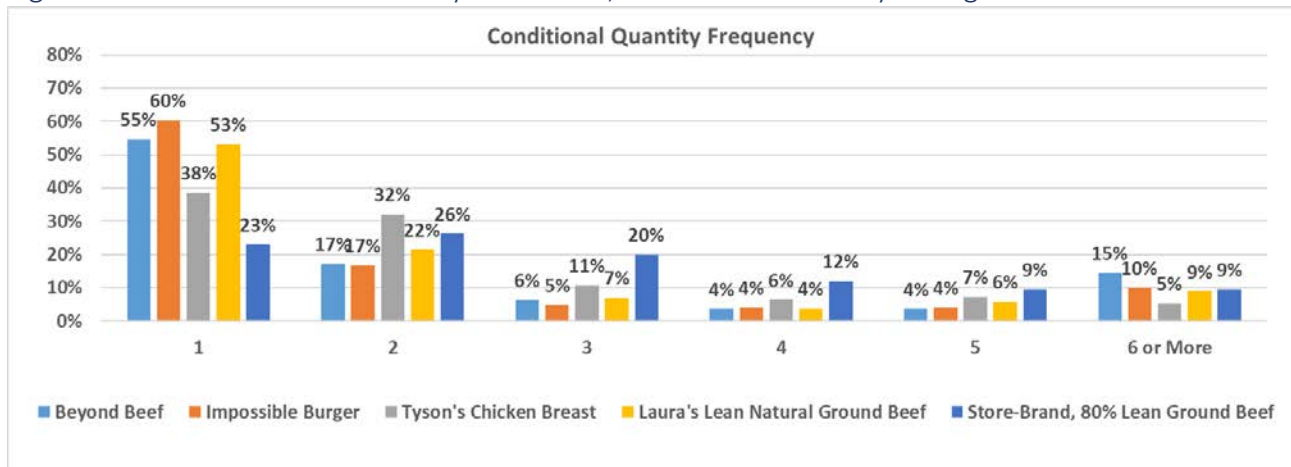


Table A8. Retail Choose How Many Treatment, Tobit Model Parameter Estimates: Beyond Beef

	Full Sample		Regular Meat Consumer		Not a Regular Meat Consumer	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	-3.466	<.0001	-4.986	0.000	-0.750	0.435
Price, Beyond	-0.137	<.0001	-0.212	<.0001	-0.108	0.007
Price, Impossible	-0.085	0.007	-0.070	0.196	-0.106	0.008
Price, Tyson Chicken Breast	0.039	0.207	0.015	0.776	0.064	0.109
Price, Laura's Lean	-0.036	0.248	0.003	0.951	-0.074	0.061
Price, Store Brand Ground	-0.063	0.041	-0.068	0.193	-0.073	0.062
Age, Under 35	3.421	<.0001	4.523	<.0001	1.167	<.0001
Age, 35 to 55	2.110	<.0001	3.341	<.0001	0.370	0.136
Male	1.942	<.0001	1.962	<.0001	1.682	<.0001
Married	0.116	0.437	-0.172	0.482	0.544	0.012
Children Under Age of 12	1.869	<.0001	0.202	0.469	2.017	<.0001
College, 4 Years or More	0.469	0.003	0.480	0.080	0.469	0.023
Income above \$100,000	0.123	0.489	-0.162	0.621	-0.229	0.316
Hispanic, Latino	0.955	<.0001	-0.803	0.019	1.432	<.0001
Race, White	-0.962	<.0001	-1.237	<.0001	-0.109	0.524
Political Party, Democratic	0.859	<.0001	-0.154	0.512	1.326	<.0001
Region, Northeast	0.016	0.931	0.058	0.873	-0.136	0.536
Region, Midwest	-0.097	0.593	0.245	0.417	0.589	0.023
Region, South	-0.336	0.027	0.609	0.024	-0.904	<.0001
Sigma	3.747	<.0001	4.393	<.0001	3.043	<.0001
Number of Observations	7,869		5,710		2,159	
Log-likelihood	-6,952		-2,877		-3,152	
AIC	13,945		5,793		6,344	

Table A9. Retail Choose How Many Treatment, Tobit Model Parameter Estimates: Impossible Burger

