

# Plant-Based versus Conventional Meat: Substitution, Complementarity, and Market Impacts

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## Abstract

Evidence regarding whether consumers view plant-based meat alternatives (PBMA) as substitutes or complements to animal-based meat is limited; however, the ultimate effect of increased demand for plant-based meats on poultry and livestock production depends on this relationship. While the research on consumer demand for meat alternatives is growing, most current elasticity estimates are based on stated preferences discrete choice models, which assume consumers choose only one option and that all options are substitutes. This study employs a basket-based choice experiment (BBCE) to estimate own- and cross-price elasticities at both disaggregate and aggregate product levels. We utilized a between-sample approach and designed two BBCEs to reflect both at-home and away-from-home consumption settings. We then used the results from the BBCE to inform an equilibrium displacement model. Our findings indicate that: 1) consumers are more price-sensitive when dining out than when eating at home, 2) own price elasticity for PBMA lie between premium meat options (salmon and ribeye steak) and more affordable choices (burgers and chicken breast), 3) PBMA complement conventional meat in at-home consumption but show a mix of complementarity and substitution dynamics in dining out; and 4) lowering prices of plant-based beef and chicken alternatives is unlikely to significantly impact conventional poultry and livestock production.

**Keywords:** Basket-based choice experiment, equilibrium displacement model, plant-based meat alternatives, conventional meat, consumer demand, price elasticities.

**JEL codes:** D03, D11, C25, Q11.

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## 1. Introduction

Novel plant-based meat alternatives (PBMA) are heralded as a solution to the health, environmental, and animal welfare externalities that exist with traditional meat production (e.g., Bryant, 2022; Good Food Institute, 2021; Hu et al., 2019). A key, often unstated, assumption behind these beliefs is that consumers will increasingly switch to PBMA as traditional meat prices rise and prices for PBMA fall, perhaps because of the industry gaining economies of scale. Stated in a more technical manner, the ultimate success of PBMA in achieving their social goals in reducing the number of poultry and livestock depends on the cross-price elasticity between meat and PBMA (Lusk et al., 2022; Schmiess et al., 2023).<sup>1</sup> Despite the importance of this key economic parameter and driving outcomes, there remains high uncertainty about the magnitude, and even the sign, of the cross-price elasticities between meat and PBMA.

Many stated preference studies use approaches that force the cross-price elasticities to be positive, indicating meat and PBMA are demand substitutes (e.g., Caputo et al., 2023; Slade et al., 2018; Van Loo et al., 2020). Even in these contexts, the estimated magnitudes of the cross-price elasticities are small, meaning even large reductions in the price of PBMA only have small effects on consumer demand for traditional meat. There have been a handful of studies estimating cross-price elasticities using retail scanner data that allow for flexible substitution patterns, and here, the estimates are all over the map. Some studies estimate PBMA are demand substitutes with beef while being demand complements for chicken (Tonsor and Bina, 2023), while others estimate PBMA are demand complements with beef and demand substitutes for chicken (Zhao et al., 2023). Neuhofer and Lusk (2023), by contrast, find very small cross-price effects, with ground PBMA being demand substitutes for ground beef and ground chicken, while being demand complements with ground turkey. A key challenge using scanner data to estimate these parameters is the difficulty of controlling for price endogeneity and measurement error, casting doubt on the reliability of estimates from time-series scanner data that do not have a clear identification strategy.

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<sup>1</sup> Previous research has shown that many consumers of meat also consume PBMA (e.g., Cuffey et al., 2023; Neuhofer and Lusk, 2022; Taylor et al., 2023). Nonetheless, this research also suggests heavy meat consumers are infrequent consumers of PBMA. These studies do not explicitly provide evidence on the extent to which consumer purchases will change in response to changing prices.

What is needed is an experimental-based approach where prices can be varied exogenously and a modeling approach where meat and PBMA's can be either demand compliments or substitutes. The basket-based approach introduced by Caputo and Lusk (2022) provides precisely such a method. In this paper, we use the basket-based approach to study demand inter-relationships between PBMA's and traditional meat products. Importantly, we move beyond most previous stated preference studies that focus on beef-like PBMA's and extend this analysis to include chicken-like PBMA's and traditional chicken, the most widely consumed meat in the United States. We consider both food at home (FAH) and food away from home (FAFH) consumption settings, given they both account for significant portions of overall food choices. In addition, we use these estimates to expand the model in Lusk et al. (2022) to explore how reductions in prices of plant-based beef or chicken alternatives affect cattle and poultry inventories.

## **2. Study 1: Animal and plant-based meat for at home consumption**

















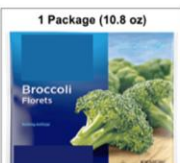
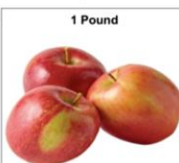



In study 1, we examined consumer preferences and demand for conventional meat and PBMA's consumed at home. We implemented a nationwide consumer survey. The data collection took place in August 2023, and participants were recruited by Qualtrics. A total of 1,011 food shoppers completed the study (see Table A1 for participant socio-demographic information).

### *2.1 The BBCE Design*

The BBCE for FAH was implemented following the same procedures as in Caputo and Lusk (2022). We included 21 food items and a no-purchase option. Of the 21 items, nine are conventional meat products (beef burger patty, ribeye, ground turkey, pork loin, pork sausage, chicken breast, chicken nuggets, chicken wings, and salmon) and three PBMA's (PB chicken nuggets, PB burger, and PB chicken sausage). The selection of meat products aimed to reflect the most frequently sold products in the United States, while the three PBMA's covered a wide range of plant-based options, including beef and chicken substitutes. We also provided alternatives to protein sources by including three vegetables (lettuce, potatoes, frozen broccoli), three fruits (banana, strawberries, and apples) and three vegetarian/vegan options (tofu, a vegan avocado sandwich, and mac and cheese).

Respondents completed an exercise like that shown in figure 1 multiple times. The only difference in each shopping scenario was the price charged for each item. In each shopping scenario, each of the 21 food items was offered at one of three different price levels (the levels used for each product are reported in Appendix, Table A2). The allocation of the price levels across alternatives and shopping scenarios was determined by orthogonal fractional factorial design, which resulted in 27 choice questions or shopping scenarios. Across all 27 questions the price of ground beef is, for example, uncorrelated with the price of plant-based ground beef alternative. To reduce fatigue, the 27 choice questions were blocked in 3 sets of 9 questions each. As a result, during the experiment, each participant answered 9 choice questions or shopping scenarios, each displayed on a separate screen. An example of BBCE question is reported in Figure 1.

Please choose the food item or items you would like to purchase for preparing a meal for yourself and/or your household. If none of the provided food items appeal to you, you can select "No-Purchase". Your total price is displayed at the bottom of the question.

<input type="checkbox"/> 1 Package (13.5 oz)  <b>Plant-Based Chicken Nuggets</b> \$5.49	<input type="checkbox"/> 1 Pound  <b>Ribeye</b> \$13.49	<input type="checkbox"/> 1 Pound  <b>Chicken Breast</b> \$3.49	<input type="checkbox"/> 1 Package (12.3 oz)  <b>Tofu</b> \$2.49	<input type="checkbox"/> 3 Hearts  <b>Lettuce</b> \$3.59	<input type="checkbox"/> 1 Pound  <b>Banana</b> \$0.59
<input type="checkbox"/> 1 Package (8 oz)  <b>Plant-Based Burger</b> \$5.49	<input type="checkbox"/> 1 Pound  <b>Ground Turkey</b> \$5.49	<input type="checkbox"/> 1 Package (32 oz)  <b>Chicken Nuggets</b> \$5.49	<input type="checkbox"/> 1 Package  <b>Vegan Avocado Sandwich</b> \$8.49	<input type="checkbox"/> 1 Pound  <b>Potatoes</b> \$1.59	<input type="checkbox"/> 1 Pound  <b>Strawberries</b> \$3.59
<input type="checkbox"/> 1 Package (13 oz)  <b>Plant-Based Chicken Sausage</b> \$9.49	<input type="checkbox"/> 1 Pound  <b>Pork Loin</b> \$5.49	<input type="checkbox"/> 1 Pound  <b>Chicken Wings</b> \$3.49	<input type="checkbox"/> 1 Package (3.5 oz)  <b>Mac and Cheese</b> \$4.49	<input type="checkbox"/> 1 Package (10.8 oz)  <b>Frozen Broccoli</b> \$5.49	<input type="checkbox"/> 1 Pound  <b>Apples</b> \$1.59
<input type="checkbox"/> 1 Pound  <b>Beef burger patty</b> \$6.49	<input type="checkbox"/> 1 Package (12 oz)  <b>Pork Sausage</b> \$5.49	<input type="checkbox"/> 1 Pound  <b>Salmon</b> \$8.49	<input type="checkbox"/> No-Purchase		

Your total bill is \$

0

**Figure 1:** BBCE question, an example for FAH

Prior to the BBCE exercise, participants were asked to report expenditure for FAH associated with meals prepared at home using groceries purchased from grocery stores<sup>2</sup>. Specifically, respondents were asked to report three types of FAH spending: typical weekly, within the last seven days, and

<sup>2</sup>We asked respondents to report expenditures for FAH consumption, excluding those associated with dining out, fast-food establishments, cafeterias, and similar venues, as well as costs incurred from food delivery services provided by restaurants.

the most recent home-cooked meal, with responses requested in dollars (\$).<sup>3</sup> Once these questions were recorded, we guided the participants into the experiment through three steps. The first step was designed to set up the scene and enhance the realism of the BBCE exercise. Accordingly, we began the experiment by posing a word association question, asking, “*What do you think when you hear “Grocery Store Shopping?”*” Following this, we presented various images depicting both supermarket and non-supermarket environments and instructed participants to select only the images associated with a supermarket setting (see Figure A1 in Appendix).

In the second step, participants were provided with information about the choice context as shown in Figure A2 in Appendix. Subsequently, they were given additional instructions on how to respond to the BBCE questions. The following verbiage was used:

*“Before proceeding with the questions, here is some important information we would like you to read:*

- *Please remember that although we will ask you nine separate questions, each question presents a fresh opportunity to make a decision. Thus, for each question, imagine yourself walking through the grocery store at that specific moment.*
- *For each question, you can choose one food item or multiple food items in any combination. To undo a selection, simply click on the item again.*
- *The total cost of your selected food items will be displayed in the cart below. If the total cost exceeds your budget, you can revise your selection.*
- *Please answer each question as honestly as possible, reflecting how you would truly purchase to prepare a meal for yourself and/or your household. Only choose higher-priced food items if you would actually pay that posted price in the grocery store.”*

Lastly, in the third step, we reminded respondents about their actual expenditures for FAH consumption based on their answers on the expenditure questions. Following Kilders et al. (2023), we did so to help them establish realistic expenditure levels before the choice exercise. The provided verbiage was: “*Before we proceed with the first question, we want to remind you that when making a decision on what to purchase, please keep in mind that you stated earlier that your weekly expense for food purchased at grocery store to prepare meals at home for yourself and/or*

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<sup>3</sup> Data from these questions indicate that, on average, respondents spend \$145 per week on FAH. They also reported having spent \$129 on FAH within the last seven days and \$43 for the most recent home-cooked meal.

*your household was [\$]. You also mentioned that you spent [\$] on groceries to prepare at home your last meal for yourself and/or your household.”*

## 2.2 Data Analysis

The data was analyzed using a multivariate logistic (MVL) model (Song and Chintagunta 2006; Kwak, Duvvuri, and Russell 2015). The MVL model is grounded in the Random Utility Theory (McFadden 1973), which posits that the utility that individual  $n$  derives from basket  $b$  can be represented as  $U_{nb} = V_{nb} + \varepsilon_{nb}$ , where  $V_{nb}$  is the systematic component, and  $\varepsilon_{nb}$  denotes the i.i.d. extreme value type I random term. The term  $V_{nb}$  can be expressed in terms of the second-order Taylor series approximation:

$$(1) \quad V_{nb} = \sum_{j=1}^J \vartheta_{nj}x_j + 0.5 \sum_{j=1}^J \sum_{k \neq j}^J \gamma_{jk}x_jx_k$$

where  $\vartheta_{nj}$  is the baseline utility for food item  $j$  derived by respondent  $n$ ;  $x_j$  is a dummy variable equals 1 if item  $j$  was added to the basket and zero otherwise;  $\gamma_{jk}$  is the cross-effect parameter that captures the degree of interdependence in demand between food items  $j$  and  $k$ :  $\gamma_{jk} > 0$  if food items are complements;  $\gamma_{jk} < 0$  if food items are substitutes, and  $\gamma_{jk} = 0$  if food items are independent in demand. Given our experimental set up,  $\vartheta_{nj}$  in equation (1) was specified as:

$$(2) \quad \vartheta_{nj} = \alpha_{0,j} + \beta p_j + \mathbf{X}_n \boldsymbol{\delta}_j$$

where  $\alpha_{0,j}$  presents a constant for each  $j$  alternative include in the BBCE;  $p_j$  is the price of each food item;  $\mathbf{X}_n$  is a vector-matrix of individual-specific factors;  $\beta$  and  $\boldsymbol{\delta}_j$  are the corresponding parameters.

For estimation, we employed the composite conditional likelihood function approach (Russell and Petersen 2000) and estimated a series of  $J$  binary logit models, where the conditional probability of respondent  $n$  selecting basket  $b$  was expressed as:

$$(3) \quad \text{Prob}[n \text{ chooses basket } b] = \frac{e^{z_{nj}}}{1 + e^{z_{nj}}}$$

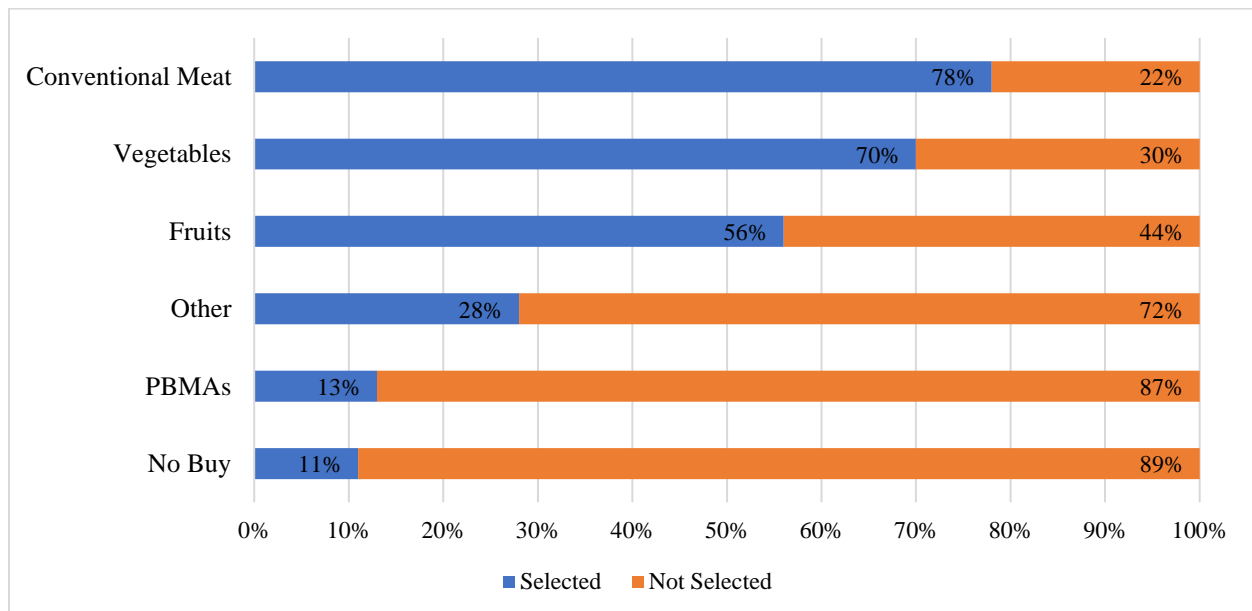
where  $z_{nj} = \vartheta_{nj} + \sum_{k \neq j}^J \gamma_{jk}y_{nk}$ , with  $y_{nk} = 1$  if food item  $k$  is added to the basket and zero otherwise. For identification purpose, we imposed the following restrictions:  $\gamma_{jj} = 0$  and  $\gamma_{jk} =$

$\gamma_{kj}$  (see Besag 1974; Russell and Petersen 2000). The formulation in (3) can be interpreted as the joint probability of choosing the observed baskets from among the  $2^N$  possible combination of baskets, conditional on the choice of item  $j$ . The estimated coefficients from the MVL model were then used to compute arc-elasticities, following similar procedures as in Richards, Hamilton, and Yonezawa (2018) and Caputo and Lusk (2022).

