DATA MINING OF MARKET INFORMATION TO ASSESS AT-HOME PORK DEMAND

A Dissertation

by

ARMEN A. ASATRYAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2003

Major Subject: Agricultural Economics

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ABSTRACT

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(December 2003)

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This study analyzes the economic and demographic patterns of at-home pork consumption for representative individuals over 18 years of age in the United States. Three data sets purchased by the National Pork Board (NPB) are mined for this purpose: (1) National Eating Trends (NET) data from National Panel Diary (NPD) on individuals' intake and their demographic characteristics; (2) weekly retail prices for fresh meats and fresh pork cuts from FreshLook; and (3) weekly retail prices for processed pork products from A.C. Nielsen.

Heckman sample selection models are used to find demographic, health, and attitudinal/lifestyle patterns of consumption of twelve fresh and processed pork products as well as beef, chicken, and seafood. In the fall, individuals have a higher probability of eating beef, chicken, pork tenderloin, and bacon, but a lower probability of eating fresh seafood, canned ham, and smoked ham relative to the spring. The New England region has the highest likelihood of eating fresh pork, beef, chicken, seafood, pork roasts, pork tenderloin, and pork hotdogs. Blacks, on average, eat more fresh and processed pork, chicken, pork sausage, bacon, and canned ham, but less beef relative to whites. Concern about serving food with fat is negatively related with the likelihood of eating processed pork, lunchmeat, ham, and bacon, but it is positively related with the likelihood of eating pork hotdogs.

A three-stage selectivity-adjusted censored LA/AIDS model is developed and estimated to find demand-price relationships for: (1) fresh meats (pork, beef, chicken, and seafood) and (2) nine fresh and processed pork cuts. However, aggregate fresh meats are substitutes for each other in the at-home market, but there are substantial complementarities between pork cuts. Pork sausage is the major competitor for the processed products, pork roasts and pork tenderloin, but a major complement for pork ribs. There is relatively week substitutability between pork and beef, and relatively strong substitutability between pork and chicken and between beef and chicken. This could suggest opportunities for some joint marketing efforts between pork and beef commodity interests.

This information can be used as a guide for marketing strategists for targeting and promotion as well as for category management of the disaggregated pork products.

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CHAPTER I

INTRODUCTION

Justification

Digital technology allows the collection and warehousing of large industry-specific marketing information. These large databases often include detailed measures of large numbers of variables, which may be important for specific research purposes. Many food industries consider it to be more feasible to purchase data on sales, eating trends, and retail prices from professional information companies like the NPD Group, Inc., FreshLook, and A.C. Nielsen than collecting the information themselves. The mining of this information has the potential to provide insights into the purchasing behavior of consumers.

Data Mining

There are many different definitions of data mining in various fields of science. In economics, for example, Mayer views data mining as "fitting of more than one econometric specification of the hypothesis." Hoover and Perez define data mining as "a broad class of activities that have in common, a search over different ways

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This dissertation follows the style and format of the *American Journal of Agricultural Economics*.

to process or package data statistically or econometrically with the purpose of making the final presentation meet certain design criteria." In computer science and marketing, it is common to see broader definitions of data mining. For example, Witten and Frank (1999) define data mining as "the extraction of implicit, previously unknown, and potentially useful information from data". Even though the authors discuss machine learning techniques, they state that "in truth, you should not look for a dividing line between machine learning and statistics, for there is a continuum — and a multidimensional one at that — of data analysis techniques." Berson, Smith, and Thearling provide yet another definition: "data mining, by its simplest definition, automates the detection of relevant patterns in a database". The authors also mention that some classical data mining techniques such as Classification and Regression Trees (CART) and Chi-Square Automatic Interaction Detector (CHAID) are taken from statistics. They explained two reasons why data mining is different from statistics. The first reason is that the classical data mining techniques "tend to be more robust for messier real world data and also more robust for use by less-expert users" and the second reason is the availability of large quantities of data for users. However, they conclude their discussion by stating that "the bottom line though, from an academic standpoint at least, is that there is little practical difference between a statistical technique and a classical data mining technique." For this dissertation Data Mining is defined as follows:

Data Mining — extraction of useful patterns from a database.

According to this definition, if the researcher uses only one model to extract useful information out of a database, then it is still a process of data mining. In this study, we use economic theory and econometric procedures to discover potentially useful economic patterns related to the demand of pork products using a database obtained by National Pork Board. Therefore, it can be stated with confidence that this study is data mining armed by economic and econometric theory.

Specifically, the techniques of data mining have the potential to provide greater precision in understanding consumption of fresh and processed pork products. Additionally, these techniques may provide assistance in establishing targets of marketing programs related to these commodities. This study, funded by the National Pork Board (NPD), attempts to disentangle and quantify the effects of the key socio-demographic, health, attitudinal/lifestyle, and economic determinants of the consumption of pork products, using secondary data purchased by NPD.

National Pork Board

An independent body established under provisions outlined by Congress in the Pork Promotion, Research and Consumer Information Act of 1985 and funded by Pork Checkoff program, NPB represents all U.S. pork producers and importers. The Pork Checkoff program collects $0.40 per $100 of value from U.S. pork producers and importers when pigs are sold and when pigs or pork products are brought into the United States. The money is spent to fund operations supporting NPB's vision (NPB website), which is as follows: (1) "increase domestic per capita demand for pork;" (2) "increase export demand for U.S. pork;" (3) "meet the challenges of responsible 21st Century pork production;" and (4) "provide access to the knowledge and opportunities that allow all producers to be competitive."