	<i>Full Sample</i>		<i>Regular Meat Consumer</i>		<i>Not a Regular Meat Consumer</i>	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	-4.742	27.000	-7.188	<.0001	-1.351	0.208
Price, Beyond	-0.019	27.000	0.001	0.984	-0.034	0.439
Price, Impossible	-0.209	27.000	-0.193	0.002	-0.221	<.0001
Price, Tyson Chicken Breast	0.097	27.000	0.040	0.518	0.136	0.002
Price, Laura's Lean	-0.050	27.000	-0.039	0.521	-0.065	0.133
Price, Store Brand Ground	-0.070	27.000	-0.048	0.423	-0.091	0.035
Age, Under 35	3.288	27.000	3.279	<.0001	1.505	<.0001
Age, 35 to 55	2.033	27.000	2.713	<.0001	0.531	0.059
Male	2.348	27.000	2.477	<.0001	1.972	<.0001
Married	0.282	27.000	0.202	0.475	0.575	0.018
Children Under Age of 12	2.331	27.000	0.621	0.053	2.303	<.0001
College, 4 Years or More	0.380	27.000	0.670	0.034	0.259	0.258
Income above \$100,000	0.332	27.000	-0.031	0.932	-0.243	0.335
Hispanic, Latino	1.316	27.000	-0.206	0.610	1.399	<.0001
Race, White	-1.181	27.000	-1.976	<.0001	0.002	0.992
Political Party, Democratic	1.061	27.000	-0.153	0.569	1.522	<.0001
Region, Northeast	0.277	27.000	0.595	0.174	-0.252	0.300
Region, Midwest	0.643	27.000	1.810	<.0001	0.857	0.003
Region, South	0.161	27.000	1.914	<.0001	-0.879	<.0001
Sigma	4.075	27.000	4.729	<.0001	3.298	<.0001
Number of Observations	7,871		5,713		2,158	
Log-likelihood	-6,400		-2,393		-3,047	
AIC	12,840		4,827		6,133	

Table A10. Retail Choose How Many Treatment, Tobit Model Parameter Estimates: Tyson's Chicken Breast

	<i>Full Sample</i>		<i>Regular Meat Consumer</i>		<i>Not a Regular Meat Consumer</i>	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	2.862	<.0001	3.360	<.0001	1.271	0.214
Price, Beyond	0.007	0.766	0.018	0.529	-0.008	0.844
Price, Impossible	-0.067	0.005	-0.051	0.072	-0.095	0.026
Price, Tyson Chicken Breast	-0.431	<.0001	-0.588	<.0001	-0.141	0.001

Price, Laura's Lean	-0.032	0.177	-0.032	0.269	-0.026	0.541
Price, Store Brand Ground	-0.087	0.000	-0.065	0.019	-0.124	0.003
Age, Under 35	1.137	<.0001	1.882	<.0001	0.100	0.701
Age, 35 to 55	0.448	0.000	0.452	0.001	0.192	0.439
Male	0.556	<.0001	0.402	0.000	0.925	<.0001
Married	0.929	<.0001	0.809	<.0001	0.999	<.0001
Children Under Age of 12	0.321	0.008	-0.407	0.013	1.357	<.0001
College, 4 Years or More	0.030	0.798	-0.251	0.079	0.460	0.031
Income above \$100,000	-0.339	0.010	0.005	0.974	-0.749	0.002
Hispanic, Latino	0.016	0.908	-0.293	0.145	1.002	<.0001
Race, White	-0.331	0.005	-0.405	0.010	-0.052	0.780
Political Party, Democratic	-0.032	0.746	-0.348	0.004	0.686	<.0001
Region, Northeast	-0.564	<.0001	-0.453	0.012	-0.315	0.182
Region, Midwest	-0.117	0.390	-0.165	0.299	0.531	0.056
Region, South	-0.545	<.0001	-0.155	0.278	-0.928	<.0001
Sigma	3.609	<.0001	3.626	<.0001	3.389	<.0001
Number of Observations	7,882		5,719		2,163	
Log-likelihood	-13,192		-9,337		-3,681	
AIC	26,425		18,715		7,403	

Table A11. Retail Choose How Many Treatment, Tobit Model Parameter Estimates: Laura's Lean Natural Ground Beef