### 2.3 The BBCE and FAH selection

In line with the findings by Caputo and Lusk (2022), respondents selected, on average, 3.5 food items. The majority of respondents chose between two and four food items (50.8%), with only 10.7% opting for the “no-purchase” option. As shown in Figure 2, most baskets included conventional meat (78%), followed by vegetables (70%), fruits (56%), and other vegan/vegetarian options (28%) like tofu, mac and cheese, and vegan avocado sandwich. PBMA options were included in 13% of the baskets, aligning the USDA (2023a) report which documents that in 2020, protein foods had the largest household FAH budget share, followed by grains, vegetables, and fruits.

**Figure 2:** Likelihood of selecting food items from each category, FAH.



Notes: 1) Conventional meat include chicken breast, ribeye, beef burger patty, pork loin, chicken wings, salmon, chicken nuggets, pork sausage, and ground turkey; 2) Vegetables include potatoes, frozen broccoli, and lettuce. 3) Fruits include bananas, strawberries, and apples; 4) PBMA include plant-based burger, plant-based chicken nuggets, and plant-based chicken sausage; 5) Other include tofu, mac and cheese and vegan avocado sandwiches.



Figure 3 shows the overall likelihood of each food item being placed in the basket by food category (conventional meat, PBMA, fruits, vegetables, and others). Looking at the overall data, the most chosen products were potatoes (51%), frozen broccoli (37%), and chicken breast (36%), while PBMA and vegan avocado sandwich were the less popular options. When considering food items within each product category, chicken breast emerged as the top choice among conventional meat products (36%), while ground turkey had the lowest selection rate, being chosen by only 12% of respondents. This finding is in line with previous demand analysis studies, such as Lusk and Tonsor (2016) and Caputo and Lusk (2022), which have consistently identified chicken breast as the preferred meat option among US consumers. This conclusion also correlates with national statistics, which show that poultry maintains the highest retail weight per capita in the US, followed by beef and pork (USDA 2022a). Also, according to the USDA (2023b), chicken continues to be the primary meat choice in terms of per-person availability in the United States

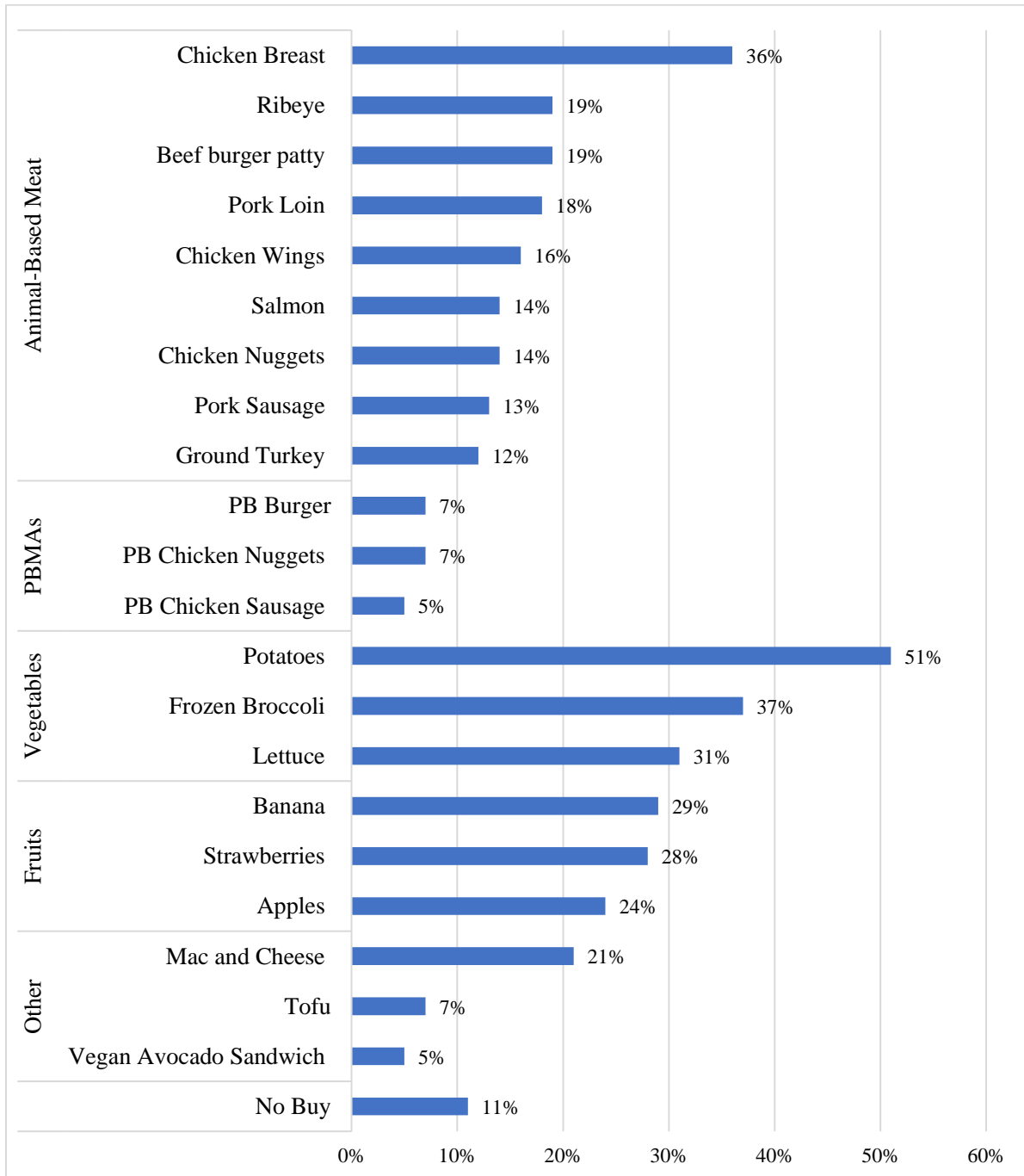
Potatoes were the most popular vegetable, chosen in 51% of cases, while the selection rates for each fruit item were relatively consistent, with bananas, strawberries, and apples appearing in 29%, 28%, and 24% of all baskets, respectively. These findings closely mirror national statistics, where potatoes and bananas dominated vegetable and fresh fruits availability in the US, respectively (USDA 2021, 2022b).

For PBMA, selection rates ranged from 5% (PB chicken sausage) to 7% (PB burgers and chicken nuggets). Notably, 13% of the baskets included at least one of the studied PBMA. This data is comparable to the existing literature based on scanner data, which suggests that 12% of households bought PBMA more than once (Neuhofer and Lusk, 2022).

Table A3 in Appendix reports the likelihood of joint product selection, which were calculated following Caputo and Lusk (2022). The results indicate high level of complementarity among PBMA, with 46.0% and 46.7% of respondents selecting PB chicken nuggets and PB burgers alongside PB chicken sausage purchases, respectively. Moreover, PBMA were commonly selected in combination with other vegan/vegetarian options: 21.2% ~ 28.7% and 28.2% ~ 36.6% of respondents opting for PBMA when also choosing tofu and vegan avocado sandwiches. In addition, 32.4% ~ 54.0% of respondents who chose PBMA also included conventional meat products in their selection. This percentage is lower than the 86% reported in scanner data by Neuhofer and Lusk (2022) for U.S. households buying PBMA. This difference can be attributed

to the fact that the authors used scanner data reflecting food selection over a two-year period rather than a single grocery shopping trip.

**Figure 3.** Likelihood of choosing each food item by food category, FAH



#### 2.4 Results from the MVL mode and elasticities

In this section we discuss the results of the MVL model, as described in equation (1). The model was specified to incorporate baseline elements and cross-utility effects as illustrated in equation (2). The baseline utility estimates are reported in Table 1.

The results in Table 1, as expected, show that the price coefficient is negative and statistically significant, suggesting that food items are less likely to be placed in baskets when offered at higher prices. The constant terms, which represent the baseline utility of each food item when the price and demographics are set to zero, are negative<sup>4</sup> and statistically significant, with varying magnitudes across food items. For example, comparing conventional meat products and PBMA, we observe that chicken breast (-0.316), salmon (-0.606), ribeye (-0.881), chicken wings (-1.205), chicken nuggets (-1.092), and beef burger patty (-1.693) are preferred over PBMA (ranging from -1.769 to -2.657). On the other hand, consumers tended to prefer PB burgers (-1.769) over pork loin (-2.518), pork sausage (-2.271), and ground turkey (-2.267), suggesting that preferences for PB burgers versus conventional meat products are product dependent. In addition, we found that, among the three PBMA, consumers favor PB burger (-1.769), followed by PB chicken nuggets (-2.344) and PB chicken sausage (-2.657). This finding can be explained by the fact that plant-based burger patties account for the largest share of PBMA sales.

We also observe diverse impacts of demographics on the baseline utility estimates, indicating varying influences of demographic factors across products. For PBMA, younger, high-income (significant only for PB burger), vegan/vegetarian consumers and households with children under 12 (significant only for PB chicken nuggets and PB chicken sausages) have higher demand for PBMA. This finding aligns with existing food choice studies on PBMA selection (Van Loo et al., 2020; Cuffey et al., 2022; Neuhofer and Lusk, 2022). We also find that white consumers have

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<sup>4</sup>The constant terms represent the log-odds of selecting each item in the baskets when price or demographic effects are zero. Hence, the negative sign does not indicate unfavorable preferences for the items. Instead, the negative signs suggest that the log-odds of each item in the possible baskets are generally below 50 percent. To illustrate this, we can calculate the probability of choosing each item using the log-odds coefficients from Table 1. Let's take the example of chicken breast (most popular product), which has a log-odds coefficient of -0.316. Converting the log-odds to a probability using the logistic function:  $P(\text{choosing "chicken breast"}) = e^{(-0.316)} / (1 + e^{(-0.316)}) \approx 0.421$ . This indicates 42.1% chance that a person will choose the item associated with the log-odds of -0.316 (in this case, chicken breast) when selecting items for their basket.

higher demand for PB chicken sausages, while urban consumers have a greater demand for PB chicken nuggets.

**Table 1:** Baseline Utility Estimates from the MVL Model – FAH

	<i>Constant</i>	Female	College	Low Income	Age	Vegan/ Vegetarian	Children under 12	White	Urban	Price
PB Chicken Nuggets	-2.344* (0.260)	-0.241* (0.103)	0.005 (0.128)	-0.054 (0.127)	-0.016* (0.004)	1.124* (0.162)	0.570* (0.110)	0.003 (0.119)	0.388* (0.138)	-0.128* (0.005)
PB Burger	-1.769* (0.230)	0.020 (0.100)	-0.019 (0.119)	-0.387* (0.118)	-0.014* (0.004)	0.749* (0.169)	0.121 (0.109)	0.0701 (0.118)	-0.162 (0.119)	-0.128* (0.005)
PB Chicken Sausage	-2.657* (0.307)	-0.236* (0.125)	0.239 (0.156)	-0.221 (0.155)	-0.017* (0.005)	0.464* (0.216)	0.230* (0.137)	0.335* (0.155)	-0.109 (0.157)	-0.128* (0.005)
Beef burger patty	-1.693* (0.159)	-0.289* (0.062)	-0.024 (0.074)	0.186* (0.074)	-0.003 (0.002)	-0.691* (0.196)	-0.053 (0.078)	0.209* (0.083)	-0.004 (0.073)	-0.128* (0.005)
Ribeye	-0.881* (0.162)	-0.265* (0.061)	-0.022 (0.072)	-0.330* (0.071)	-0.009* (0.002)	-0.491* (0.165)	0.401* (0.072)	0.300* (0.080)	0.244* (0.075)	-0.128* (0.005)
Ground Turkey	-2.267* (0.178)	-0.096 (0.075)	0.152* (0.088)	0.129 (0.089)	-0.005* (0.002)	-0.218 (0.178)	0.227* (0.085)	-0.317* (0.087)	0.234* (0.093)	-0.128* (0.005)
Pork Loin	-2.518* (0.165)	-0.185* (0.062)	-0.144* (0.073)	0.011 (0.073)	0.005* (0.002)	-0.564* (0.184)	0.045 (0.078)	0.447* (0.086)	0.124* (0.074)	-0.128* (0.005)
Pork Sausage	-2.271* (0.201)	-0.431* (0.078)	0.035 (0.096)	0.120 (0.095)	-0.005* (0.003)	-0.286 (0.223)	-0.078 (0.095)	0.162 (0.101)	-0.194* (0.093)	-0.128* (0.005)
Chicken Breast	-0.316* (0.125)	-0.131* (0.051)	-0.119* (0.059)	-0.070 (0.059)	-0.019* (0.002)	-1.381* (0.155)	0.090 (0.063)	0.296* (0.066)	0.192* (0.060)	-0.128* (0.005)
Chicken Nuggets	-1.092* (0.160)	-0.145* (0.070)	-0.214* (0.086)	0.001 (0.084)	-0.020* (0.002)	-0.640* (0.194)	0.424* (0.0775)	0.195* (0.085)	-0.074 (0.082)	-0.128* (0.005)
Chicken Wings	-1.205* (0.163)	-0.119* (0.070)	-0.032 (0.085)	-0.103 (0.084)	-0.009* (0.002)	-0.212 (0.183)	0.355* (0.079)	-0.851* (0.080)	-0.083 (0.085)	-0.128* (0.005)
Salmon	-0.606* (0.178)	-0.008 (0.071)	0.184* (0.082)	-0.471* (0.082)	-0.007* (0.002)	-0.118 (0.169)	0.017 (0.082)	-0.492* (0.083)	0.130 (0.089)	-0.128* (0.005)
Tofu	-2.037* (0.232)	0.227* (0.097)	0.143 (0.112)	-0.481* (0.111)	-0.014* (0.003)	1.171* (0.149)	0.350* (0.101)	-0.477* (0.105)	0.105 (0.121)	-0.128* (0.005)
Vegan Sandwich	-2.778* (0.274)	-0.048 (0.113)	0.473* (0.139)	0.158 (0.141)	-0.016* (0.00405)	1.038* (0.172)	0.790* (0.118)	0.048 (0.129)	-0.116 (0.138)	-0.128* (0.005)
Mac and Cheese	-0.737* (0.138)	-0.146* (0.059)	-0.349* (0.071)	0.174* (0.070)	-0.011* (0.002)	0.120 (0.142)	0.248* (0.069)	0.227* (0.075)	-0.152* (0.067)	-0.128* (0.005)
Lettuce	-2.528* (0.126)	0.369* (0.0538)	0.089 (0.060)	-0.210* (0.060)	0.007* (0.002)	0.126 (0.127)	-0.126* (0.067)	0.202* (0.070)	0.187* (0.062)	-0.128* (0.005)

Potatoes	-0.908*	0.012	-0.096*	0.113*	0.001	0.220*	-0.132*	0.165*	-0.281*	-0.128*
	(0.122)	(0.049)	(0.056)	(0.057)	(0.002)	(0.122)	(0.063)	(0.064)	(0.057)	(0.005)
Frozen Broccoli	-1.412*	0.214*	0.024	0.078	0.002	-0.105	0.090	0.032	-0.054	-0.128*
	(0.123)	(0.050)	(0.056)	(0.057)	(0.002)	(0.125)	(0.062)	(0.064)	(0.057)	(0.005)
Banana	-2.317*	-0.132*	0.369*	0.371*	-0.004*	0.575*	-0.195*	-0.029	0.046	-0.128*
	(0.145)	(0.058)	(0.066)	(0.067)	(0.002)	(0.132)	(0.0728)	(0.074)	(0.067)	(0.005)
Strawberries	-2.975*	0.319*	-0.049	-0.026	0.0120*	0.137	-0.088	-0.083	-0.190*	-0.128*
	(0.150)	(0.061)	(0.068)	(0.068)	(0.002)	(0.143)	(0.076)	(0.078)	(0.067)	(0.005)
Apples	-2.459*	0.129*	-0.074	-0.131*	-0.001	0.305*	-0.025	-0.200*	-0.014	-0.128*
	(0.153)	(0.062)	(0.071)	(0.071)	(0.002)	(0.140)	(0.075)	(0.078)	(0.071)	(0.005)
No Buy	-1.951*	0.120*	-0.088	0.037	0.011*	-0.652*	-0.194*	-0.728*	-0.244*	-0.128*
	(0.155)	(0.072)	(0.082)	(0.082)	(0.002)	(0.240)	(0.095)	(0.085)	(0.079)	(0.005)

<sup>a</sup>One asterisk (\*) denotes values that are statistically significant at the .05 level or lower.