To accomplish its vision, NPB works on acquiring more information about the key factors affecting domestic pork consumption. Information about consumer profiles as well as own-price elasticities, cross-price elasticities and income elasticities can be vital for its successful marketing strategy. In particular, this research will enable NPB analysts to predict either the probability of consumption or the amount of intake of disaggregated pork products (fresh and processed) for any demographic profile. Soundly based preference information is absolutely essential for developing consumer targets for the marketing of pork. The project builds a predictive platform, which is able to provide guidelines to marketing specialists of the NPB to assist in the merchandising of value-added pork products.

The information about which individuals to target could benefit all parties interested in developing and implementing marketing strategies associated with the marketing of pork and pork products in the United States. Hence, U.S. and international pork producers and processors as well as retail or food service industries selling pork products domestically could be potential beneficiaries of this research.

Purpose and Objectives of This Research

The **purpose of this research** is to analyze the patterns of at-home pork consumption for representative individuals over 18 years of age in the United States. Specifically, we attempt to examine the key socio-demographic, health, attitudinal/lifestyle, and economic factors that drive the decision made by consumers to eat pork and that determine their intake level or quantity of selected fresh and processed pork products as well as for fresh pork, fresh beef, fresh chicken, and fresh seafood.

Fresh pork cuts include pork chops, pork ribs, pork tenderloin, and pork roasts. Processed pork products include processed pork, ham, lunchmeat, bacon, pork sausage, canned ham, smoked ham, and pork hotdogs. A comparative investigation of both at-home and away-from-home intakes of the selected products would be ideal. This study however, centers its attention only on at-home intakes of the selected products due to two major reasons. First, data on away-from-home consumption with linked socio-demographic variables are not generally available for such research. Data available for this study are mainly focused on at-home consumption and do not fully reflect away-from-home consumption patterns. Second, available price series are limited to commodities and products consumed in the at-home market.

The **specific objectives of this study** are as follows:

1. To find the key determinants or drivers affecting the *probability* of eating the selected products in the at-home market.
2. To find the key drivers associated with the *volume* of the selected products eaten in the at-home market. Conditional effects (for eaters of the corresponding products) and unconditional effects (for all individuals) are examined related to each driver.
3. To measure the predictive power of the Heckman sample selection models in terms of forecasting probabilities of consumers eating and forecasting consumption levels of fresh and processed pork products.
4. To find the existing relationships among fresh pork and other fresh meats (beef, chicken, seafood).

5. To find the existing relationships among fresh and processed pork cuts.

Objectives one and two are accomplished applying a two-step Heckman sample selection model. This procedure models a two-stage decision process. The first stage (further referred to as the selection stage) models the decision to eat or not to eat the selected products and the second stage (further referred to as the intake stage) models the actual intake of the particular products. The second stage models the volume of the intake of the selected products. Objective three is accomplished by using techniques based on out-of-sample forecast. Objectives four and five are achieved by estimating the *own-price, cross-price, and expenditure elasticities* of demand for the selected products in the at-home market. The Linear Approximation Almost Ideal Demand System (LA/AIDS) is used to determine these relationships. The demand system for fresh meats and the demand system for pork cuts are based on the assumption that aggregate fresh meats and disaggregate pork cuts, respectively, are separable groups. In the economic literature, it is common to have pork, beef, chicken, and seafood as a separable group. A three-step estimation technique is developed and applied in conjunction with censored demand systems.

These results allow for the identification of potential target market areas associated with the probability of consumption. As well, these results allow for the development of marketing strategies with the goal of increasing the consumption of the selected products for the at-home market.

Extant Literature

Many studies have dealt with economic and/or consumer characteristics affecting the consumption of meat products. We divide the extant literature into articles focusing on the effects of socioeconomic factors and those focusing on price responses.

Literature Focusing on Socio-Demographic Determinants

Studies by Capps, Moen, and Branson ; Nayga and Capps; Li; Moon and Ward; Park and Capps; and Briggeman all have focused on socio-demographic factors effecting the consumption of pork. In general, these studies concluded that many socio-demographic, health, and attitudinal factors are important determinants for both the decision to eat and the actual intake of meat products.

Capps, Moen, and Branson investigated factors affecting the decision by consumers to try lean meat products from a particular retail food chain in Houston. The analysis was based on a qualitative choice probit model. The information used for this analysis came from telephone interviews gathered from 200 shoppers from nine retail food stores belonging to the same retail food chain in 1987. The factors considered consisted of demographic and attitudinal characteristics of consumers. Socio-demographic factors in the data set were age, education, income, household size of the respondent, and the length of residency in Texas. The attitudinal factors were price- and fat-consciousness of the respondent.

They found that attitudes towards fat affected the decision of trying lean meat products. The results also showed age, education, and household size were important determinants in the decision to try lean meat products. Consumers over 30 years old were more likely to try lean meat products than those between 20 and 29 years of age. Education and household size were found to be positively associated with the likelihood of trying lean meats products. Further, the study found no statistically significant relationship between price-consciousness of consumers and their likelihood of trying of lean meats. Fat-conscious consumers however, were found to be more likely to try lean meat products relative to non-fat conscious consumers. The authors suggested that future studies should include an investigation of the factors affecting the volume of consumption of the selected products as well. They also mentioned the importance of including race, urbanization, and seasonality factors in the future studies of the decision to eat lean meat products.