	<i>Full Sample</i>		<i>Regular Meat Consumer</i>		<i>Not a Regular Meat Consumer</i>	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	-0.248	0.691	0.371	0.638	-0.827	0.405
Price, Beyond	0.043	0.095	0.046	0.155	0.024	0.560
Price, Impossible	-0.131	<.0001	-0.130	<.0001	-0.127	0.002
Price, Tyson Chicken Breast	0.040	0.115	0.038	0.223	0.044	0.272
Price, Laura's Lean	-0.328	<.0001	-0.484	<.0001	-0.142	0.001
Price, Store Brand Ground	-0.035	0.174	0.007	0.820	-0.089	0.028
Age, Under 35	1.347	<.0001	1.347	<.0001	0.819	0.002
Age, 35 to 55	0.536	<.0001	0.402	0.010	0.617	0.014
Male	1.414	<.0001	0.932	<.0001	1.717	<.0001
Married	0.599	<.0001	0.539	0.000	0.898	<.0001
Children Under Age of 12	1.133	<.0001	-0.124	0.516	1.783	<.0001
College, 4 Years or More	0.608	<.0001	0.857	<.0001	0.321	0.126
Income above \$100,000	0.266	0.062	0.408	0.024	-0.425	0.071
Hispanic, Latino	0.472	0.001	-1.209	<.0001	1.283	<.0001
Race, White	-0.644	<.0001	-0.545	0.002	-0.128	0.473

Political Party, Democratic	0.396	0.000	-0.186	0.181	1.097	<.0001
Region, Northeast	-0.079	0.605	0.116	0.578	-0.386	0.091
Region, Midwest	0.349	0.018	0.532	0.003	0.751	0.005
Region, South	-0.020	0.877	0.662	<.0001	-0.796	<.0001
Sigma	3.482	<.0001	3.441	<.0001	3.168	<.0001
Number of Observations	7,789		5,636		2,153	
Log-likelihood	-9,084		-5,226		-3,261	
AIC	18,208		10,492		6,563	

Table A12. Retail Choose How Many Treatment, Tobit Model Parameter Estimates: Store-Brand 80% Lean Ground Beef

	<i>Full Sample</i>		<i>Regular Meat Consumer</i>		<i>Not a Regular Meat Consumer</i>	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	1.786	0.001	2.228	0.001	0.605	0.523
Price, Beyond	0.078	0.001	0.080	0.003	0.059	0.132
Price, Impossible	-0.112	<.0001	-0.092	0.001	-0.146	0.000
Price, Tyson Chicken Breast	0.033	0.137	0.029	0.278	0.048	0.219
Price, Laura's Lean	0.049	0.026	0.098	0.000	-0.035	0.374
Price, Store Brand Ground	-0.612	<.0001	-0.766	<.0001	-0.341	<.0001
Age, Under 35	1.260	<.0001	1.399	<.0001	1.006	<.0001
Age, 35 to 55	0.906	<.0001	1.014	<.0001	0.720	0.002
Male	0.825	<.0001	0.439	<.0001	1.497	<.0001
Married	0.677	<.0001	0.553	<.0001	0.534	0.011
Children Under Age of 12	0.895	<.0001	0.046	0.757	1.721	<.0001
College, 4 Years or More	-0.355	0.002	-0.457	0.001	0.073	0.715
Income above \$100,000	-0.027	0.831	-0.043	0.777	-0.259	0.254
Hispanic, Latino	0.470	0.000	0.532	0.004	0.977	<.0001
Race, White	-0.256	0.019	-0.179	0.218	0.024	0.887
Political Party, Democratic	-0.216	0.019	-0.749	<.0001	0.672	<.0001
Region, Northeast	-0.211	0.111	0.180	0.286	-0.741	0.001
Region, Midwest	0.398	0.002	0.446	0.003	0.552	0.029
Region, South	-0.055	0.616	0.543	<.0001	-0.950	<.0001
Sigma	3.241	<.0001	3.210	<.0001	3.054	<.0001
Number of Observations	7,779		5,656		2,123	
Log-likelihood	-11,461		7,835		-3,353	
AIC	22,962		15,709		6,745	

Table A13. Retail Choose How Many Treatment, Tobit Model Marginal Effect Estimates: Beyond Beef

	<i>Full Sample</i>	<i>Regular Meat Consumer</i>	<i>Not a Regular Meat Consumer</i>
Age, Under 35	0.540	0.354	0.437
Age, 35 to 55	0.333	0.261	0.139
Male	0.307	0.154	0.631
Married	0.018	-0.013	0.204
Children Under Age of 12	0.295	0.016	0.756
College, 4 Years or More	0.074	0.038	0.176
Income above \$100,000	0.019	-0.013	-0.086
Hispanic, Latino	0.151	-0.063	0.537
Race, White	-0.152	-0.097	-0.041
Political Party, Democratic	0.136	-0.012	0.497
Region, Northeast	0.002	0.005	-0.051
Region, Midwest	-0.015	0.019	0.221
Region, South	-0.053	0.048	-0.339

Number of Observations 7,869 5,710 2,159

Note: These marginal effects are derived as the average impact across all respondents included in each model.