<sup>b</sup>Numbers in parentheses are standard errors.

The cross-utility effects from the MVL model, denoted as  $\gamma_{jk}$  in equation (1), are reported in Appendix, Table A4. The estimated values are generally negative, suggesting complementary relationships between food items. This is even the case for PBMA and conventional meat products, which are found to be complement in utilities. However, cross-utility effects alone may not suffice to determine whether an item serves as complements or substitutes for another (Richards, Hamilton, and Yonezawa 2018). To look into this, we used the estimates from the MVL model and calculated own- and cross-price elasticities at the mean price and demographic level. The results are reported in Table 2.

The diagonal values represent own price elasticities and indicate how the quantity demanded of each product changes in response to a change in its own price. Products with the highest absolute own-price elasticities are the most responsive (more elastic) to price changes. In this category, salmon (1.414) and ribeye steak (1.213) show the highest price sensitivity, indicating a highly elastic demand. Following these products are the PBMA, which show notable price sensitivity with values of 0.934, 0.919, and 0.912 for PB chicken sausage, PB chicken nuggets, and PB burger, respectively. Comparatively, vegetarian/vegan choices like vegan avocado sandwich and other conventional meat options demonstrate lower price sensitivity compared to PBMA, ranging from 0.452 to 0.804. Nevertheless, they still show greater elasticity than most fruits and vegetable options, where consumers tend to show relatively low sensitivity to price changes. Own-price elasticity from these products range from 0.095 to 0.317.

The off-diagonal values in Table 2 denote cross-price elasticities. Negative values imply that the products are complements, where an increase in the price of one product leads to a decrease in the quantity demanded for the other product, and vice versa. Positive values suggest substitution patterns, where an increase in the price of one product leads to an increase in the quantity demanded for the other product. Overall, our results indicate negative cross-price elasticities, even for PBMA which are viewed by respondents as complements to other products including conventional meat options. This finding partially aligns with Zhao et al. (2022), who found that PBMA are, at aggregate level, complements for beef and pork and substitutes for chicken, turkey, and fish. Our results also reveal that changes in PBMA prices have a smaller effect on the demand for conventional meat compared to the impact of changes in conventional meat prices on PBMA demand. This finding aligns with Zhao et al.'s (2022) scanner data-based research, which also

suggests that variations in PBMA prices have limited effects on demand of conventional meat products. For instance, our data show that a 1% increase in PBMA prices only results in a decrease in demand for conventional meat by approximately 0.040% to 0.005% (similar to the 0.009% to 0.003% reported in Zhao et al. (2022)). Conversely, a 1% increase in conventional meat prices leads to a decrease in PBMA demand by approximately 0.184% to 0.026% (smaller than the 1.413% to 0.223% reported in Zhao et al. (2022)).

Furthermore, our results indicate that changes in PBMA prices have a limited influence on the demand for other food products, such as vegan/vegetarian options (-0.010 to -0.087), vegetables (-0.014 to -0.003), and fruits (-0.015 to -0.005). In contrast, the impact on the demand for other PBMA products is relatively pronounced (-0.159 to -0.081). We also observe close-to-zero cross-price elasticities for several product pairs, including apples and frozen broccoli (0.003), chicken breast and frozen broccoli (0.002), burger patty and pork loin (0.001), ground turkey and chicken breast (0.001), and frozen broccoli and potatoes (0.001). This data suggests that there is no significant relationship between the price changes of these products.





### **3. Study 2: Animal and plant-based meat for outside at home consumption**

In study 2, we examined consumer preferences and demand for conventional meat and PBMAAs consumed away from home. The data collection, conducted via Qualtrics, took place in August 2023, simultaneously with the data collection for Study 1. A total of 999 US consumers completed the FAFH study (Table A5 reports the socio-demographic information of the participants).

#### *3.1 The BBCE Design*

The BBCE for FAFH was implemented following the same procedures as in Kilders, Caputo and Lusk (2023). We included 21 dishes and a no-order option, distributed across four main categories: five appetizers, ten main entrée, four sides, and two desserts. Each category, except for desserts, included conventional meat options, PBMAAs, and vegetarian/vegan alternatives. For the appetizers, we included PB chicken nuggets, chicken nuggets, chicken wings, mozzarella sticks and spinach artichoke dip. Main entrees consisted of beef burger, ribeye steak, pork loin, pork sausage, chicken breast, salmon, PB Burger, PB chicken sausage, tofu, and vegan avocado sandwich. Side dishes comprised salad, fries, broccoli and mac and cheese. Lastly, dessert options consisted of fruits cup and cheesecake.

We followed the same experimental procedure for the design as in Study 1. Each of the 21 dishes was offered at three different price levels (see Table A6 in Appendix). The allocation of these price levels across alternatives and questions was determined using an orthogonal fractional factorial design. The design resulted in 27 choice questions, which were randomly organized into 3 blocks, each containing 9 questions. During the experiment, participants repeated a task similar to the one illustrated in Figure 4 nine times, with each task displayed on a separate screen.






Please select the **appetizer(s), entree(s), side(s), and/or dessert(s)** you would be most likely to order if you were to eat at a restaurant.

If none of the provided dishes appeal to you, you can select "I would not order any of these Appetizers/Entrees/Sides/Desserts".











Your total price is displayed at the bottom of the menu.

*Restaurant Menu*

**Appetizer**

<input type="checkbox"/>	 6 Pieces <b>Plant-based Chicken Nuggets</b> \$9.49	<input type="checkbox"/>	 6 Pieces <b>Chicken Nuggets</b> \$6.49	<input type="checkbox"/>	 6 Pieces <b>Chicken Wings</b> \$12.49	<input type="checkbox"/>	 6 Pieces <b>Mozzarella Sticks</b> \$7.49	<input type="checkbox"/>	 3 OZ <b>Spinach Artichoke Dip</b> \$5.49	<input type="checkbox"/>	I would not order any of these Appetizers
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**Entrees**

<input type="checkbox"/>	 1 Patty <b>Plant-Based Burger</b> \$14.49	<input type="checkbox"/>	 4 Links <b>Pork Sausage</b> \$12.49	<input type="checkbox"/>	 12 OZ <b>Chicken Breast</b> \$7.49	<input type="checkbox"/>	 12 OZ <b>Ribeye Steak</b> \$19.49	<input type="checkbox"/>	 4 Links <b>Plant-Based Chicken Sausage</b> \$9.49	<input type="checkbox"/>	 12 OZ <b>Pork Loin</b> \$12.49
<input type="checkbox"/>	 12 OZ <b>Tofu</b> \$12.49	<input type="checkbox"/>	 1 Patty <b>Beef Burger</b> \$12.49	<input type="checkbox"/>	 8 Inches <b>Vegan Avocado Sandwich</b> \$7.49	<input type="checkbox"/>	 12 OZ <b>Salmon</b> \$14.49	<input type="checkbox"/>	I would not order any of these Entrees		

**Sides**

<input type="checkbox"/>	 3 OZ <b>Salad</b> \$6.49	<input type="checkbox"/>	 3 OZ <b>Mac and Cheese</b> \$6.49	<input type="checkbox"/>	 3 OZ <b>Fries</b> \$4.49	<input type="checkbox"/>	 3 OZ <b>Broccoli</b> \$5.49	<input type="checkbox"/>	I would not order any of these Sides		
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**Desserts**

<input type="checkbox"/>	 3 OZ <b>Fruit Cup</b> \$6.49	<input type="checkbox"/>	 1 Slice <b>Cheese Cake</b> \$5.49	<input type="checkbox"/>	I would not order any of these Desserts	
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Your total bill is \$

**Figure 4:** BBCE question, an example for FAFH

Mirroring the setup used in Study 1, prior to the BBCE exercise, participants were first asked to report three types of FAFH expenditure: weekly, within the last seven days, and the most recently consumed FAFH meal<sup>5</sup>. Once these questions were recorded, we followed the same three steps as in Study 1. Participants were first asked to respond to a word association question (*What do you think when you hear “Restaurant Dining”?*), and then identify restaurant-related scenarios by selecting from a set that depicted both restaurant-related and non-restaurant-related environments (see Figure A3 in Appendix). Second, participants were given information about the choice context (see Figure A4), followed by additional choice instructions resembling those used in Study 1:

*“Before proceeding with the questions, here is some important information:*

- Please remember that although we will ask you nine separate questions, each question presents a fresh opportunity to make a decision. Thus, for each question, imagine yourself walking through the restaurant at that specific moment.*
- For each question, you can choose single dishes or multiple dishes in any combination, both within and between categories. To undo a selection, simply click on the item again.*
- The total cost of your selected dishes will be displayed in the cart below. If the total cost exceeds your budget, you can revise your selection.*
- Please answer each question as honestly as possible, reflecting how you would truly order. Only choose higher-priced dishes if you would actually pay that posted price in the restaurant.*

Lastly, we reminded respondents about their actual expenditures for FAFH consumption using the following verbiage: *“Before we proceed with the first question, we want to remind you that when making a decision on what to order, please keep in mind that you stated earlier that your weekly expense for meals eaten at restaurants was [\$]. You also mentioned that you spent [\$] on the last meal you ate at the restaurant.”*

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<sup>5</sup>Data from these questions indicate that, on average, respondents spend \$81 per week for FAFH. Respondents also reported spending \$42 on FAFH within the last seven days and \$24 for the most recent meal consumed away from home.

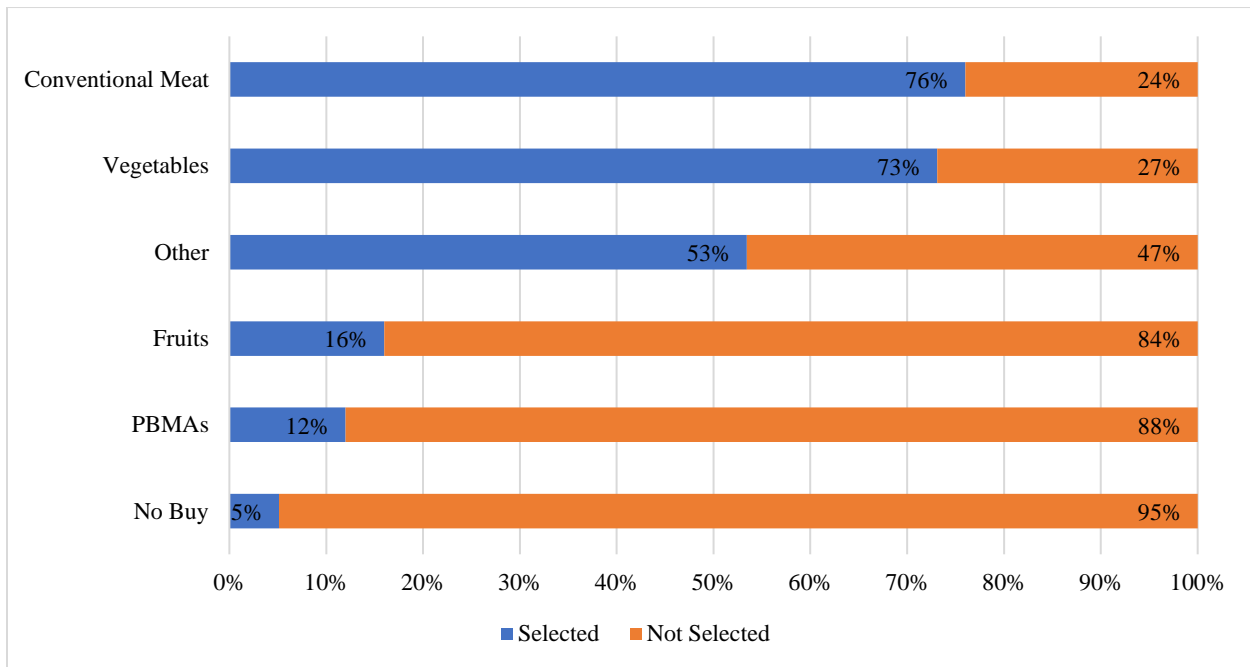
### 3.2 Data Analysis

For the data analysis, we used the same econometric model, the MVL model, and empirical approach as in Study 1. The model was estimated using the approach described in equation (3), and the term  $V_{nb}$  in equation (1) was expressed in terms of the second-order Taylor series approximation,  $V_{nb} = \sum_{j=1}^J \vartheta_{nj}x_j + 0.5 \sum_{j=1}^J \sum_{k \neq j}^J \gamma_{jk}x_jx_k$ , with each element specified as in Study 1. In the context of FAFH, the terms in  $\vartheta_{nj} = \alpha_{0,j} + \beta p_j + \mathbf{X}_n \boldsymbol{\delta}_j$  represent the following:  $\alpha_{0,j}$  is a constant for each  $j$  dish include in the BBCE;  $p_j$  is the price of each dish;  $\mathbf{X}_n$  is a vector-matrix of individual-specific factors;  $\beta$  and  $\boldsymbol{\delta}_j$  are the corresponding parameters. As in Study1, the estimated coefficients from the MVL model were used to compute arc-elasticities.

### 3.3 The BBCE and FAFH orders

In the FAFH experiment, respondents ordered an average of 2.96 dishes, consistent with Kilders et al. (2023), who found an average order of 2.70 in a restaurant setting. Most participants opted for two (33.1%) or three dishes (23.1%), with only 5.1% choosing the “No-Order” option. Main entrée and side dishes were selected by 82% of the respondents, while appetizers and desserts were chosen by 50% and 38% of the respondents, respectively. As in Study 1, conventional meat products were the most chosen options (76%), followed closely by vegetables (73%) (see Figure 5). Fruits were selected by 16% of respondents, while 53% ordered other dishes like mozzarella sticks, spinach artichoke dip, mac and cheese, vegan avocado sandwiches, tofu, and cheesecake. PBMA were chosen by 12% of participants.

**Figure 5:** Likelihood of selecting food items from each category, FAFH.



Notes: 1) Conventional meat include chicken breast, ribeye steak, beef burger, pork loin, chicken wings, salmon, chicken nuggets, and pork sausage. 2) Vegetables include fries, salad, and broccoli. 3) Fruits include fruit cups. 4) PBMA's include plant-based burger, plant-based chicken nuggets, and plant-based chicken sausage. 5) Other include mozzarella sticks, spinach artichoke dip, mac and cheese, vegan avocado sandwiches, tofu, and cheesecake.

Figure 6 illustrates the overall likelihood of each dish being ordered as a part of a meal by course. Among appetizers, mozzarella sticks were the most popular (19% of orders), while PB chicken nuggets were the least chosen (5%) and less favored than conventional chicken nuggets (8%). The popularity of mozzarella sticks is well-documented in academic research (Kilders et al. 2023), newspapers (Krishna 2021), and industry-related reports (DoorDash 2021). In terms of main entrees, the top choice was the beef burger (26% of orders), consistent with recent FAFH data (Kilders et al. 2023). PB burgers were selected by 7% of respondents, placing them fifth after salmon (10%), alongside the vegan avocado sandwich (7%). The least ordered entree was PB chicken sausage, comprising only 2% of orders. Among side dishes, fries were the most popular (36% of orders). In the dessert category, cheesecake was the preferred option (24% of orders) over fruit cups (16%).