Nayga and Capps used a qualitative choice logit model to find the key socio-demographic and health factors affecting the decision to consume pork in at-home and away-from-home markets. The data used for this analysis pertained to the individual intake phase of the Nationwide Food Consumption Survey conducted by United States Department of Agriculture (USDA), covering the period from April 1987 to August 1988. The food intake data were based on three consecutive days of consumption information.

The results showed that penetration of pork in away-from-home and at-home markets were 10% and 37%, respectively. The authors found that urbanization had a significant negative impact on the decision to eat pork in both away-from-home and at-home pork markets. They also found that region played a role on the decision to eat pork in the at-home market model. Individuals from the Northeast and the West were less likely to eat pork at home relative to the individuals from the South. Race was found to be a key determinant in the decision to eat pork at home as well. Blacks and Asians or Pacific Islanders were found to have a higher likelihood of eating at-home pork relative to whites. Ethnicity was not found to have a statistically significant impact on the likelihood of eating pork in both markets. Males had a higher likelihood of eating pork in both markets compared to females. Income was found to have statistically significant positive effect on the decision to eat away-from-home pork.

Despite large improvement the leanness of pork (Levine), Nayga and Capps also showed that being on a special diet had a negative impact on the likelihood of pork consumption in both markets. The authors explained that that situation perhaps was related to nutritional perceptions of consumers. Indeed, Peterson, et al., based on data from a study conducted by the National Livestock and Meat Board, found that chicken and turkey had much lower perceived levels of fat relative to beef and pork. Moreover, this finding was consistent for all the pork products considered in their analysis. For example, the results indicated that the perceived (actual) percent of fat for regular ham, pork roast, low-fat ham, pork ribs, and center cut pork chops were 30.1% (18.9%), 30.4% (15.8%), 16.8% (10.6%), 34.7% (22.0%), and 24.5% (13.4%), respectively.

Further, Nayga and Capps found that household size was negatively related to the probability of pork consumption in the away-from-home market but positively related to the likelihood of eating pork in the at-home market. In terms of future research, the authors recommended focusing on more disaggregate pork products in both at-home and away-from-home markets. They also recommended analyzing possible interactions (including price and income effects) among pork products and their major substitutes and complements.

Li used a selectivity-adjusted probit model to study the key factors affecting the decision to eat branded pork in Taipei, Taiwan using data from a survey of 547 families in Taipei conducted in 1993. This model is a unique application of the two-stage decision process in considering pork. The first stage focused attention on analyzing factors affecting the decision regarding which type of market (supermarkets vs. traditional markets) from which to purchase. The second stage investigated factors affecting the decision to purchase pork with the mark of Chinese Agricultural Standards (CAS) given that supermarkets were selected in the first stage. The factors under investigation were socio-demographic characteristics of the respondents, time of shopping, knowledge of the CAS mark, and whether the respondent learned about CAS through advertising. Li found that socio-demographics characteristics were important determinants affecting the decision to shop in supermarkets. For example, the results showed that college-educated respondents had a higher likelihood of shopping from supermarkets relative to those without high school education. Employment was found to play a role in both stages. Not employed respondents were found to have a lower probability of selecting to shop from supermarkets relative to those who were employed. Additionally, given that employed individuals had selected supermarkets, they showed a higher likelihood of choosing pork with the CAS mark than those not employed.

The results also showed that the age of the respondent, the number meals cooked at home during a week, and respondent being a housewife were negatively associated with the probability of purchasing in supermarkets. Further, both advertising and understanding of the CAS mark were found to be statistically insignificant in the decision to purchase pork from supermarkets. These factors however had a positive impact on the decision to buy branded pork.

Moon and Ward tried to find the key socio-demographic and attitudinal characteristics affecting the consumption of beef, pork, chicken, turkey and fish by applying a generalized Heckman model using the NPD Survey data from 1998. The authors found that health concerns had a negative effect on the consumption of beef and pork, but health concerns had a positive effect on the consumption of chicken, turkey and fish. Employment of the female head, education and market size were found to be negatively associated with the probability of consuming pork. Further, they found that household size and age were positively associated with the decision to consume pork. Moon and Ward also found that there were regional differences in the decision to eat pork. For example, households located in the Central and Southern regions had a higher likelihood of consuming pork relative to those living in the Eastern region of the United States.

Park and Capps focused attention on identifying and assessing the micro-level impact of branded and generic advertising on the decision to consume pork and conditional on consuming pork, the amount of pork intake. This study used data from 1994-96 Continuing Survey of Food Intakes for Individuals and the 1994-96 Diet Health and Knowledge Survey, available from the U.S. Department of Agriculture. The data pertained to two nonconsecutive days of intake for 4,691 individuals. The explanatory variables used in the analysis were socio-demographic, health, and attitudinal/lifestyle factors. The research showed that on average 31 percent of the people surveyed consumed pork. Pork intake on average was 13.12 (41.75) grams per individual for all individuals (individuals who ate pork). Zero consumption was assumed to be due to the possibility of corner solutions. The authors employed Cragg's (1971) double-hurdle model to adjust for corner solutions. The study showed that branded and generic advertising of pork had a positive impact on both the decision to eat pork and on the volume of pork intake. Income, age, health, attitudinal, and lifestyle factors were found to impact the probability of consuming pork rather than the amount of pork consumed. Intake was higher for males compared to females, but gender differences were insignificant in the decision stage. Given that pork consumption occurred, intake for males was found to be 10.66 grams higher than intake for females. Ethnicity and weekday were found to have no statistically significant impact on both stages. Region, race, and season were found to play a role in both selection and intake stages of pork consumption. Park and Capps however, calculated marginal effects of the explanatory variables conditional on consuming pork only. It is equally important, however, to calculate unconditional marginal effects of the factors as well. Unconditional marginal effects give information about the changes in the total market (for all individuals), not just one segment of it (for example, eaters of pork only in this case). Our study focuses on investigating both conditional and unconditional marginal effects.