Table A14. Retail Choose How Many Treatment, Tobit Model Marginal Effect Estimates: Impossible Burger

	<i>Full Sample</i>	<i>Regular Meat Consumer</i>	<i>Not a Regular Meat Consumer</i>
Age, Under 35	0.453	0.216	0.510
Age, 35 to 55	0.280	0.179	0.180
Male	0.323	0.163	0.668
Married	0.039	0.013	0.195
Children Under Age of 12	0.321	0.041	0.780
College, 4 Years or More	0.052	0.044	0.088
Income above \$100,000	0.046	-0.002	-0.082
Hispanic, Latino	0.181	-0.014	0.474
Race, White	-0.163	-0.130	0.001
Political Party, Democratic	0.146	-0.010	0.515
Region, Northeast	0.038	0.039	-0.085
Region, Midwest	0.089	0.119	0.290
Region, South	0.022	0.126	-0.298

Number of Observations 7,871 5,713 2,158

Note: These marginal effects are derived as the average impact across all respondents included in each model.

Table A15. Retail Choose How Many Treatment, Tobit Model Marginal Effect Estimates: Tyson's Chicken Breast

	<i>Full Sample</i>	<i>Regular Meat Consumer</i>	<i>Not a Regular Meat Consumer</i>
Age, Under 35	0.537	0.869	0.050
Age, 35 to 55	0.212	0.209	0.096
Male	0.263	0.186	0.460
Married	0.439	0.373	0.497
Children Under Age of 12	0.152	-0.188	0.675
College, 4 Years or More	0.014	-0.116	0.229
Income above \$100,000	-0.160	0.002	-0.373
Hispanic, Latino	0.008	-0.135	0.498
Race, White	-0.156	-0.187	-0.026
Political Party, Democratic	-0.015	-0.160	0.341
Region, Northeast	-0.267	-0.209	-0.157
Region, Midwest	-0.055	-0.076	0.264
Region, South	-0.258	-0.072	-0.461
Number of Observations	7,882	5,719	2,163

Note: These marginal effects are derived as the average impact across all respondents included in each model.

Table A16. Retail Choose How Many Treatment, Tobit Model Marginal Effect Estimates: Laura's Lean Natural Ground Beef

	<i>Full Sample</i>	<i>Regular Meat Consumer</i>	<i>Not a Regular Meat Consumer</i>
Age, Under 35	0.369	0.305	0.328
Age, 35 to 55	0.147	0.091	0.247
Male	0.387	0.211	0.687
Married	0.164	0.122	0.359
Children Under Age of 12	0.310	-0.028	0.713
College, 4 Years or More	0.166	0.194	0.128
Income above \$100,000	0.073	0.092	-0.170
Hispanic, Latino	0.129	-0.274	0.513
Race, White	-0.176	-0.123	-0.051
Political Party, Democratic	0.108	-0.042	0.439
Region, Northeast	-0.022	0.026	-0.154
Region, Midwest	0.095	0.120	0.301
Region, South	-0.005	0.150	-0.318

Number of Observations	7,789	5,636	2,153
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Note: These marginal effects are derived as the average impact across all respondents included in each model.

Table A17. Retail Choose How Many Treatment, Tobit Model Marginal Effect Estimates: Store-Brand 80% Lean Ground Beef

	<i>Full Sample</i>	<i>Regular Meat Consumer</i>	<i>Not a Regular Meat Consumer</i>
Age, Under 35	0.503	0.542	0.435
Age, 35 to 55	0.362	0.393	0.311
Male	0.330	0.170	0.647
Married	0.271	0.214	0.231
Children Under Age of 12	0.358	0.018	0.743
College, 4 Years or More	-0.142	-0.177	0.032
Income above \$100,000	-0.011	-0.017	-0.112
Hispanic, Latino	0.188	0.206	0.422
Race, White	-0.102	-0.069	0.010
Political Party, Democratic	-0.086	-0.290	0.290
Region, Northeast	-0.084	0.070	-0.320
Region, Midwest	0.159	0.173	0.239
Region, South	-0.022	0.210	-0.411
Number of Observations	7,779	5,656	2,123

Note: These marginal effects are derived as the average impact across all respondents included in each model.