**Figure 6.** Likelihood of ordering each dish option by course, FAFH

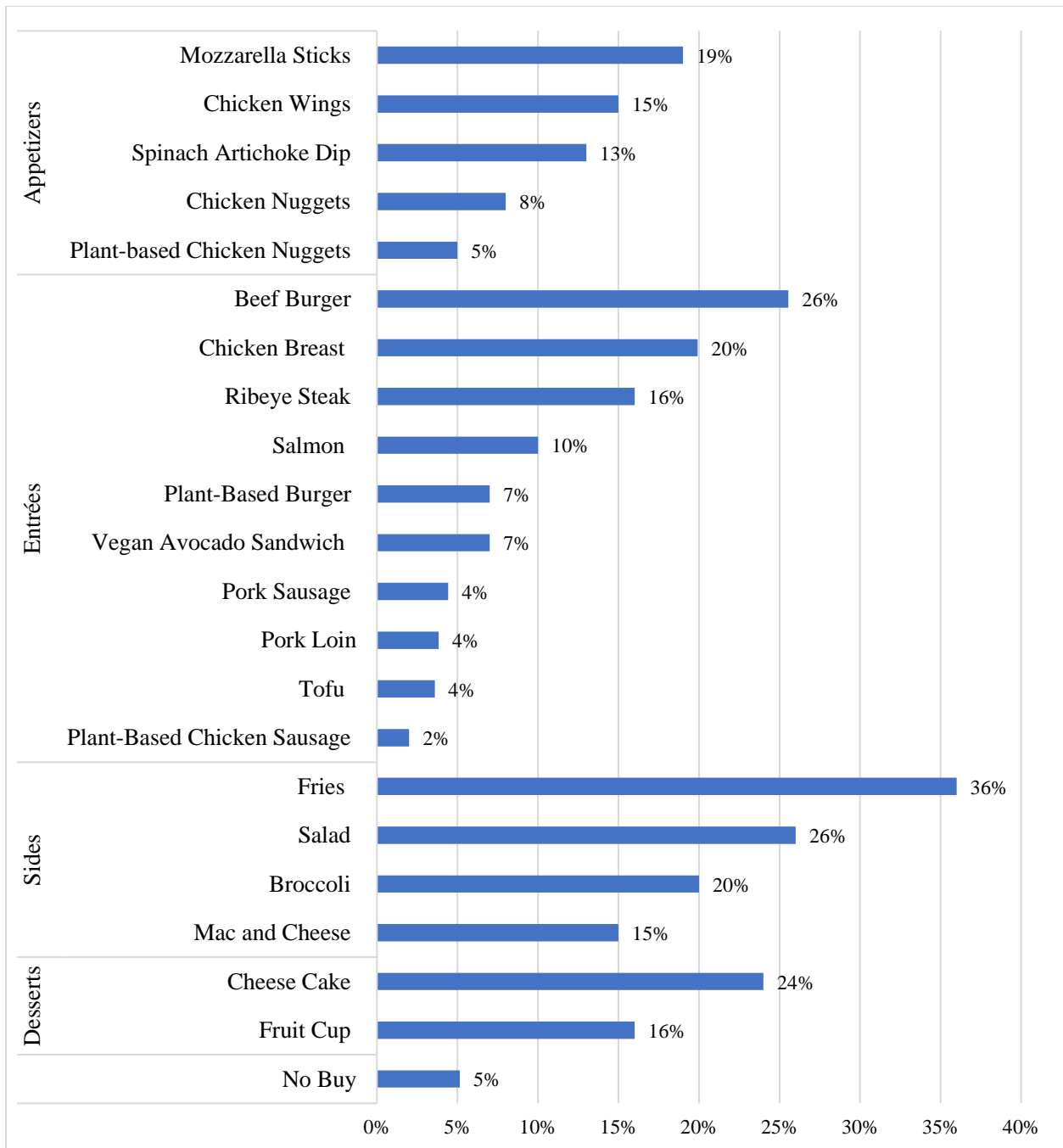


Table A7 in the Appendix reports the joint selection of dishes. The results reveal a high level of complementarity of dishes across courses and substitution of dishes within courses. For example, 65.5% of the orders include fries (the most popular sides) when they also include beef burgers (the most popular entrée). By contrast, only 12.2% of the orders include chicken breasts (the second

most popular entrée) when they also include beef burgers (the most popular entrée). The appetizer, PB chicken nuggets, is often selected with PBMA and/or other vegan/vegetarian entrees: 28.1%, 27.3%, 26.8%, and 25.1% of the orders include PB chicken nuggets when they also include PB burgers, PB chicken sausages, vegan avocado sandwiches, and tofu, respectively. Respondents ordering PB chicken nuggets as an appetizer are more likely to order PB burgers (44.7%) as entrée instead of conventional meat options (6.7% ~ 25.9%).

### *3.4 Results From the MVL model and price elasticities*

Table 3 reports the results from the MVL model. The price coefficient is negative and statistically significant, meaning that people are less likely to order FAFH when it becomes more expensive. The constants, which represent the baseline utility of each menu item when price and demographics are set to zero, show varying preferences across courses and dishes within each course. Focusing on variations across courses, our findings confirm those illustrated in Figure 6: fries and beef burgers are the most popular dishes.

In terms of variations across dishes within courses, chicken wings (-0.342) and mozzarella sticks (-0.672) have the highest utility as appetizers, while PB chicken nuggets were the least preferred option (-3.072). Among the main entrée, the beef burger was the top choice, followed by ribeye steak (-0.514), salmon (-0.648), and PB burger (-0.717). PB burgers were favored over some conventional meat options (chicken breast, pork sausage, pork loin), the other PBMA, and alternative vegetarian/vegan options like vegan avocado sandwich and tofu. The most popular side dish was fries (-0.049), while salad was the least preferred (-1.846). For desserts, cheesecake (-1.483) was preferred over the fruit cup (-1.649).

Demographic analysis reveals interesting preference patterns. Gender, age and dietary choices play a key role, with male, younger and vegan/vegetarian consumers showing higher preferences for PBMA. College-educated consumers demonstrate higher preferences for PB chicken nuggets and PB burgers than those with a lower education level. However, this distinction is not evident in the case of PB chicken sausages. Respondents with lower incomes tend to favor PB chicken nuggets but display reduced preferences for PB burgers and PB chicken sausages. Among white respondents, a higher preference is observed for PB burgers, while preferences for PB chicken nuggets are lower. Interestingly, PB burgers and beef burgers share similar demographic patterns,



with lower preference among female, low-income, older, and white respondents. However, PB burgers are preferred by vegetarian/vegan consumers, while conventional beef burgers are favored by those residing in urban areas. Preferences for PB chicken nuggets and conventional chicken nuggets also show similarities among certain demographic groups; they are more preferred by individuals with low incomes, younger consumers, and those with children under 12. In contrast to conventional chicken nuggets, PB chicken nuggets are favored by vegetarians/vegans and consumers with a college degree.

Interestingly, when examining other demographic effects, what stands out is that, compared to male, female have lower preferences for conventional meat products and higher preferences for vegetarian options like spinach artichoke dip, avocado sandwich, salad, and broccoli. These findings align with Kilders et al. (2023), who found that females generally prefer vegetarian options over conventional meat dishes. They also reflect the statistics outlined in the Dietary Guidelines for Americans 2020-2025, which indicate that females consume less protein-rich foods than males. In addition, our results indicate that low-income consumers generally show a lower preference for most meat products, which may indicate that affordability plays a significant role in their food choices. This finding is in line with the findings presented in Unnevehr et al. (2010) and Kilders et al. (2023).

**Table 3:** Baseline Utility Estimates from the MVL Model – FAFH

	Constant	Female	College	Low Income	Age	Vegan/ Vegetarian	Children under 12	White	Urban	Price
<i><b>Appetizers</b></i>										
PB Chicken Nuggets	-3.072*	-0.517*	0.262*	0.324*	-0.018*	0.887*	0.911*	-0.158	0.237	-0.110*
	(0.342)	(0.127)	(0.153)	(0.155)	(0.004)	(0.195)	(0.138)	(0.152)	(0.181)	(0.003)
Chicken Nuggets	-1.960*	-0.314*	0.062	0.372*	-0.020*	0.216	0.471*	0.026	-0.132	-0.110*
	(0.228)	(0.089)	(0.107)	(0.106)	(0.003)	(0.187)	(0.099)	(0.109)	(0.108)	(0.003)
Chicken Wings	-0.342*	-0.388*	0.130	0.0491	-0.024*	-0.174	0.264*	-0.407*	0.063	-0.110*
	(0.174)	(0.069)	(0.081)	(0.080)	(0.002)	(0.166)	(0.080)	(0.082)	(0.087)	(0.003)
Mozzarella Sticks	-0.672*	-0.014	0.191*	0.371*	-0.028*	0.115	0.080	0.0980	0.018	-0.110*
	(0.151)	(0.062)	(0.070)	(0.070)	(0.002)	(0.144)	(0.072)	(0.0770)	(0.073)	(0.003)
Spinach Artichoke Dip	-1.842*	0.206*	0.010	-0.039	-0.008*	-0.457*	0.356*	0.070	-0.082	-0.110*
	(0.186)	(0.074)	(0.077)	(0.077)	(0.002)	(0.203)	(0.086)	(0.093)	(0.081)	(0.003)
<i><b>Entrees</b></i>										
PB Burgers	-0.714*	-0.271*	0.369*	-0.206*	-0.023*	0.849*	-0.199*	0.282*	0.092	-0.110*
	(0.239)	(0.096)	(0.111)	(0.111)	(0.003)	(0.166)	(0.111)	(0.119)	(0.120)	(0.003)
Tofu	-2.329*	-0.339*	0.115	0.292*	-0.017*	0.478*	0.178	-0.294*	0.431*	-0.110*
	(0.317)	(0.125)	(0.148)	(0.149)	(0.004)	(0.215)	(0.139)	(0.141)	(0.175)	(0.003)
Pork Sausage	-2.057*	-0.924*	-0.293*	-0.341*	-0.014*	0.422*	0.0716	0.314*	0.087	-0.110*
	(0.296)	(0.119)	(0.149)	(0.141)	(0.004)	(0.212)	(0.135)	(0.149)	(0.156)	(0.003)
Beef Burger	-0.199	-0.114*	-0.0841	-0.193*	-0.003*	-0.216	0.0377	0.352*	0.162*	-0.110*
	(0.158)	(0.061)	(0.069)	(0.068)	(0.002)	(0.168)	(0.0747)	(0.081)	(0.070)	(0.003)
Chicken Breast	-0.770*	-0.157*	-0.005	-0.306*	-0.001	0.050	0.057	0.254*	0.203*	-0.110*
	(0.158)	(0.063)	(0.069)	(0.068)	(0.002)	(0.163)	(0.078)	(0.083)	(0.074)	(0.003)
Vegan Sandwich	-2.147*	0.349*	0.411*	-0.085	-0.009*	1.374*	-0.022	-0.0321	0.281*	-0.110*
	(0.232)	(0.096)	(0.103)	(0.104)	(0.003)	(0.147)	(0.105)	(0.110)	(0.118)	(0.003)
Ribeye Steak	-0.513*	-0.546*	-0.166*	-0.135*	0.004*	0.139	0.137	0.036	0.064	-0.110*
	(0.178)	(0.069)	(0.078)	(0.077)	(0.002)	(0.175)	(0.087)	(0.090)	(0.082)	(0.003)
Salmon	-0.648*	-0.411*	0.344*	-0.320*	0.001	0.057	0.051	-0.300*	0.516*	-0.110*
	(0.212)	(0.081)	(0.088)	(0.089)	(0.003)	(0.196)	(0.101)	(0.101)	(0.109)	(0.003)
PB Chicken Sausage	-2.389*	-0.745*	-0.118	-0.839*	-0.005	0.481*	0.599*	-0.465*	0.158	-0.110*

	(0.407)	(0.157)	(0.185)	(0.184)	(0.005)	(0.260)	(0.169)	(0.181)	(0.216)	(0.003)
Pork Loin	-2.697*	-0.172	0.110	0.061	0.005	-0.591	-0.208	0.055	0.216	-0.110*
	(0.311)	(0.121)	(0.132)	(0.132)	(0.004)	(0.386)	(0.157)	(0.160)	(0.145)	(0.003)
<b>Sides</b>										
Salad	-1.846*	0.502*	0.112*	-0.635*	0.024*	0.017	-0.035	0.117	-0.059	-0.110*
	(0.157)	(0.063)	(0.064)	(0.065)	(0.002)	(0.157)	(0.079)	(0.083)	(0.070)	(0.003)
Mac and Cheese	-0.544*	-0.0164	-0.527*	-0.411*	-0.009*	-0.223	0.004	0.0311	-0.258*	-0.110*
	(0.181)	(0.073)	(0.086)	(0.083)	(0.002)	(0.175)	(0.086)	(0.091)	(0.085)	(0.003)
Fries	-0.049	-0.037	-0.225*	-0.368*	-0.001	-0.079	0.007	-0.056	-0.130*	-0.110*
	(0.143)	(0.058)	(0.065)	(0.065)	(0.002)	(0.144)	(0.072)	(0.075)	(0.067)	(0.003)
Broccoli	-1.292*	0.272*	-0.014	-0.458*	0.009*	-0.274	-0.194*	-0.105	-0.029	-0.110*
	(0.161)	(0.066)	(0.070)	(0.071)	(0.002)	(0.175)	(0.085)	(0.084)	(0.076)	(0.003)
<b>Desserts</b>										
Fruit Cup	-1.649*	0.088	-0.202*	-0.065	-0.002	-0.153	0.471*	-0.453*	0.021	-0.110*
	(0.161)	(0.069)	(0.076)	(0.074)	(0.002)	(0.167)	(0.079)	(0.081)	(0.080)	(0.003)
Cheesecake	-1.483*	-0.130*	0.023	0.246*	-0.012*	0.096	0.233*	-0.0844	0.124*	-0.110*
	(0.143)	(0.059)	(0.067)	(0.066)	(0.002)	(0.145)	(0.0703)	(0.074)	(0.070)	(0.003)
<b>No Buy</b>	-3.914*	-0.631*	-0.061	0.868*	0.020*	0.460*	-0.082	-0.159	-0.218*	-0.110*
	(0.253)	(0.099)	(0.116)	(0.129)	(0.003)	(0.243)	(0.150)	(0.137)	(0.112)	(0.003)

<sup>a</sup> \*, \*\*, and \* denote values that are statistically significant at the 0.01, 0.05, and 0.10 level or lower.

<sup>b</sup> Numbers in parentheses are standard errors.

Table A8 reports the cross-utility effect estimates from the MVL model, while Table 4 presents own- and cross-price elasticities. We focus on the results from table 4 and discuss complementarity and substitution patterns across dishes, recognizing that cross-utility effects alone may not fully determine these patterns, as discussed earlier. In doing so, we begin by comparing the findings in Table 4 to those in Table 2, which reports price elasticities for food items consumed at home. A clear trend emerges: consumers, overall, show greater price sensitivity in the context of FAFH when compared to FAH.

In addition, when examining the own price elasticities of the various food items, interesting similarities and differences exist across the two consumption settings. For instance, similar to FAH, salmon and ribeye steak consumed away from home have the highest own price elasticities: 1.928 and 1.780, respectively. This pattern extends to PBMAAs, with PB chicken sausage (1.558), PB burgers (1.490), and PB chicken nuggets (1.323) showing similar price sensitivity observed for these products in FAH. Also, akin to FAH, vegetables and fruits maintain relatively low elasticities, indicating that alterations in their market prices are less likely to lead to significant shifts in consumer demand. However, unlike FAH, in the FAFH context several conventional meat options such as pork loin (1.728), pork sausage (1.326), and chicken breast (1.087) have their own price elasticities exceeding one. This suggests that consumers are more price-sensitive when dining out for these meat selections compared to purchasing them at grocery stores for FAH. The same trend holds for other dishes like beef burgers (0.991), chicken nuggets (0.968), chicken wings (0.902), and tofu (0.902), which demonstrate relatively high own price elasticities compared to FAH.

Differences between FAH and FAFH are also evident when examining the cross-price elasticities. In the FAH study, most food items were identified as complements. However, in the case of FAFH, the off-diagonal values in Table 4 indicate the existence of both substitution and complementarity patterns. Importantly, these patterns vary across product categories, highlighting the importance of conducting studies at the disaggregated level to disentangle product-related effects. For instance, PB burgers are considered price substitutes for their conventional meat counterparts, beef burgers. They are also viewed as price substitutes for chicken breasts, ribeye steak, and salmon, but as price complements for other conventional meat products, including chicken nuggets and chicken wings. On the other hand, chicken nuggets and PB chicken sausages

are not perceived as substitutes for their respective conventional meat counterparts, chicken nuggets, and pork sausages. This observation aligns with the findings in Vural et al. (2023), which suggest that substituting chicken nuggets with PB chicken nuggets is perceived as offering fewer health benefits but resulting in a greater loss of pleasantness, fullness, and satisfaction compared to substituting beef burgers with PB burgers.

Our findings also indicate that PB chicken nuggets are price substitutes for chicken wings and beef burgers, but price complements for pork sausage and salmon, while PB chicken sausages are price substitutes for beef burgers, chicken breasts, and ribeye steak, but price complements for chicken wings, salmon, and pork loin.