Briggeman attempted to find the key socio-demographic, health, and economic factors affecting the decision to consume processed and fresh pork in the at-home and away-from home markets using logit models. Overall six models were analyzed based on place and type of pork consumption: (1) at-home pork consumption; (2) at-home processed pork consumption; (3) at-home fresh pork consumption; (4) away-from-home pork consumption; (5) away-from-home processed pork consumption; and (6) away-from-home fresh pork consumption. The study used data from consumer household diaries collected by NPD over the period March 1998 to February 2001. The data give information about biweekly consumption of fresh and processed pork for 15,167 individuals. Based on in-sample data, the percent of individuals who consumed at-home (away-from-home) pork was 89.78% (22.43%). The study also showed that market penetration of processed pork was 93.47% for at-home consumption and 89.94% for away-from-home consumption. These numbers were very high relative to the penetration findings of Nayga and Capps 1995 (10% (away-from-home) and 37% (at-home)).

Briggeman confirmed the findings of Nayga and Capps that there were differences in individuals who consume pork in at-home and away-from-home markets. There were also differences found in individuals who eat fresh pork and processed pork. Briggeman therefore, concluded that disaggregating pork into finer categories allowed a richer analysis for creating consumer profiles and establishing appropriate marketing strategies. Briggeman found that seasonality affected the decision to consume pork in all six models. This finding was in contrast to the findings of Nayga and Capps. The study also showed that health indicators were important in all six models. Dieting had a negative impact on the probability of consumption, but body mass index (BMI) was found to have a positive affect on the probability of consumption. Males were found to have higher likelihood of consumption in all models. Characteristics of the female head (age, employment status and education) and market size were found to be important determinants of the decision to consume pork in all six models. Age was found to have different effects in at-home (positive) models and in away-from-home (negative) models.

Briggeman also conducted a validation analysis to test the predictive power of the models. Specifically, prediction success tables with different cutoff values based on the toss of a fair coin, penetration, average probability, and calibration was applied to the in-sample data (from 1998 to 2000). The author selected the average probability to be the cutoff value for the prediction success tables in out-of-sample models. The weighted average percentages of correctly identified individuals who ate and the percentage of correctly identified individuals who did not eat ranged from 56.28% (at-home fresh pork) to 69.75% (away-from-home fresh pork). Concerning future research, Briggeman's main suggestions were: (1) further disaggregating the fresh and processed pork products to find the key drivers affecting the decision to consume; (2) investigating the factors affecting the volume of consumption; (3) studying advertising, own-price, and cross-price effects. Our study in part is a continuation of Briggeman's research.

Literature Focusing on Income and Price Determinants

The studies that emphasized income and price factors were usually based on analysis of demand systems. Many of those studies which emphasize the demand system approach use a seemingly unrelated regression (SUR) procedure due to three main reasons (Capps (1993), Piggott). First, the demand system allows imposition of restrictions implied by the economic theory not only within an equation (such as homogeneity) but also across different equations (such as symmetry and adding up) which improves efficiency by estimating as a demand system. Second, a system of equations approach is more efficient than single-equation models if disturbances in different equations are contemporaneously correlated. Third, a system of equations approach is more efficient than a single-equation model if the exogenous variables are not the same in each equation (which is the case in censored demand systems).

The studies in this group were based on macro-level annual, quarterly, or monthly time-series data of prices and the corresponding quantities. Macro-level time-series data however, do not contain detailed information in terms of disaggregate product and price (Capps (1989)). Other studies which use micro-level data to estimate demand systems are based on either weekly time series scanner information (e.g., Capps (1993)) or cross-sectional household surveys (e.g., Yen, Lin, and Smallwood).

The demand systems in these studies mainly consisted of pork, beef, poultry, and fish products. The attitude of those studies towards including fish was mixed, however (see Table 1). Many studies excluded fish from the demand systems by assuming that it was a separable from pork, beef, and poultry. Other studies however, considered fish as an integral part of the demand system (Capps and Schmitz; Kinnucan et al.; and Yen, Lin, and Smallwood).