#### 4. Study 3: Modeling the impact of price changes on beef and chicken production.

To further explore the impact of changes in prices of plant-based alternatives on beef and chicken production, in Study 3 we constructed an equilibrium displacement model that links consumer demand for conventional meats and PBMA's to the supply of chicken and livestock. The model described in Lusk et al. (2022)<sup>6</sup> is extended to include chicken production; in addition, the demand-side of the model is expanded to include three chicken products, two plant-based chicken alternatives, tofu, and salmon (see Figure 7). Thus, there are 10 retail demand equations for U.S. consumers, which take the form:

$$(4) - (14) \quad \hat{Q}_{US,D}^j = \sum_{k=1}^{10} \eta^{jk} (\hat{P}^k + \delta^k) \quad \text{for } j = 1 \text{ to } 10$$

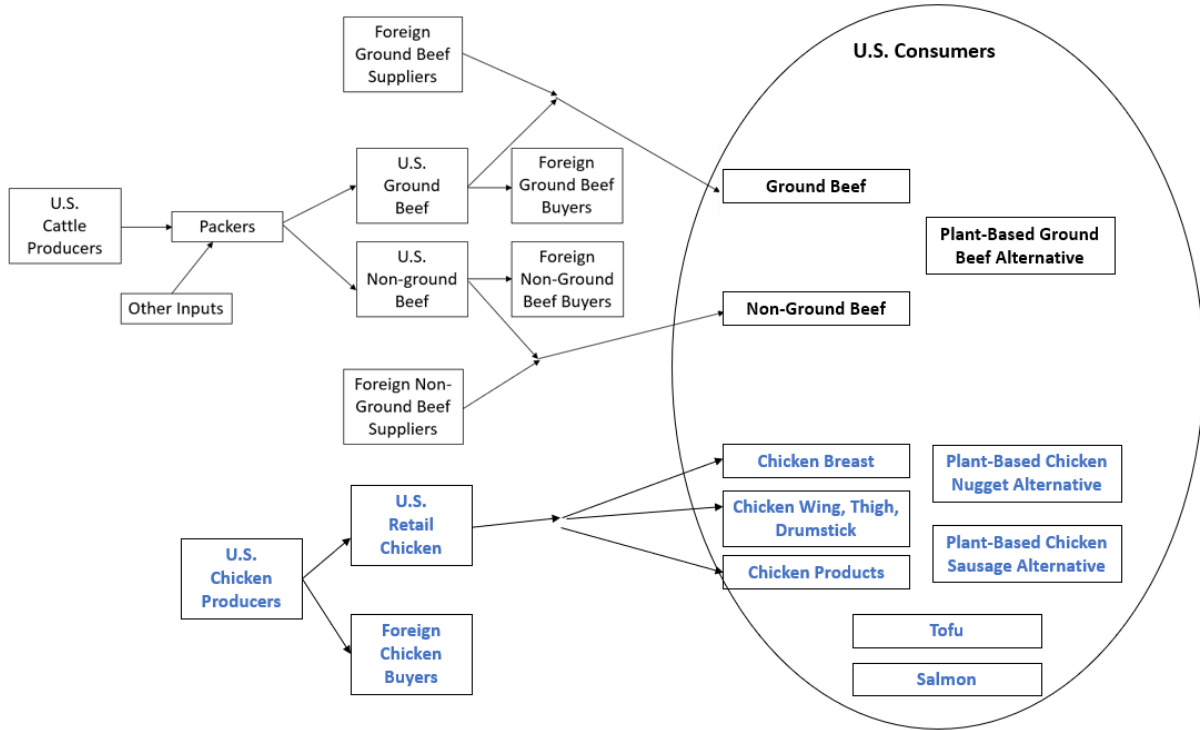
where  $\hat{Q}_{US,D}^j$  is the proportionate change in retail quantity of good  $j$  (i.e.,  $\hat{Q} = \Delta Q/Q \approx \ln Q/Q$ ),  $\hat{P}^k$  is the proportionate change in retail price of good  $k$ ,  $\eta^{jk}$  is the elasticity of demand for good  $j$  with respect to the price of good  $k$ , and  $\delta^k$  is a demand-shock representing the proportional change in consumer willingness-to-pay for the  $k^{\text{th}}$  commodity.  $\delta^k$  is the relative change in consumers' willingness-to-pay for good  $j$ ; it is the vertical shift in the demand curve for  $j$  at the initial quantity level. A negative value represents a demand increase, and a positive value represents a reduction in willingness-to-pay, e.g.,  $\delta^k=0.1$  implies a 10% reduction in demand for good  $k$ .

For simplicity, the supplies of plant-based alternatives, salmon, and tofu are assumed perfectly elastic, which implies that the changes in prices of these products are exogenous. From a practical modeling standpoint, this implies that the analyst chooses what, if any, change in plant-based alternatives price occurs. This also implies there is no distinction between price changes,  $\hat{P}$ , and demand changes,  $\delta$ , in terms of model outcomes, for these products. That is, reducing the price of plant-based ground beef alternatives by, say, 10% (i.e.,  $\hat{P}^3 = -0.1$ ) has the same effect of assuming consumer willingness-to-pay for plant-based ground beef increases 10% (i.e.,  $\delta^k = -0.1$ ).

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**Figure 7.** Overview of Equilibrium Displacement Model linking Chicken and Cattle Production to Consumption of Beef, Chicken, and Plant-Based Alternatives.



Note: the items colored blue are additions to the model described in Lusk et al. (2022)

#### 4.1 Beef Supply Chain

The beef supply chain portion of the model follows exactly from Lusk et al (2022). For completeness, the details are repeated here, only changing the numbering of equations. Total quantity of U.S. consumption,  $\hat{Q}_{US,D}^j$ , of ground beef and non-ground beef consists of domestic supplies (US, S),  $\hat{Q}_{US,S}^j$ , and foreign imports (FI),  $\hat{Q}_{FI}^j$ . Thus:

$$(15)-(16) \quad \hat{Q}_{US,D}^j = (1 - S_{FI}^j)\hat{Q}_{US,S}^j + S_{FI}^j\hat{Q}_{FI}^j,$$

where  $S_{FI}^j$  is the share of beef type j that is imported.

Supply of foreign imported ground beef and non-ground beef are given by:

$$(17)-(18) \quad \hat{Q}_{FI}^j = \varepsilon_{FI}^j \hat{P}^j,$$



where  $\varepsilon_{FI}^j$  is the own-price supply elasticity of foreign ground and non-ground beef. There are also foreign demands for U.S.-produced ground beef and non-ground beef. These foreign export (FE) demands are given by:

$$(19)-(20) \quad \hat{Q}_{FE}^j = \sum_{k=1}^2 \eta_{FE}^{jk} (\hat{P}^k + \delta_{FE}^j),$$

where  $\eta_{FE}^{jk}$  are own- and cross-price foreign-consumer demand elasticities for U.S. ground and non-ground beef, and  $\delta_{FE}^j$  are foreign-consumer demand shifters.

Total quantity of U.S. production,  $\hat{Q}_{US}^j$ , of ground beef and non-ground beef consists of supply to the domestic market,  $\hat{Q}_{US,S}^j$ , and foreign exports (FE),  $\hat{Q}_{FE}^j$ , beef. Thus:

$$(21)-(22) \quad \hat{Q}_{US}^j = (1 - S_{FE}^j) \hat{Q}_{US,S}^j + S_{FE}^j \hat{Q}_{FE}^j$$

where  $S_{FE}^j$  is the share of domestic ground beef and non-ground beef that is exported.

Assuming constant returns to scale in production of beef, there are two U.S. beef supply equations of the form:

$$(23)-(24) \quad \hat{P}^j = SR^j \hat{w}_1 + (1 - SR^j) \hat{w}_2$$

where  $\hat{w}_1$  is an endogenous variable indicating the proportionate change in the price of cattle inputs,  $\hat{w}_2$  is the proportionate change in the price of marketing inputs,  $SR^j$  is the share of the total cost of producing beef product j attributable to cattle and  $(1 - SR^j)$  is the share attributable to marketing inputs. Assuming constant returns to scale and fixed proportions technology, two Hicksian demands for the commodities used in food production take the form:

$$(25)-(26) \quad \hat{x}_k = SC_k \hat{Q}_{US}^1 + (1 - SC_k) \hat{Q}_{US}^2 \quad \text{for } k = 1 \text{ to } 2$$

where  $\hat{x}_k$  is the proportionate change in quantity of commodity k (either cattle or marketing inputs)  $SC_k$  is the share of the total cost of commodity k used by ground beef and  $(1 - SC_k)$  is the cost share used by non-ground beef.

There are primary supply curves for two products (cattle and other inputs to meat packing and processing). These supply equations take the form:

$$(27)-(28) \quad \hat{x}_k = \varepsilon_k(\hat{w}_k + v_k).$$

$\varepsilon_k$  are own-price supply elasticities of cattle and marketing inputs and  $v_k$  are exogenous supply-shifters representing the percent change in marginal cost of cattle or marketing inputs.

#### 4.2 Chicken Supply Chain

The chicken supply chain is modeled in a similar fashion as the beef supply chain with a couple notable differences. First, the U.S. only imports a very small quantity of chicken. Only a fraction of a percent of U.S. chicken consumption is derived from foreign sources. Thus, chicken imports are ignored. Second, chicken production is highly vertically integrated, and the packers own the birds through the entire production phase. As such, the model does not segregate farm-level and wholesale-level chicken supply.

Starting on the bottom left-hand side of figure 7, the primary supply curves for wholesale chicken takes the form:

$$(29) \quad \hat{x}_3 = \varepsilon_3(\hat{w}_3 + v_3).$$

$\hat{x}_3$  is the proportionate change in wholesale chicken quantity,  $\hat{w}_3$  is the proportionate change in wholesale chicken price,  $\varepsilon_k$  is the own-price supply elasticities of chicken and  $v_3$  is an exogenous supply-shifter representing the percent change in marginal cost of chicken production. Supply of chicken production is allocated to domestic and foreign sources:

$$(30) \quad \hat{x}_3 = (1 - S_{FE}^3)\hat{x}_3^{US} + S_{FE}^3\hat{x}_3^{FE}$$

where  $S_{FE}^3$  is the share of domestic chicken that is exported,  $\hat{x}_3^{US}$  is the change in quantity of chicken left on the U.S. market, and  $\hat{x}_3^{FE}$  is the change in quantity of chicken exported.

Export demand for U.S. chicken is given by:

$$(31) \quad \hat{x}_3^{FE} = \eta_{FE}^3(\hat{w}_3 + \delta_{FE}^3)$$

where  $\eta_{FE}^3$  is the own-price elasticity of demand by foreign buyers for U.S. chicken.

Assuming constant returns to scale and fixed proportions technology, retailers' derived demand for wholesale chicken is:

$$(32) \quad \hat{x}_3^{US} = SC_3^3 \hat{Q}_{US,D}^3 + SC_3^4 \hat{Q}_{US,D}^4 + SC_3^5 \hat{Q}_{US,D}^5$$

where  $SC_3^j$  is the share of the total cost of broiler chickens used by retail chicken type j ( $SC_3^3 + SC_3^4 + SC_3^5 = 1$ ) and  $\hat{Q}_{US,D}^j$  is the change in quantity of retail chicken type j (3=chicken breast, 4=chicken thigh, drumstick, wings, and 5=chicken products such as sausage or nuggets).

Output supplies by packers to retailers of the three types of chicken meat are given by:

$$(33)-(35) \quad \hat{P}^j = SR_3^j \hat{w}_3$$

where  $SR_3^j$  is the share of the cost of producing retail chicken product j attributable to broiler chickens.

### 4.3 Implementation

Equations (4)-(35) define an equilibrium consisting of 31 endogenous variables, 13 possible exogenous demand or shift shifters, and a set of technology/preference parameters. The model can be solved using matrix algebra to determine the changes in endogenous variables, which are a function of the supply/demand shifts and other model parameters. Table A9 shows each of the 31 endogenous variables in the model. These 31 variables change in response to a change in any of the exogenous variables shown in table A10 in Appendix A. Let Y be a 31x1 vector of endogenous variables be represented, Z be a 31x1 vector of exogenous shocks be given, and B be an 31x31 matrix of model parameters, such that the aforementioned equations can be written as  $YB=Z$ . The values for the endogenous variables (changes in prices and quantities) are given by:  $Y=B^{-1}Z$ . The model, thus, can be used to determine how the change in an exogenous variable like the retail price of plant-based ground beef affects endogenous variables such as the quantity of U.S. cattle,  $\hat{x}_1$ .

To implement the model, values need to be assigned for the parameter values shown in equations (4)-(35). For the supply-side of the model, we use the same parameters as in Lusk et al. (2022).

Demand-side parameters come from the present Studies 1 and 2 outlined above. The only additional parameters needed to implement the model are the supply-side parameters associated with chicken production. The own-price supply elasticity of chicken is set at 0.3 (Suh and Moss, 2017, the share of chicken exported is set at 0.89 following data from USDA WASDE. The shares of cost of producing broiler/chicken used to produce breast and other parts (thigh, drum, and wing) are set at 0.4, 0.5, and 0.1, respectively. The share of cost of producing retail chicken attributable to the three poultry meats are each set at 0.33.

#### 4.4 Results

**Table 5** shows the output from the economic model of the supply chain showing the impacts of a 5% price reduction of a particular beef or chicken alternative on the quantity of retail foods consumed and farm level beef and chicken produced. The results from this table utilize the own- and cross-price elasticities of demand that were obtained from the FAH experiment described above. The first column of results shows the impacts of a 5% reduction in the price of plant-based beef alternatives. It might be a bit surprising to see that a fall in the price of plant-based beef results in an *increase* in the quantity of beef consumed and cattle produced. This is a direct result of the finding that, in the food-at-home context, plant-based beef alternatives and conventional beef are demand complements. If two products are complements, an increase (reduction) in the price of one causes a reduction (increase) in the quantity of the other consumed. One typically thinks about products like hotdogs and buns being complements, but in the context of grocery shopping, households may attempt to bundle beef and beef alternatives to create variety in their diets over the course of a week or month. Whatever the reason, the complementary relationships observed in our food-at-home experiment, when entered in our model, imply that reductions in the prices of any of the plant-based alternatives (or salmon) result in increased production of cattle and beef. Nonetheless, the effects are quite small. A 5% reduction in the price of plant-based chicken nuggets, for example, are associated with a 0.02% increase in quantity of chicken produced. This is consistent with the results in Lusk et al. (2022) and are explained, in part, by the fact that the farm share of the retail dollar is fairly small and that supply of animal products are highly inelastic.

**Table 5.** Impacts of a 5% Reduction in Prices of Five Products on the Quantity of Beef, Chicken, and Plant-Based Consumed and Produced Assuming Demand Elasticities from the FAH Experiment

Change in Quantity of ...	Impact of 5% Reduction in Price of ...				
	Plant-Based Beef Alt	Plant-Based Chicken Nugget	Plant-Based Chicken Sausage	Tofu	Salmon
Retail Ground Beef	0.04%	0.00%	0.05%	-0.04%	0.23%
Retail Non-Ground Beef	0.04%	0.02%	0.00%	0.03%	0.19%
Retail Chicken Breast	-0.01%	-0.02%	0.00%	0.00%	0.15%
Retail Chicken Parts	0.08%	0.07%	0.07%	0.04%	0.49%
Retail Chicken Products	0.05%	0.11%	0.05%	0.03%	-0.02%
Plant-Based Beef Alternative	4.55%	0.62%	0.40%	0.13%	0.73%
Plant-Based Chicken Nugget	0.75%	4.59%	0.43%	0.21%	0.52%
Plant-Based Chicken Sausage	0.78%	0.70%	4.66%	0.23%	0.85%
Retail Tofu	0.21%	0.29%	0.19%	2.73%	0.45%
Retail Salmon	0.18%	0.11%	0.11%	0.07%	6.98%
Farm-level Cattle	0.02%	0.01%	0.01%	0.01%	0.13%
Farm-level Chicken	0.02%	0.02%	0.02%	0.01%	0.15%

**Table 6** undertakes the same exercise but using, instead, the demand elasticities from the food away from home experiment. Because the cross-price elasticities from this experiment suggest generally conventional meats and plant-based alternatives are substitutes in this context, increasing the prices of plant-based alternatives tend to *reduce* the quantity of cattle and chicken produced, as is commonly assumed. Again, however, the effects tend to be small for the same reasons just described. For example, a 5% reduction in the price of plant-based beef alternatives, is associated with a 0.06% reduction in the quantity of cattle produced and a 0.01% reduction in the quantity of chicken produced. A 5% reduction in the plant-based chicken nuggets has an effect on cattle production approximately equal to zero and a small, 0.01% reduction in the quantity of chicken production.