Table 1. Past Studies Concerning Pork Demand Relationships, 1983 – 2003

Study	Years	Frequency	Model	Own Price	Beef Price	Poultry Price	Fish Price	Income or Expenditure	Generic Advertising	Health
Brester and Schroeder	1970-93	Quarterly	Rotterdam	-0.690	0.230	0.040		0.033	-0.009	
Capps and Schmitz (1991)	1966-88	Annual	Rotterdam	-0.451	0.343	0.046	0.062	1.889		
Chavas	1950-70	Annual	Sage and Melsa (1971)	-0.723	0.217	0.076		0.429		
Coulibaly and Brorsen	1970-93	Quarterly	Rotterdam	-0.689	0.769	-0.080		0.294	-0.000106	
Dahlgran	1950-85	Annual	Inverse Rotterdam	-0.584	0.255	0.069		-0.054		
Eales et al.,	1980-96	Quarterly	Rotterdam	-0.520	0.470	0.050		0.950		
Eales and Unnevehr (1988)	1965-85	Annual	AIDS	-0.762	0.314	0.007		0.278		

Table 1. Continued

Study	Years	Frequency	Model	Own Price	Beef Price	Poultry Price	Fish Price	Income or Expenditure	Generic Advertising	Health
Eales and Unnevehr (1993)	1962-89	Annual	AIDS (3SLS)	-1.234	-0.107	0.013		1.281		
Kinnucan et al. (1997)	1976-93	Quarterly	Rotterdam	-0.651	0.610	-0.064	0.105	1.005	0.00001	-0.195
Piggott	1979-95	Quarterly						1.230		
Schroeder, Marsh, and Mintert	1982-98	Quarterly	LA/AIDS	-0.503	0.078	-0.0004		0.731		
Yen, Lin, and Smallwood (2003)	06/1996 to 01/1997	Cross-sectional 7-day intake	QML	-0.990	0.150	0.010	0.070	1.270		

These studies used several commonly accepted models. The Rotterdam model of Theil and Barten and the Almost Ideal Demand System (AIDS) model of Deaton and Muellbauer (1980a) are the most popular models in the literature. Further, Nested PIGLOG (Piggott and Censored Translog (Yen, Lin, and Smallwood) are also common models in the demand analysis.

In Table 1, past studies concerning pork demand relationships are summarized. Own-price, cross-price, expenditure, and advertising elasticities, along with, and health effects are proposed. Own-price elasticities of pork demand ranged from -0.451 (Capps and Schmitz) to -1.234 (Eales and Unnevehr (1993)), with most estimates falling between -0.5 and -0.75. The only cross sectional study in this group was conducted by Yen, Lin, and Smallwood, which found the own-price elasticity to be -0.99. Many of these studies again emphasized the importance of studying disaggregate meat commodities. Appropriate data, however, are lacking to allow the investigation of disaggregate cuts.

Capps (1993) was an exception in this line of studies in terms of narrowing the focus on specific cuts of pork products. Capps applied the Rotterdam model to twenty-one disaggregated meat products including six pork products (pork chops, ham, spare ribs, roast, pork loin, and all other pork) using weekly time series scanner data (running from September 1986 to November 1988) based on point-of-sale purchases obtained from forty-three supermarkets in Houston. The author found that all own-price elasticities of the pork cuts were above unity ranging from -1.719 (pork chops) to -4.012 (spare ribs).

Further, many of these studies were based on classical demand theory and, therefore, included only income and price determinants. Others however, were based on more generalized theories of demand (e.g., household production theory) and, therefore, integrated advertising, health, and other factors in addition to prices and income (Bryant and Davis). The last two columns of Table 1 summarize the results found in the literature in terms of the effects of generic advertising and health on the demand for pork. Pigott (1997) found that advertising by the Beef Industry Council (BIC) and the National Pork Producers' Council (NPPC had a statistically significant effect on the demands for pork, beef, and poultry.

Bryant and Davis investigated the magnitude of impact on the estimates in the demand systems when one of the following is changed: (a) the functional form of the model; (b) the points used for calculation of elasticities; and (c) the presence of non-economic variables. They studied those impacts using a demand system for meats (pork, beef, poultry, and fish). The study included four functional forms: (a) the Rotterdam model (Barten and Theil), (b) the first-differenced AIDS model (Deaton and Muellbauer (1980a)), (c) the Central Bureau of Statistics (CBS) model (Keller and van Driel), (d) and the National Bureau of Research (NBR) model (Neves); three non-economic variables: (i) advertising; (ii) health information; and (iii) woman's labor force participation; and four possible combinations of theoretical restrictions. By comparing all these possible combinations (576 demand systems) they came to the conclusion that the theoretical restrictions and the points of evaluationfor the calculation of elasticities were more important in terms of affecting the variation of the elasticity estimates than functional form considerations and the presence of non-economic variables.

Concluding Remarks

Some important conclusions can be gleaned from the literature review. First, many of the studies (especially newer ones) emphasize the importance of focusing on disaggregated meat commodities. Second, most of the studies emphasize the importance of considering the effects of economic, socio-demographic, attitudinal/ lifestyle, health, and advertising factors on the consumption of meat products. Socio-demographic and attitudinal/lifestyle effects are usually investigated within single-equation demand models. Common socio-demographic factors examined were income, gender, age, household size, urbanization, race, region, education and employment. These studies were mainly based on cross-sectional household data. In general, these data have a detailed demographic and intake information, but luck information on prices.

Prices effects were usually estimated within demand systems framework to take advantage of the SUR models and the restrictions of the economic theory. Time series data were the main source of such analysis. These data, in many cases, pertained to aggregate intake and price information, but luck detailed information on demographic characteristics. The relationships among pork, beef, poultry, and fish were the main focus of those studies. There are however, very few studies, which investigated disaggregate pork commodities. The main reason behind this situation was the unavailability of relevant socio-demographic and economic data to the public.

The Distinct Contribution of this Study to the Literature

This study contributes to the literature both empirically and methodologically. From an empirical prospective, this study is a useful addition to the literature because it presents a unique discussion of the key drivers affecting the consumption of the selected fresh pork, beef, chicken, and seafood in the at-home market in the United States.