Overall, the results from our economic analysis in tables 5 and 6 suggest innovations that reduce the prices of plant-based beef and chicken alternatives are likely to have only very small effects on farm-level production of poultry and livestock.

**Table 6.** Impacts of a 5% Reduction in Prices of Five Products on the Quantity of Beef, Chicken, and Plant-Based Consumed and Produced Assuming Demand Elasticities from the Food at Away from Home Experiment

Change in Quantity of ...	Impact of 5% Reduction in Price of ...				
	Plant-Based Beef Alt	Plant-Based Chicken Nugget	Plant-Based Chicken Sausage	Tofu	Salmon
Retail Ground Beef	-0.09%	-0.04%	-0.05%	-0.05%	-0.55%
Retail Non-Ground Beef	-0.11%	0.01%	0.00%	-0.01%	0.09%
Retail Chicken Breast	-0.30%	0.02%	-0.05%	-0.04%	-0.41%
Retail Chicken Parts	0.08%	-0.06%	0.06%	0.00%	0.27%
Retail Chicken Products	0.51%	0.01%	0.04%	0.10%	0.09%
Plant-Based Beef Alternative	7.39%	1.04%	0.04%	0.15%	-0.29%
Plant-Based Chicken Nugget	2.32%	6.61%	0.33%	0.45%	0.52%
Plant-Based Chicken Sausage	0.15%	0.62%	7.78%	0.17%	0.40%
Retail Tofu	0.50%	0.68%	0.14%	4.50%	-0.16%
Retail Salmon	-0.15%	0.11%	0.05%	-0.02%	9.58%
Farm-level Cattle	-0.06%	-0.001%	-0.01%	-0.01%	-0.05%
Farm-level Chicken	-0.01%	-0.01%	0.01%	-0.004%	-0.01%

## 5. Concluding Remarks

This study employs a basket-based choice experiment (BBCE) to assess consumer preferences for plant-based meat alternatives (PBMAs) consumed both at home (FAH) and away from home (FAFH). The data were estimated using a Multivariate logistic (MNL) model, and the coefficient estimates were then used to compute own- and cross-price elasticities. These elasticities were applied in an expanded model of Lusk et al. (2022) to evaluate how reductions in prices of PB beef or chicken alternatives affect cattle and poultry inventories. The findings from this study offer several implications for the food industry and businesses operating in the meat alternative sector, as well as policy makers.

A key finding of this study is the substantial difference in price sensitivity between consumers when dining out and eating at home, with consumers showing greater price sensitivity for FAFH than FAH. The own price elasticities of PBMA exemplify this difference: in the FAH study, the own price elasticities of PBMA range from -0.91 to -0.93, while in the FAFH setting they range from -1.32 to -1.56. This discrepancy suggests that consumers prioritize their budgets differently when prices rise, opting to reduce spending on dining out while maintaining their expenditures on essential groceries. Notably, this also highlights the importance of recognizing differing consumer responses to price changes based on the consumption setting.

Analyzing the own price elasticities of PBMA in relation to conventional meats further enriches our understanding of consumer food choice behavior. In both the FAH and FAFH experiments, we find that PBMA have price elasticity falling between the more elastic, premium animal meat options (salmon and ribeye steak) and the less elastic, lower-cost choices like burgers and chicken breast. The implications of this finding are noteworthy for restaurants and food retailers. It indicates the potential to position PBMA as sustainable, moderately priced alternatives to more expensive conventional meat options. This product positioning can effectively attract price-sensitive consumers seeking both affordability and sustainability in their food choices.

Fresh insights also emerge from the cross-price elasticities, especially in terms of differences between consumption settings. In the FAH context, PBMA are observed to be price complements to conventional meat products. However, in the FAFH setting, consumer choices become more distinct, reflecting both complementarity and substitution dynamics depending on specific food items and meal contexts. For instance, in FAFH, PB burgers substitute to conventional meat entrées like beef burger, chicken breast, ribeye steak, and salmon, but compliment to conventional meat appetizers like chicken nuggets. . Related to this, our findings from the economic model indicate that lowering prices of plant-based beef and chicken alternatives is unlikely to significantly impact conventional poultry and livestock production. This is a significant addition to the literature and suggests that the growing consumer demand for PBMA may coexist with conventional meat consumption, limiting potential impacts on the poultry and livestock industry in the short-term.

Taken together, these results show that consumer preferences and behaviors vary substantially based on the specific product and purchase setting. This evidence stresses the importance of conducting disaggregated demand analysis at the product level and choice setting to gain a deeper understanding of consumer preferences and decision-making processes. As consumer demand for PBMA continues to grow, the findings from this can guide strategies for pricing, marketing, and product positioning.

The generalizability of these results is subject to certain limitations. For instance, the demographic composition of our respondents, particularly the overrepresentation of women and the underrepresentation of SNAP recipients, may limit the applicability of our results to broader populations. This concern also extends to analyses based on scanner data, as the representativeness of samples concerning vulnerable groups, such as low-income, single-adult, and minority households remains a limiting factor (National Research Council in 2005). More research combining different data sources is needed to better understand consumption patterns, as also discussed in Caputo and Just (2022). In Addition, it is important to recognize that consumers may treat other PB beef and chicken alternatives differently than those examined in our BBCE. Furthermore, consumers' perceptions of PB and conventional meat products as complements or substitutes may vary, particularly if they are less familiar with PB options. These limitations highlight the need for future research to look into these aspects and how they influence consumer demand for emerging PBMA.



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## Appendix A: Tables

**Table A1.** Characteristics of Survey Respondents

<b>Characteristic</b>	<b>Variable description</b>	<b>FAH</b>	<b>U.S. Census</b>
Female	1 if female; 0 if male	63%	51%
Age	Age in years (median in years)	52	57
Household Size	The number of people in the household	2.55	2.54
Children <12	1 if household having children under 12; 0 otherwise	23%	30%
SNAP	1 if respondent receives SNAP benefits; 0 otherwise	17%	33%
College and above	1 if obtained college degree and above; 0 otherwise	40%	45%
Urban	1 if urban; 0 if suburban/rural	76%	80%
<b>Household Income</b>			
< \$49K	1 if income below \$49,999; 0 otherwise	38%	36%
\$50K-\$99K	1 if income between \$50,000 and \$99,999; 0 otherwise	31%	30%
= >\$100K	1 if income above \$100,000; 0 otherwise	31%	34%
<b>Race</b>			
White	1 if respondent is White; 0 otherwise	80%	76%
Black	1 if respondent is Black; 0 otherwise	12%	14%
Hispanic	1 if respondent has Hispanic or Latino origin; 0 otherwise	10%	19%
Other	1 if American Indian or Alaska Native, Asian/Pacific Islander, and/or other; 0 otherwise	10%	11%
<b>Region</b>			
Northeast	1 if respondent lives in Northeast region; 0 otherwise	19%	17%
Midwest	1 if respondent lives in Midwest region; 0 otherwise	20%	21%
South	1 if respondent lives in South region; 0 otherwise	43%	39%
West	1 if respondent lives in West region; 0 otherwise	18%	24%
Number of Respondents		1011	/

**Table A2.** Selected Price levels for FAH

	Unit	Low	Medium	High
Plant-Based Chicken Nuggets	1 package (13.5 oz)	\$5.49	\$7.49	\$9.49
Plant-Based Burger	1 package (8 oz)	\$5.49	\$7.49	\$9.49
Plant-Based Chicken Sausage	1 package (13 oz)	\$5.49	\$7.49	\$9.49
Beef burger patty	1 lb	\$4.49	\$6.49	\$8.49
Ribeye	1 lb	\$9.49	\$11.49	\$13.49
Ground Turkey	1 lb	\$3.49	\$5.49	\$7.49
Pork Loin	1 lb	\$3.49	\$5.49	\$7.49
Pork Sausage	1 package (12 oz)	\$3.49	\$5.49	\$7.49
Chicken Breast	1 lb	\$3.49	\$5.49	\$7.49
Chicken Nuggets	1 package (32 oz)	\$3.49	\$5.49	\$7.49
Chicken Wings	1 lb	\$3.49	\$5.49	\$7.49
Salmon	1 lb	\$8.49	\$12.49	\$16.49
Tofu	1 package (12.3 oz)	\$2.49	\$4.49	\$6.49
Vegan Avocado Sandwich	1 package	\$4.49	\$6.49	\$8.49
Mac and Cheese	1 package (3.5 oz)	\$4.49	\$6.49	\$8.49
Lettuce	3 hearts	\$1.59	\$2.59	\$3.59
Potatoes	1 lb	\$1.59	\$2.59	\$3.59
Frozen Broccoli	1 package (10.8 oz)	\$1.49	\$3.49	\$5.49
Banana	1 lb	\$0.49	\$0.59	\$0.69
Strawberries	1 lb	\$1.59	\$2.59	\$3.59
Apples	1 lb	\$0.99	\$1.59	\$2.19

**Table A3. Likelihood of Joint Product Selection (excluding none or no buy choices) (FAH)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 PB Chicken Nuggets																				
2 PB Burger	2.8% (41.3%) [38.9%]																			
3 PB Chicken Sausage	2.1% (30.9%) [46.0%]	2.1% (29.6%) [46.7%]																		
4 Beef Burger Patty	2.2% (32.4%) [11.8%]	2.6% (36.0%) [13.9%]	2.0% (43.3%) [10.6%]																	
5 Ribeye	2.7% (40.2%) [14.1%]	3.0% (41.8%) [15.5%]	2.1% (45.3%) [10.6%]	6.7% (36.3%) [34.9%]																
6 Ground Turkey	2.4% (35.8%) [19.8%]	2.5% (35.2%) [20.7%]	2.0% (44.6%) [16.5%]	4.0% (21.5%) [32.6%]	4.1% (21.2%) [33.5%]															
7 Pork Loin	2.4% (35.1%) [13.2%]	2.6% (36.1%) [14.4%]	2.1% (46.7%) [11.8%]	6.5% (34.9%) [35.8%]	6.5% (33.8%) [36.1%]	4.5% (37.1%) [25.1%]	13.2% (34.7%) [34.1%]													
8 Pork Sausage	2.3% (33.7%) [17.8%]	2.4% (33.7%) [18.9%]	2.1% (45.3%) [16.1%]	6.8% (36.8%) [53.3%]	5.9% (30.6%) [46.1%]	4.4% (35.7%) [46.1%]	6.3% (34.7%) [34.1%]													
9 Chicken Breast	3.3% (48.1%) [9.1%]	3.5% (48.4%) [9.7%]	2.5% (54.0%) [6.8%]	9.1% (49.1%) [25.4%]	9.5% (49.2%) [26.5%]	6.7% (54.8%) [18.7%]	8.5% (47.0%) [23.7%]	7.5% (58.5%) [20.9%]												
10 Chicken Nuggets	2.5% (36.6%) [17.8%]	2.3% (32.2%) [16.6%]	1.8% (40.4%) [13.2%]	5.4% (29.1%) [38.8%]	5.2% (26.9%) [37.4%]	3.8% (31.5%) [27.7%]	4.4% (24.6%) [31.9%]	4.6% (35.9%) [33.0%]	7.4% (20.7%) [53.3%]											
11 Chicken Wings	2.7% (40.2%) [16.8%]	2.8% (38.9%) [17.3%]	2.2% (47.9%) [13.5%]	6.4% (34.6%) [39.8%]	6.9% (35.7%) [42.8%]	5.0% (40.8%) [31.0%]	6.6% (36.4%) [40.8%]	9.4% (48.4%) [38.4%]	5.5% (26.2%) [58.3%]	5.5% (39.2%) [33.8%]										
12 Salmon	2.5% (37.1%) [18.0%]	2.8% (38.6%) [19.8%]	2.1% (45.5%) [14.8%]	4.9% (26.2%) [34.8%]	5.4% (28.2%) [39.0%]	4.1% (33.8%) [29.6%]	4.6% (25.6%) [33.1%]	4.7% (37.1%) [34.0%]	3.5% (20.6%) [52.8%]	5.2% (25.3%) [25.2%]										
13 Tofu	2.1% (31.5%) [28.7%]	1.9% (26.6%) [25.8%]	1.6% (34.6%) [21.2%]	1.8% (9.5%) [23.7%]	2.7% (13.9%) [36.3%]	2.6% (21.1%) [34.8%]	2.2% (11.9%) [29.0%]	3.4% (18.1%) [31.3%]	2.1% (9.6%) [46.2%]	2.6% (15.3%) [28.6%]	2.5% (15.9%) [34.5%]	2.6% (17.6%) [33.0%]								
14 Vegan Avocado Sandwich	2.0% (29.1%) [36.6%]	1.9% (27.0%) [36.0%]	1.5% (33.4%) [28.2%]	1.7% (9.0%) [30.9%]	2.2% (11.2%) [40.1%]	2.1% (17.0%) [38.7%]	2.0% (10.8%) [36.4%]	1.8% (14.2%) [33.7%]	2.6% (7.2%) [48.3%]	2.0% (14.3%) [37.0%]	2.2% (13.4%) [40.3%]	2.1% (14.8%) [38.4%]	2.1% (27.7%) [38.2%]							
15 Mac and Cheese	2.8% (40.8%) [13.2%]	2.8% (39.4%) [13.6%]	2.1% (46.2%) [10.1%]	6.7% (36.1%) [32.1%]	6.6% (34.0%) [31.6%]	4.0% (33.0%) [19.4%]	5.6% (31.3%) [27.1%]	4.8% (37.5%) [23.1%]	9.8% (27.5%) [47.2%]	6.1% (44.2%) [29.5%]	6.6% (41.2%) [31.9%]	4.4% (31.6%) [21.2%]	2.5% (33.9%) [12.1%]	2.4% (43.8%) [11.3%]						
16 Lettuce	3.2% (47.8%) [10.3%]	3.6% (50.8%) [11.6%]	2.3% (51.6%) [7.5%]	7.8% (41.8%) [24.8%]	7.8% (46.5%) [28.7%]	9.0% (49.0%) [19.1%]	6.0% (42.8%) [24.7%]	7.7% (44.2%) [18.0%]	15.7% (43.7%) [50.0%]	5.7% (40.7%) [18.1%]	7.3% (45.6%) [23.4%]	6.8% (48.9%) [21.8%]	4.0% (53.9%) [12.8%]	2.4% (45.2%) [7.8%]	8.0% (38.2%) [25.4%]					
17 Potatoes	3.8% (56.9%) [7.5%]	4.1% (57.4%) [8.1%]	2.6% (57.6%) [5.1%]	12.1% (65.2%) [23.7%]	13.4% (69.3%) [26.2%]	8.0% (65.6%) [15.7%]	12.3% (68.1%) [24.1%]	8.2% (64.2%) [16.1%]	24.4% (68.1%) [47.8%]	7.8% (56.1%) [15.3%]	10.3% (63.8%) [20.1%]	8.7% (62.2%) [17.0%]	4.1% (55.4%) [8.1%]	2.9% (53.2%) [5.6%]	11.1% (53.2%) [21.7%]	21.4% (68.4%) [42.0%]				
18 Frozen Broccoli	3.2% (47.5%) [8.6%]	3.6% (49.8%) [9.6%]	2.4% (53.0%) [6.5%]	7.7% (41.7%) [20.7%]	9.0% (46.4%) [24.0%]	5.9% (48.3%) [15.8%]	9.0% (50.1%) [24.2%]	5.9% (45.9%) [15.7%]	17.7% (49.5%) [47.5%]	6.1% (44.0%) [16.4%]	7.5% (46.8%) [20.2%]	7.7% (55.1%) [20.6%]	3.5% (47.1%) [9.4%]	2.6% (49.1%) [7.1%]	10.8% (51.9%) [29.0%]	14.8% (47.4%) [39.8%]	25.4% (49.8%) [68.1%]			
19 Banana	3.3% (49.4%) [11.6%]	3.4% (47.3%) [11.8%]	2.0% (44.8%) [7.1%]	8.4% (45.3%) [29.2%]	7.6% (39.6%) [26.6%]	6.0% (49.3%) [20.9%]	7.6% (42.3%) [26.5%]	6.6% (51.8%) [23.1%]	14.8% (41.3%) [51.5%]	6.2% (44.7%) [21.6%]	7.8% (48.7%) [27.3%]	3.5% (44.4%) [21.6%]	2.5% (46.8%) [12.1%]	2.5% (45.6%) [8.5%]	7.6% (36.7%) [26.6%]	14.2% (45.4%) [26.6%]	18.8% (36.8%) [49.4%]	13.0% (34.8%) [45.1%]		
20 Strawberries	3.1% (45.2%) [10.9%]	3.3% (46.4%) [11.9%]	2.1% (45.3%) [7.4%]	8.2% (44.0%) [29.2%]	8.1% (42.1%) [29.1%]	5.5% (45.1%) [19.7%]	7.3% (40.4%) [26.1%]	6.1% (47.5%) [21.7%]	14.6% (40.6%) [52.1%]	5.8% (41.7%) [20.8%]	7.5% (46.8%) [22.0%]	6.2% (44.1%) [12.7%]	3.5% (47.7%) [9.0%]	2.5% (46.8%) [27.3%]	7.6% (36.6%) [52.2%]	14.6% (46.5%) [27.3%]	19.2% (37.7%) [48.8%]	13.6% (36.6%) [48.8%]	17.0% (59.3%) [61.0%]	
21 Apples	3.0% (43.9%) [12.6%]	3.0% (41.8%) [12.7%]	2.1% (45.5%) [8.7%]	7.2% (39.0%) [30.6%]	7.1% (36.9%) [30.2%]	5.3% (43.6%) [22.6%]	7.0% (38.7%) [29.5%]	5.9% (46.1%) [25.0%]	12.4% (34.7%) [52.6%]	5.2% (37.2%) [21.9%]	6.9% (42.7%) [29.1%]	5.8% (41.3%) [24.4%]	3.1% (41.6%) [13.1%]	2.2% (40.3%) [9.2%]	7.1% (34.3%) [30.2%]	12.8% (40.9%) [54.3%]	16.0% (31.5%) [67.9%]	12.3% (33.1%) [52.3%]	14.2% (49.5%) [60.3%]	14.4% (51.5%) [60.9%]

**Note:** Top number is overall probability of joint choice; Number in ( ) is probability of buying row product conditional on buying the column product; Number in [ ] is probability of buying column product conditional on buying the row product.