Another unique contribution of this project is the examination of the drivers associated with the decision to eat and the amount of intake of disaggregate commodities of fresh and processed pork. From a micro perspective, no published study to date has provided predictions as to whether individuals with known socio-demographic, health and attitudinal characteristics will consume disaggregated fresh and processed pork products at home and, if so, how much they will consume. Moreover, this study discusses the effects of key factors on the volume of intake in two aspects (for eaters of the selected products and for all individuals, consumers and non-consumers).

Further, this study contributes to the literature by evaluating the interaction between pork and other fresh meat products as well as the interaction among fresh and processed pork cuts including own-, cross-price, and expenditure elasticities in the at-home market.

There are also two methodological contributions of this study:

1. This study has extended the works of Byrne, Capps, and Saha and by Saha, Capps, and Byrne by deriving and applying the exact expression of the unconditional marginal effects for Heckman models.

2. The study also has extended the work of Shonkwiler and Yen by presenting a three-step procedure to correct for sample selection bias within the demand systems.

Organization

The dissertation is organized as follows. This chapter constitutes the introduction to this research. It includes the purpose, the objectives, and the literature review of the study. Chapter II addresses the development of the Heckman model, and the selectivity-adjusted censored linear approximate Almost Ideal Demand System (LA/AIDS) model used in the analysis. A detailed literature review covering each model is presented in each subsection.

Chapter III discusses the original and final data sets and the development of the candidate variables used in the models. It is based on five sections. The first section discusses the three datasets (NPD, FreshLook , and A.C. Nielsen) purchased by the NPB. The second section discusses the cleaning and reorganization of the data obtained from NPD National Eating trends (NET) Survey, which is the only data set used in the Heckman models. The third section discusses the cleaning and reorganization of the data sets used in the LA/AIDS models. The first data set is constructed by merging NPD data with FreshLook data and is used in the investigation of price effects on fresh meats via the LA/AIDS model. The second data set is based on the merger of all three data sets (NPD, FreshLook , and A.C. Nielsen) and is used in the investigation of price effects on the disaggregate pork cuts via the LA/AIDS model. The fourth section discusses the development of the candidate variables in the Heckman models. The fifth section discusses the development of the candidate variables in the LA/AIDS models.

Descriptive statistics of the three final data are discussed in Chapter IV. This chapter is divided into two sections. The first section discusses the descriptive statistics of the cleaned NPD NET data used in the Heckman models. The second section discusses the descriptive statistics of the two cleaned and reorganized samples used in the LA/AIDS models.

Empirical results of the sixteen Heckman models are discussed in Chapter V. The chapter is broken into three sections based on the meat categories. Both selection stage results and intake stage results are discussed within each section. The first section presents a comparative discussion of the results from the Heckman models for four fresh meat products (fresh pork, fresh beef, fresh chicken, and fresh seafood). The second section presents a comparative discussion of the results from the Heckman models for four fresh pork cuts (pork chops, pork ribs, pork roasts, and pork tenderloin). The third section presents a comparative discussion of the results from the Heckman models for eight processed pork products (processed pork, bacon, pork sausage, ham, smoked ham, canned ham, pork hotdogs, and lunchmeat). Validation of the Heckman model results is discussed in Chapter VI.

Empirical results of the two LA/AIDS models are examined in Chapter VII. The chapter is divided into two sections. The first section discusses the results of the LA/AIDS model for fresh meats (pork, beef, chicken, and seafood). The second section discusses the results of the LA/AIDS model for nine fresh and processed pork cuts (pork chops, pork ribs, pork roasts, pork tenderloin, bacon, pork sausage, smoked ham, canned ham, and lunchmeat). Finally, the conclusions of this study are given in Chapter VIII.

CHAPTER II

MODEL DEVELOPMENT

Introduction

In this study all statistical/econometric models deal with at-home intakes of individuals over 18 years of age. What are the determinants or drivers affecting the probability of selecting specific products for consumption? What are the drivers associated with the volume (intake) of the selected products eaten? What are the own-price, cross-price, and expenditure elasticities of demand for the selected products? These are questions that can be beneficial to the NPB in developing marketing strategies for the at-home market. By analyzing these questions, this research sheds light on who is eating what type of selected product and how much is being consumed.

The literature reviewed in Chapter I shows there are key socio-demographic, health, attitudinal/lifestyle, and economic drivers affecting the probability and volume of consumption of pork products. We also attempt to investigate the impact of these factors on the consumption of fresh and processed pork products as well as fresh beef, chicken and seafood.

There are two methodologically different models applied in this study: (1) two-stage Heckman sample selection models and (2) selectivity-adjusted censored LA/AIDS models. Figure 1 shows the general scheme of methods and procedures used in this

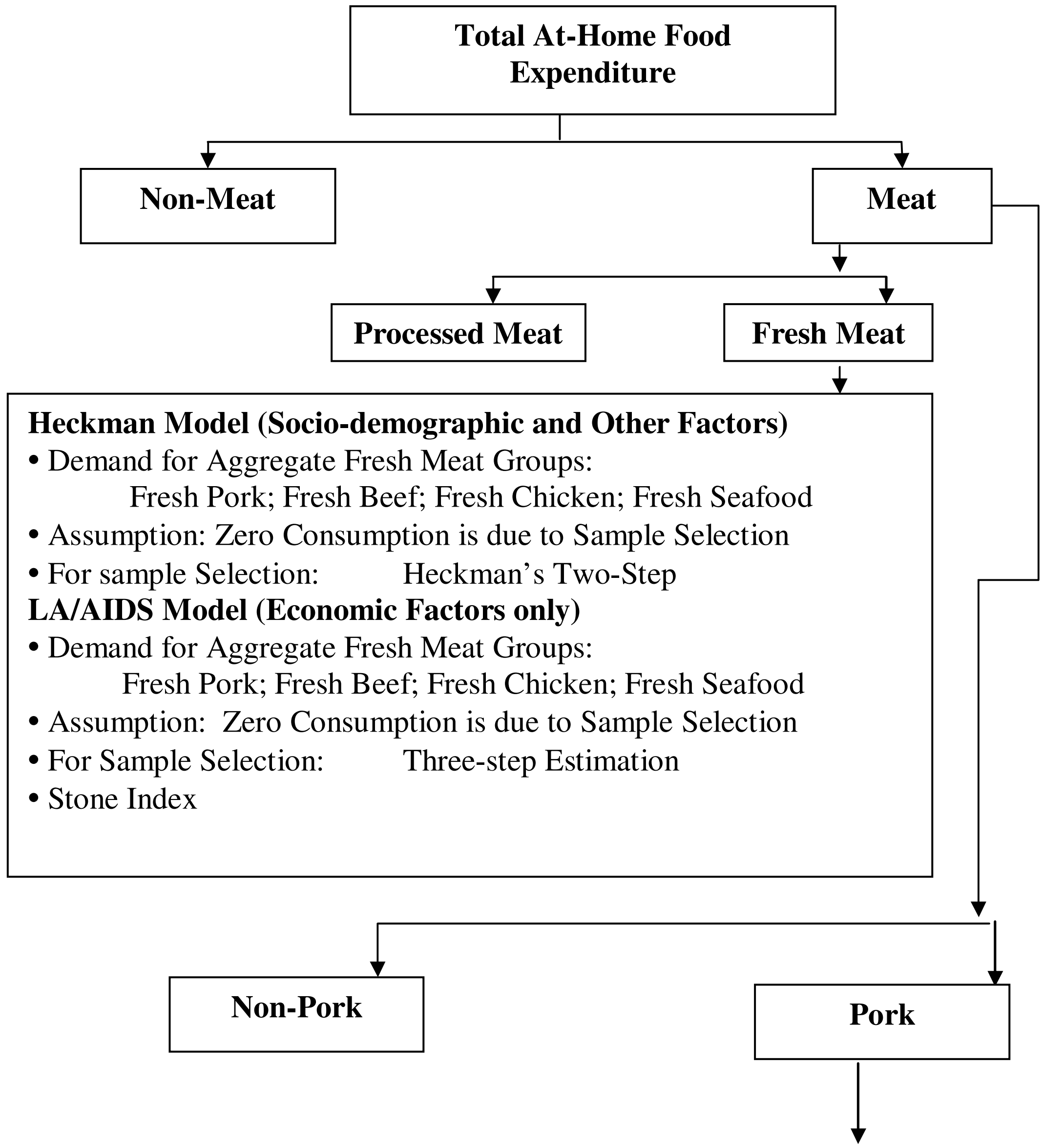


Figure 1. Modeling at-home meat demand in the United States

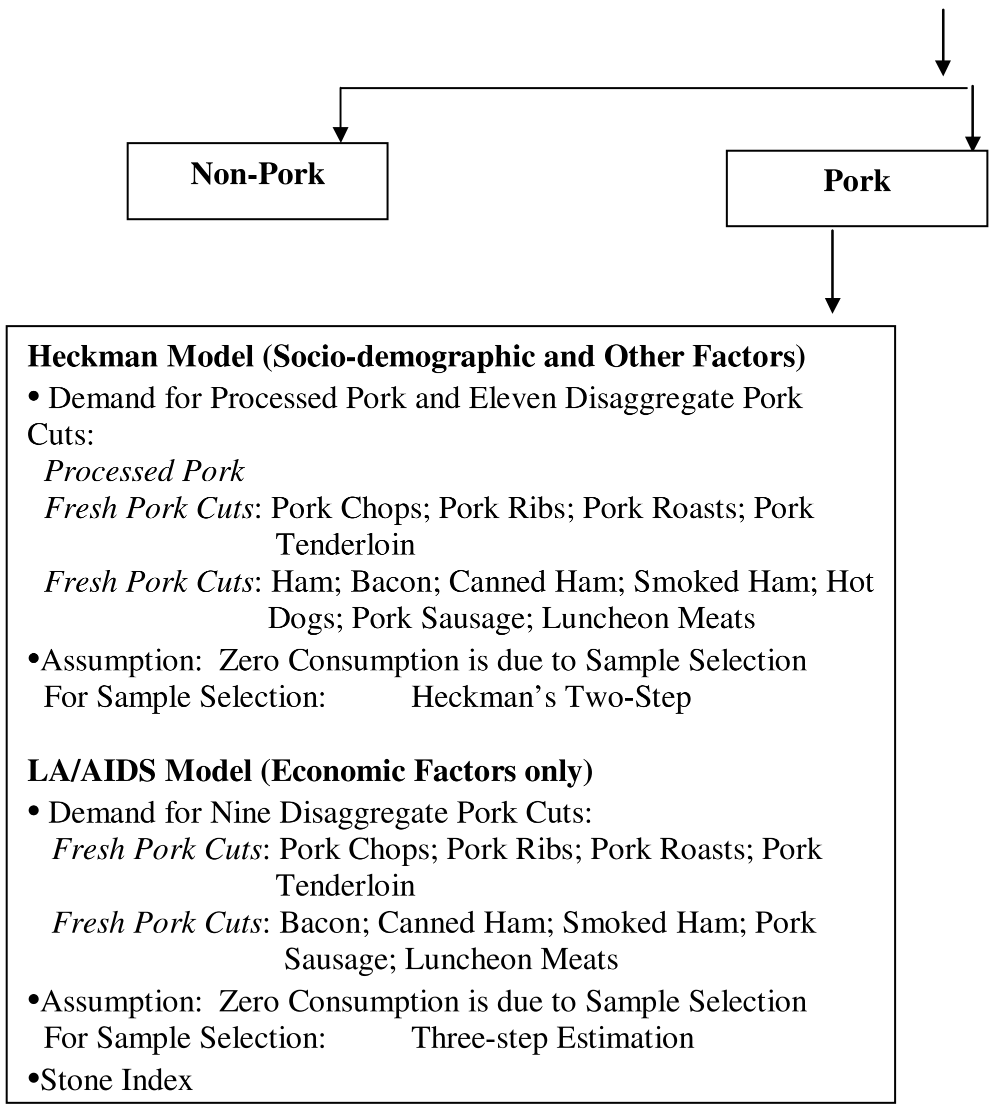


Figure 1. Continued

study. Heckman sample selection models are used to find out the key socio-demographic, attitudinal/lifestyle, and health factors affecting the decision to eat and actual intake of the sixteen selected products. Three unique data sets are used in this research: (1) NPD data (intake and socio-demographic information on individuals); (2) Information Resources, Inc. (IRI) data (weekly price information on fresh pork, beef, chicken, and seafood); and (3) A.C. Nielsen data (weekly price information on processed pork).

All sixteen Heckman sample selection models are estimated based on NPD data. The NPD data cover a six-year period from March 1996 to February 2002. The first step is to clean and reorganize these data to fit the needs of this research.

Then, we present a discussion of the descriptive statistics of the discrete and continuous variables extracted from the NPD data. The discrete variables concern whether or not a specific product is consumed, season, diet status, ethnicity of individual, gender of individual, employment of female head, education of female head, age of individual, body mass index of individual, market size, race, household size, presence of children under 18 in the household, region, and the responses to the eight attitudes/lifestyles questions from September Nutritional Quiz. The continuous variables correspond to the volume of the selected product consumed and income of household. Penetration numbers for a specific product are calculated by dividing the number of individuals who ate the corresponding product by the total number of individuals.

Intake data however, contain large number of zeros for all sixteen products (see Table 2). Given that the volume of intake used in the single-equation models represents two-week consumption, we assume these zeros are primarily due to non-preference. We therefore, focus on a two-stage decision process: (1) to eat or not to eat (selection stage) and (2) how much to eat (intake stage). Heckman's (1976) two-step sample selection procedure is applied to fit the models. For each of the sixteen commodities, three sets of determinants are investigated: (1) drivers affecting the decision to eat the selected products at home; (2) factors affecting the volume of selected products for all individuals; and (3) factors affecting the volume of selected products for eaters.