**Table A4.** Cross-Utility Effect Estimates from MVL Model – FAH

Interactions of ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 PB Chicken Nuggets																				
2 PB Burger	1.481*																			
	(0.085)																			
3 PB Chicken Sausage	1.282*	1.232*																		
	(0.102)	(0.100)																		
4 Beef Burger Patty	-0.183**	0.267*	0.358*																	
	(0.092)	(0.084)	(0.102)																	
5 Ribeye	0.100	0.334*	-0.116	0.374*																
	(0.084)	(0.079)	(0.102)	(0.052)																
6 Ground Turkey	0.235*	0.388*	0.535*	-0.126*	-0.267*															
	(0.089)	(0.085)	(0.100)	(0.066)	(0.065)															
7 Pork Loin	0.041	0.158*	0.423*	0.374*	0.371*	0.398*														
	(0.089)	(0.084)	(0.100)	(0.053)	(0.052)	(0.061)														
8 Pork Sausage	0.022	-0.004	0.380*	1.258*	0.555*	0.626*	0.999*													
	(0.100)	(0.096)	(0.111)	(0.058)	(0.061)	(0.069)	(0.059)													
9 Chicken Breast	-0.156**	-0.121	-0.009	0.005	-0.037	0.226*	-0.142*	0.295*												
	(0.078)	(0.075)	(0.094)	(0.047)	(0.046)	(0.055)	(0.047)	(0.058)												
10 Chicken Nuggets	0.435*	-0.007	0.088	0.555*	0.306*	0.410*	0.046	0.478*	0.253*											
	(0.085)	(0.087)	(0.103)	(0.057)	(0.058)	(0.066)	(0.062)	(0.066)	(0.052)											
11 Chicken Wings	0.135	0.073	0.225**	0.351*	0.577*	0.497*	0.751*	0.757*	0.433*	0.475*										
	(0.090)	(0.088)	(0.106)	(0.058)	(0.055)	(0.064)	(0.056)	(0.064)	(0.051)	(0.061)										
12 Salmon	0.249*	0.460*	0.366*	0.339*	0.435*	0.468*	0.096	0.675*	0.194*	-0.207*	0.344*									
	(0.088)	(0.082)	(0.102)	(0.061)	(0.057)	(0.064)	(0.061)	(0.068)	(0.052)	(0.069)	(0.064)									
13 Tofu	0.683*	0.213**	0.584*	-0.691*	0.194**	0.610*	-0.126	0.620*	-0.103	0.061	-0.002	0.194**								
	(0.092)	(0.096)	(0.109)	(0.094)	(0.078)	(0.079)	(0.086)	(0.091)	(0.072)	(0.085)	(0.085)	(0.082)								
14 Vegan Avocado Sandwich	0.734*	0.775*	0.620*	-0.201**	0.074	0.519*	0.206**	-0.058	-0.082	0.354*	0.099	0.367*	1.166*							
	(0.099)	(0.100)	(0.115)	(0.101)	(0.093)	(0.093)	(0.096)	(0.110)	(0.085)	(0.092)	(0.097)	(0.094)	(0.091)							
15 Mac and Cheese	0.189**	0.128*	0.209**	0.550*	0.337*	-0.054	0.070	-0.033	0.167*	0.771*	0.602*	-0.095	0.039	0.391*						
	(0.079)	(0.077)	(0.095)	(0.050)	(0.050)	(0.062)	(0.053)	(0.063)	(0.044)	(0.052)	(0.054)	(0.060)	(0.076)	(0.084)						
16 Lettuce	0.046	0.317*	0.190**	0.049	0.360*	0.257*	0.063	-0.272*	0.437*	0.003	0.074	0.330*	0.642*	-0.137	0.065					
	(0.079)	(0.074)	(0.095)	(0.049)	(0.046)	(0.056)	(0.048)	(0.061)	(0.038)	(0.055)	(0.054)	(0.053)	(0.069)	(0.087)	(0.046)					
17 Potatoes	-0.061	-0.214*	-0.265*	0.425*	0.742*	0.310*	0.540*	-0.120**	0.790*	-0.213*	0.088*	-0.022	-0.238*	-0.330*	-0.416*	0.652*				
	(0.076)	(0.073)	(0.093)	(0.047)	(0.046)	(0.056)	(0.047)	(0.059)	(0.036)	(0.053)	(0.052)	(0.053)	(0.070)	(0.084)	(0.043)	(0.038)				
18 Frozen Broccoli	-0.061	0.131*	0.156*	-0.302*	-0.015	-0.002	0.335*	-0.180*	0.447*	-0.070	-0.116**	0.620*	0.053	0.084	0.697*	0.130*	0.948*			
	(0.075)	(0.071)	(0.089)	(0.046)	(0.044)	(0.054)	(0.044)	(0.058)	(0.036)	(0.052)	(0.051)	(0.050)	(0.068)	(0.081)	(0.042)	(0.037)	(0.035)			
10 Banana	0.347*	0.135*	-0.355*	0.258*	-0.199*	0.307*	0.110**	0.308*	0.362*	0.272*	0.252*	0.047	0.104	0.024	-0.067	0.429*	0.223*	-0.103**		
	(0.082)	(0.079)	(0.104)	(0.051)	(0.052)	(0.059)	(0.052)	(0.062)	(0.041)	(0.057)	(0.056)	(0.058)	(0.075)	(0.091)	(0.050)	(0.041)	(0.041)	(0.041)		
20 Strawberries	0.012	0.181**	-0.046	0.288*	0.259*	-0.008	-0.057	-0.008	0.362*	0.168*	0.224*	0.112*	0.415*	0.415*	0.044	0.537*	0.445*	0.168*	1.501*	
	(0.086)	(0.082)	(0.106)	(0.052)	(0.051)	(0.062)	(0.053)	(0.065)	(0.042)	(0.059)	(0.058)	(0.059)	(0.076)	(0.092)	(0.051)	(0.042)	(0.042)	(0.041)	(0.042)	
21 Apples	0.228*	-0.025	0.177*	0.195*	0.070	0.253*	0.249*	0.325*	0.168*	-0.010	0.100*	0.163*	0.059	-0.083	0.209*	0.619*	0.201*	0.388*	1.066*	1.186*
	(0.085)	(0.082)	(0.104)	(0.053)	(0.053)	(0.061)	(0.053)	(0.064)	(0.044)	(0.061)	(0.059)	(0.059)	(0.078)	(0.095)	(0.051)	(0.043)	(0.044)	(0.042)	(0.044)	(0.044)

**Table A5.** Characteristics of Survey Respondents, FAFH

<b>Characteristic</b>	<b>Variable description</b>	<b>FAH</b>	<b>U.S. Census</b>
Female	1 if female; 0 if male	64%	51%
Age	Age in years (median in years)	50	57
Household Size	The number of people in the household	2.48	2.54
Children <12	1 if household having children under 12; 0 otherwise	21%	30%
SNAP	1 if respondent receives SNAP benefits; 0 otherwise	15%	33%
College and above	1 if obtained college degree and above; 0 otherwise	38%	45%
Urban	1 if urban; 0 if suburban/rural		
<b>Household Income</b>			
< \$49K	1 if income below \$49,999; 0 otherwise	40%	36%
\$50K-\$99K	1 if income between \$50,000 and \$99,999; 0 otherwise	32%	30%
= >\$100K	1 if income above \$100,000; 0 otherwise	28%	34%
<b>Race</b>			
White	1 if respondent is White; 0 otherwise	9%	19%
Black	1 if respondent is Black; 0 otherwise	81%	76%
Hispanic	1 if respondent has Hispanic or Latino origin; 0 otherwise	11%	14%
Other	1 if American Indian or Alaska Native, Asian/Pacific Islander, and/or other; 0 otherwise	10%	11%
<b>Region</b>			
Northeast	1 if respondent lives in Northeast region; 0 otherwise	18%	17%
Midwest	1 if respondent lives in Midwest region; 0 otherwise	22%	21%
South	1 if respondent lives in South region; 0 otherwise	41%	39%
West	1 if respondent lives in West region; 0 otherwise	19%	24%
Number of Respondents		999	/



**Table A6.** Selected Price levels for FAFH

	Unit	Low	Medium	High
<i><b>Appetizers</b></i>				
Plant-based Chicken Nuggets	6 pieces	\$9.49	\$12.49	\$15.49
Chicken Nuggets	6 pieces	\$6.49	\$9.49	\$12.49
Chicken Wings	6 pieces	\$6.49	\$9.49	\$12.49
Mozzarella Sticks	6 pieces	\$5.49	\$6.49	\$7.49
Spinach Artichoke Dip	3 oz	\$5.49	\$6.49	\$7.49
<i><b>Entrees</b></i>				
Plant-Based Burger	1 patty	\$9.49	\$14.49	\$18.49
Tofu	12 oz	\$5.49	\$8.49	\$12.49
Pork Sausage	4 links	\$7.49	\$12.49	\$16.49
Beef Burger	1 patty	\$7.49	\$12.49	\$16.49
Chicken Breast	12 oz	\$7.49	\$12.49	\$16.49
Vegan Avocado Sandwich	8 inches	\$7.49	\$11.49	\$15.49
Ribeye Steak	12 oz	\$14.49	\$19.49	\$23.49
Salmon	12 oz	\$14.49	\$19.49	\$23.49
Plant-Based Chicken Sausage	4 links	\$9.49	\$14.49	\$18.49
Pork Loin	12 oz	\$12.49	\$16.49	\$21.49
<i><b>Sides</b></i>				
Salad	3 oz	\$4.49	\$5.49	\$6.49
Mac and Cheese	3 oz	\$3.49	\$6.49	\$7.49
Fries	3 oz	\$3.49	\$4.49	\$5.49
Broccoli	3 oz	\$3.49	\$4.49	\$5.49
<i><b>Desserts</b></i>				
Fruit Cup	3 oz	\$4.49	\$5.49	\$6.49
Cheese Cake	1 slice	\$4.49	\$5.49	\$6.49

**Table A7. Likelihood of Joint Product Selection (excluding none or no buy choices) (FAFH)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 PB Chicken Nuggets																				
2 Chicken Nuggets	0.9% (20.2%) [11.5%]																			
3 Chicken Wings	1.1% (23.8%) [7.6%]	2.1% (25.6%) [14.3%]																		
4 Mozzarella Sticks	0.9% (20.2%) [5.0%]	1.8% (22.1%) [9.6%]	2.8% (19.2%) [15.0%]																	
5 Spinach Artichoke Dip	0.6% (12.6%) [4.6%]	0.6% (7.5%) [4.8%]	1.0% (7.1%) [8.1%]	1.3% (6.7%) [9.9%]																
6 PB Burgers	2.1% (44.7%) [28.1%]	1.6% (19.2%) [21.2%]	1.6% (11.0%) [21.7%]	1.5% (6.7%) [20.6%]	0.9% (12.1%) [12.1%]															
7 Tofu	0.9% (19.2%) [25.1%]	0.7% (8.7%) [19.8%]	0.7% (5.0%) [20.4%]	0.8% (4.3%) [22.6%]	0.7% (5.8%) [20.7%]	0.7% (10.0%) [20.7%]														
8 Pork Sausage	1.1% (23.5%) [24.9%]	1.4% (17.3%) [32.2%]	1.9% (12.8%) [42.8%]	1.5% (7.8%) [33.5%]	0.6% (5.0%) [14.6%]	0.6% (8.7%) [14.6%]	0.5% (14.9%) [12.1%]													
9 Beef Burger	1.2% (25.9%) [4.7%]	2.9% (35.5%) [11.4%]	4.5% (30.4%) [17.5%]	6.1% (32.2%) [23.8%]	2.7% (21.0%) [10.6%]	1.2% (16.0%) [4.7%]	0.5% (28.2%) [1.8%]	1.2% (13.0%) [4.9%]												
10 Chicken Breast	1.2% (24.9%) [5.9%]	2.5% (30.8%) [12.7%]	3.7% (25.1%) [18.5%]	4.6% (24.3%) [23.0%]	2.8% (21.9%) [14.1%]	0.8% (11.1%) [4.1%]	0.9% (16.7%) [3.0%]	2.4% (20.2%) [4.5%]												
11 Vegan Avocado Sandwich	1.3% (26.8%) [17.1%]	1.3% (16.3%) [18.2%]	1.9% (12.8%) [25.6%]	1.9% (10.3%) [26.6%]	1.6% (12.5%) [22.0%]	1.0% (12.9%) [13.1%]	0.4% (20.7%) [6.1%]	1.0% (4.0%) [12.4%]	1.3% (6.3%) [13.8%]											
12 Ribeye Steak	0.9% (20.2%) [5.8%]	1.7% (21.0%) [10.6%]	3.8% (26.1%) [23.6%]	4.3% (23.0%) [26.8%]	3.0% (23.5%) [18.6%]	0.5% (6.7%) [3.1%]	0.4% (10.8%) [2.4%]	0.9% (19.9%) [5.4%]	2.1% (8.3%) [13.0%]	1.5% (7.8%) [9.5%]	1.3% (18.1%) [8.2%]									
13 Salmon	0.9% (18.8%) [8.9%]	1.1% (13.1%) [10.9%]	2.1% (14.0%) [20.8%]	1.8% (9.7%) [18.6%]	2.1% (16.1%) [20.9%]	0.7% (9.7%) [7.3%]	0.4% (10.5%) [3.8%]	0.8% (12.6%) [5.6%]	0.8% (3.3%) [8.4%]	1.4% (7.2%) [14.5%]	0.6% (8.6%) [5.6%]	1.4% (8.6%) [14.2%]								
14 PB Chicken Sausage	0.7% (14.0%) [27.3%]	0.5% (6.4%) [21.8%]	0.8% (5.5%) [33.8%]	0.9% (4.8%) [38.0%]	0.6% (5.7%) [25.5%]	0.4% (5.7%) [17.6%]	0.3% (8.4%) [12.5%]	0.3% (7.6%) [13.9%]	0.4% (1.6%) [16.7%]	0.5% (2.3%) [19.0%]	0.4% (6.2%) [19.0%]	0.5% (2.5%) [16.7%]	0.5% (4.6%) [19.0%]							
15 Pork Loin	0.3% (6.7%) [8.1%]	0.4% (5.3%) [11.3%]	0.7% (4.5%) [17.2%]	0.8% (4.4%) [21.8%]	0.8% (5.9%) [19.8%]	0.3% (3.4%) [6.7%]	0.2% (6.2%) [5.8%]	0.3% (2.4%) [7.6%]	0.6% (2.4%) [16.0%]	0.5% (2.6%) [13.7%]	0.2% (3.2%) [6.1%]	0.6% (3.6%) [15.4%]	0.3% (3.4%) [8.7%]	0.2% (9.3%) [5.8%]						
16 Salad	2.0% (41.8%) [7.6%]	2.1% (25.6%) [8.1%]	3.8% (25.8%) [14.7%]	4.4% (23.3%) [17.0%]	4.4% (34.3%) [17.0%]	2.3% (30.6%) [8.8%]	1.0% (29.1%) [4.0%]	1.3% (30.0%) [5.1%]	3.8% (15.0%) [14.8%]	6.7% (33.8%) [26.0%]	1.8% (24.9%) [7.1%]	6.3% (38.7%) [24.3%]	3.8% (38.9%) [14.9%]	0.8% (35.2%) [3.3%]	1.5% (39.0%) [5.8%]					
17 Mac and Cheese	1.7% (35.6%) [11.2%]	2.9% (35.4%) [19.5%]	3.8% (25.6%) [25.3%]	4.6% (24.4%) [31.0%]	2.0% (15.8%) [13.7%]	1.6% (21.5%) [10.8%]	1.0% (27.9%) [6.7%]	1.8% (41.6%) [12.3%]	4.1% (16.1%) [27.7%]	4.4% (22.3%) [29.8%]	1.7% (23.4%) [11.5%]	3.7% (22.7%) [24.7%]	1.6% (16.4%) [10.9%]	0.8% (34.7%) [5.6%]	1.0% (25.0%) [6.4%]	2.5% (9.6%) [16.7%]				
18 Fries	1.9% (41.1%) [5.3%]	4.6% (56.0%) [12.6%]	7.7% (52.0%) [21.1%]	8.8% (46.5%) [24.2%]	3.9% (30.2%) [10.7%]	3.6% (48.1%) [9.9%]	1.2% (34.7%) [3.4%]	2.2% (50.4%) [6.1%]	16.7% (65.5%) [46.1%]	6.3% (31.5%) [17.3%]	3.4% (45.8%) [9.2%]	6.4% (39.5%) [17.7%]	2.2% (22.2%) [6.0%]	1.0% (41.7%) [2.8%]	1.3% (34.6%) [3.6%]	4.0% (15.6%) [11.1%]	3.3% (22.4%) [9.2%]			
19 Broccoli	1.1% (22.6%) [5.3%]	1.3% (16.4%) [6.7%]	3.0% (20.3%) [14.9%]	4.2% (22.2%) [20.9%]	4.4% (34.2%) [21.9%]	1.2% (16.3%) [6.0%]	1.1% (30.0%) [5.4%]	1.0% (23.7%) [12.5%]	2.5% (9.8%) [5.2%]	6.5% (32.4%) [12.5%]	1.7% (22.9%) [8.4%]	4.7% (29.0%) [23.5%]	4.2% (42.4%) [16.5%]	0.9% (37.5%) [4.5%]	1.4% (37.8%) [7.2%]	3.3% (12.8%) [16.5%]	2.5% (17.1%) [12.7%]	2.8% (7.6%) [13.8%]		
20 Fruit Cup	2.3% (48.2%) [14.2%]	2.9% (35.5%) [18.3%]	3.8% (25.5%) [23.6%]	3.5% (18.7%) [22.1%]	2.7% (21.4%) [17.2%]	2.7% (35.9%) [16.7%]	1.3% (35.9%) [8.1%]	1.5% (35.0%) [9.7%]	3.9% (15.3%) [24.5%]	3.9% (19.8%) [24.7%]	2.5% (34.7%) [16.0%]	2.6% (16.1%) [16.4%]	2.3% (23.4%) [14.5%]	0.8% (34.3%) [5.2%]	0.8% (21.5%) [5.2%]	5.9% (22.9%) [37.2%]	3.7% (25.1%) [23.4%]	5.8% (16.0%) [36.4%]	3.7% (18.6%) [23.4%]	
21 Cheesecake	2.1% (43.9%) [8.6%]	3.1% (38.2%) [13.1%]	6.4% (43.7%) [26.8%]	7.4% (39.4%) [31.0%]	4.4% (33.9%) [18.2%]	2.3% (30.5%) [9.5%]	1.0% (28.8%) [4.3%]	1.8% (40.1%) [7.4%]	7.1% (27.7%) [29.5%]	5.7% (28.6%) [23.7%]	2.5% (34.4%) [10.5%]	6.5% (40.1%) [27.1%]	3.1% (30.9%) [12.7%]	1.1% (46.3%) [4.6%]	0.9% (23.8%) [3.8%]	6.1% (23.6%) [25.4%]	1.1% (43.0%) [26.6%]	6.4% (32.3%) [48.9%]	5.3% (26.6%) [22.2%]	1.9% (12.1%) [8.0%]

**Note:** Top number is overall probability of joint choice; Number in ( ) is probability of buying row product conditional on buying the column product; Number in [ ] is probability of buying column product conditional on buying the row product.

**Table A8.** Cross-Utility Effect Estimates from MVL Model – FAFH

Interactions of ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 PB Chicken Nuggets																				
2 Chicken Nuggets	-1.364*																			
	(0.137)																			
3 Chicken Wings	-1.378*	-0.652*																		
	(0.121)	(0.082)																		
4 Mozzarella Sticks	-1.200*	-0.814*	-1.008*																	
	(0.115)	(0.079)	(0.064)																	
5 Spinach Artichoke Dip	-1.315*	-1.360*	-1.502*	-1.425*																
	(0.142)	(0.120)	(0.092)	(0.080)																
6 PB Burgers	2.577*	1.126*	0.425*	0.227*	0.238**															
	(0.099)	(0.091)	(0.085)	(0.082)	(0.101)															
7 Tofu	1.527*	0.729*	0.123	0.176	0.734*	0.073														
	(0.133)	(0.127)	(0.119)	(0.107)	(0.112)	(0.122)														
8 Pork Sausage	1.775*	1.381*	1.332*	0.723*	0.496*	-0.970*	0.360**													
	(0.130)	(0.103)	(0.091)	(0.092)	(0.123)	(0.139)	(0.143)													
9 Beef Burger	0.604*	0.614*	0.346*	0.494*	0.272*	-1.516*	-1.246*	-0.591*												
	(0.108)	(0.069)	(0.056)	(0.050)	(0.063)	(0.089)	(0.131)	(0.098)												
10 Chicken Breast	0.660*	0.935*	0.568*	0.529*	0.261*	-1.667*	-0.816*	-1.014*	-1.633*											
	(0.107)	(0.071)	(0.058)	(0.052)	(0.061)	(0.103)	(0.117)	(0.110)	(0.061)											
11 Vegan Avocado Sandwich	1.346*	0.724*	0.587*	0.488*	0.993*	-0.489*	-0.476*	0.183	-1.447*	-0.817*										
	(0.113)	(0.096)	(0.081)	(0.076)	(0.080)	(0.105)	(0.140)	(0.116)	(0.092)	(0.085)										
12 Ribeye Steak	0.646*	0.519*	0.811*	0.701*	0.669*	-1.978*	-1.060*	-0.890*	-1.739*	-2.118*	-0.554*									
	(0.119)	(0.083)	(0.060)	(0.056)	(0.063)	(0.125)	(0.140)	(0.112)	(0.067)	(0.075)	(0.087)									
13 Salmon	0.828*	0.638*	0.633*	0.209*	0.611*	-0.887*	-0.720*	-0.521*	-1.581*	-1.408*	-1.039*	-1.210*								
	(0.121)	(0.099)	(0.074)	(0.073)	(0.071)	(0.113)	(0.143)	(0.131)	(0.095)	(0.078)	(0.119)	(0.081)								
14 PB Chicken Sausage	1.679*	0.690*	0.848*	1.039*	1.013*	-0.594*	0.105	-0.675*	-1.272*	-1.170*	-0.148	-1.302*	-0.355**							
	(0.161)	(0.158)	(0.127)	(0.116)	(0.131)	(0.167)	(0.180)	(0.187)	(0.154)	(0.144)	(0.153)	(0.156)	(0.144)							
15 Pork Loin	0.447**	0.286*	0.203*	0.266**	0.486*	-0.709*	0.040	-0.100	-1.012*	-1.346*	-0.690*	-0.963*	-1.023*	0.185						
	(0.204)	(0.149)	(0.122)	(0.105)	(0.108)	(0.175)	(0.182)	(0.175)	(0.116)	(0.121)	(0.176)	(0.118)	(0.147)	(0.197)						
16 Salad	0.606*	0.200**	0.269*	0.223*	0.496*	0.684*	0.386*	0.590*	0.051	1.131*	-0.017	1.521*	1.007*	0.661*	1.231*					
	(0.098)	(0.078)	(0.059)	(0.053)	(0.056)	(0.080)	(0.107)	(0.101)	(0.054)	(0.050)	(0.079)	(0.054)	(0.063)	(0.126)	(0.094)					
17 Mac and Cheese	0.523*	0.938*	0.476*	0.628*	0.128*	0.479*	0.611*	1.183*	0.768*	1.147*	0.348*	1.174*	0.347*	0.883*	1.245*	-1.765*				
	(0.105)	(0.076)	(0.064)	(0.057)	(0.072)	(0.092)	(0.112)	(0.096)	(0.059)	(0.058)	(0.087)	(0.064)	(0.082)	(0.130)	(0.110)	(0.067)				
18 Fries	-0.066	0.789*	0.684*	0.525*	0.046	1.040*	0.354*	0.691*	1.827*	0.748*	0.702*	1.222*	0.046	0.519*	1.026*	-2.174*	-2.409*			
	(0.099)	(0.068)	(0.054)	(0.048)	(0.059)	(0.073)	(0.102)	(0.093)	(0.044)	(0.052)	(0.070)	(0.055)	(0.075)	(0.127)	(0.101)	(0.053)	(0.065)			
10 Broccoli	0.048	-0.227**	0.163**	0.401*	0.799*	0.367*	0.872*	0.589*	0.031	1.542*	0.381*	1.481*	1.580*	1.114*	1.615*	-2.033*	-1.424*	-2.337*		
	(0.115)	(0.092)	(0.065)	(0.055)	(0.057)	(0.095)	(0.104)	(0.109)	(0.063)	(0.051)	(0.081)	(0.058)	(0.062)	(0.123)	(0.095)	(0.057)	(0.066)	(0.063)		
20 Fruit Cup	1.247*	0.919*	0.676*	0.310*	0.566*	0.862*	0.603*	0.276*	0.195*	0.272*	0.961*	-0.041	0.440*	0.311**	0.112	0.823*	0.671*	0.231*	0.361*	
	(0.096)	(0.073)	(0.062)	(0.059)	(0.064)	(0.077)	(0.102)	(0.101)	(0.058)	(0.057)	(0.075)	(0.068)	(0.072)	(0.133)	(0.112)	(0.053)	(0.064)	(0.055)	(0.060)	
21 Cheesecake	0.934*	0.445*	0.940*	0.785*	0.851*	0.238*	-0.047	-0.043	0.190*	0.327*	0.335*	0.746*	0.493*	0.454*	-0.291*	0.433*	1.099*	0.854*	0.364*	-2.184*
	(0.097)	(0.071)	(0.052)	(0.047)	(0.055)	(0.078)	(0.107)	(0.095)	(0.049)	(0.051)	(0.075)	(0.052)	(0.066)	(0.120)	(0.110)	(0.051)	(0.054)	(0.046)	(0.053)	(0.081)

**Table A9.** Description of Endogenous Variables

	<b>Variable</b>	<b>Proportionate change in ...</b>
1	$\hat{Q}_{US,D}^1$	U.S. consumption of ground beef
2	$\hat{Q}_{US,D}^2$	U.S. consumption of non-ground beef
3	$\hat{Q}_{US,D}^3$	U.S. consumption of chicken breast
4	$\hat{Q}_{US,D}^4$	U.S. consumption of thighs, drumsticks, and wings
5	$\hat{Q}_{US,D}^5$	U.S. consumption of chicken products (e.g., sausage, nuggets)
6	$\hat{Q}_{US,D}^6$	U.S. consumption of plant-based ground beef alternative
7	$\hat{Q}_{US,D}^7$	U.S. consumption of plant-based chicken nugget alternative
8	$\hat{Q}_{US,D}^8$	U.S. consumption of plant-based chicken sausage alternative
9	$\hat{Q}_{US,D}^9$	U.S. consumption of tofu
10	$\hat{Q}_{US,D}^{10}$	U.S. consumption of salmon
11	$\hat{P}^1$	Retail price of ground beef
12	$\hat{P}^2$	Retail price of non-ground beef
13	$\hat{P}^3$	Retail price of chicken breast
14	$\hat{P}^4$	Retail price of thighs, drumsticks, and wings
15	$\hat{P}^5$	Retail price of chicken products (e.g., sausage, nuggets)
16	$\hat{Q}_{FI}^1$	Quantity of ground beef imported to U.S.
17	$\hat{Q}_{FI}^2$	Quantity of non-ground beef imported to U.S.
18	$\hat{Q}_{FE}^1$	Quantity of U.S. ground beef exported
19	$\hat{Q}_{FE}^2$	Quantity of U.S. non-ground beef exported
20	$\hat{Q}_{US}^j$	Total Quantity of U.S. ground beef production
21	$\hat{Q}_{US}^j$	Total Quantity of U.S. non-ground beef production
22	$\hat{Q}_{US,S}^1$	U.S. ground beef production supplied to domestic market
23	$\hat{Q}_{US,S}^2$	U.S. non-ground beef production supplied to domestic market
24	$\hat{x}_3^{US}$	Quantity of U.S. chicken remaining in U.S.
25	$\hat{x}_3^{FE}$	Quantity of U.S. chicken exported
26	$\hat{w}_1$	Price of U.S. cattle
27	$\hat{w}_2$	Price of marketing inputs to packing
28	$\hat{w}_3$	Price of wholesale chicken
29	$\hat{x}_1$	Quantity of U.S. cattle
30	$\hat{x}_2$	Quantity of marketing inputs to packers
31	$\hat{x}_3$	Quantity of U.S. chicken

**Table A10.** Exogenous Shocks to the Model

	<b>Variable</b>	<b>Proportionate change in ...</b>
1	$\hat{p}^6$	Retail price of plant-based ground beef alternative
2	$\hat{p}^7$	Retail price of plant-based chicken nugget alternative
3	$\hat{p}^8$	Retail price of plant-based chicken sausage alternative
4	$\hat{p}^9$	Retail price of tofu
5	$\hat{p}^{10}$	Retail price of salmon
6	$\delta^1$	Willingness-to-pay for ground beef * -1
7	$\delta^2$	Willingness-to-pay for non-ground beef * -1
8	$\delta^3$	Willingness-to-pay for chicken breast * -1
9	$\delta^4$	Willingness-to-pay for chicken thigh, drumstick, wing * -1
10	$\delta^5$	Willingness-to-pay for chicken products * -1
11	$v_1$	Marginal cost of producing cattle * -1
12	$v_2$	Marginal cost of marketing inputs * -1
13	$v_3$	Marginal cost of producing chicken * -1

## Appendix B. Figures

**Figure A1:** Grocery store and non-grocery store settings, images

Please click all images showing a scenario related to **grocery store setting**.



**Figure A2:** BBCE instructions, FAH

**Now imagine you are at the grocery store, planning to purchase food to prepare a meal for yourself and/or your household.**



In what follows, we will present you with **nine questions, each on a different screen**. In each question, you will see **various food items you would typically find in grocery stores**. The food items that we present **remain the same in each of the nine questions**. However, **their price** in each question **changes**. All other product characteristics not mentioned here are assumed to be the same.

Based on your preferences and budget for one meal, **please select the food item or combination of food items that you would purchase to prepare this meal**. You can choose as many food items as you would like. If you would not make any purchase, simply select the option "**No-Purchase**" option.

**Figure A3:** In-dining restaurant and non-in-dining restaurant settings, images

Please click all images showing a scenario related to restaurant dining.





**Figure A4:** BBCE instructions, FAFH

Now imagine you are dining out, planning to have dinner at a restaurant.



In what follows, we will present you with **nine questions, each on a different screen**. In each question, you will see **various dishes (appetizers, entrees, sides, and desserts) you would typically find on a restaurant menu**.

The **dishes that we present remain the same in each of the nine questions**. However, **their price** in each question **changes**. All other dishes characteristics not mentioned here are assumed to be the same.

Based on your preferences and budget for one meal at the restaurant, **please select the dish or combination of dishes that you would order at a restaurant**. You can choose as many dishes as you would like in each category. If you would not make any purchase, simply select the option "**I would not order**".