Table 2. Percentage of Individuals with Zero Consumption Levels over a Two-Week Period

Intake Variables	% of Zeros	Intake Variables	% of Zeros
Aggregate Fresh Products		*Processed Pork Cuts*	
Fresh Pork	**59.02%**	**Processed Pork**	**15.39%**
Fresh Beef	**20.34%**	**Bacon**	**69.20%**
Fresh Chicken	**27.30%**	**Pork Sausage**	**64.08%**
Fresh Seafood	**67.02%**	**Smoked Ham**	**83.54%**
		Canned Ham	**96.73%**
Fresh Pork Cuts		**Pork Lunchmeat**	**74.06%**
Pork Chops	**73.61%**	**Ham**	**49.01%**
Pork Ribs	**94.39%**	**Pork Hotdogs**	**76.55%**
Pork Roasts	**95.34%**		
Pork Tenderloin	**96.98%**		

Source: NPD March 1996 to February 2002

Further, we validate the results of Heckman sample selection models by way of out-of-sample forecasts. For this purpose, the data are separated into in-sample and out-of-sample components. The out-of- sample portion consists of randomly selected observations equal to 20% of the entire data set (to give each observation an equal chance of being selected, the selection process is based on a uniform distribution). Validation of the models is based on evaluating the predictive power of the models (estimated using in-sample data) on the out-of-sample data. We applied the following methods to validate the Heckman model. First, prediction success tables and comparison of average predicted probabilities of eating and average actual probabilities of eating of the selected products are used to validate the selection stage of the Heckman models. Second, comparison of average predicted volumes of intake and average actual volumes of intake of the selected products is used to certify the predictive power of the intake stage of the Heckman models.

Selectivity-adjusted censored LA/AIDS models are used to investigate the price relationships between pork with other fresh meats (beef, chicken, and seafood) and among nine pork cuts (pork chops, pork ribs, pork roasts, pork tenderloin, bacon, pork sausage, smoked ham, canned ham, and lunchmeat). Each of these models is estimated using a separate data created through mergers of three available data sets (NPD, IRI, and A.C. Nielsen). First, we cleaned and reorganized the NPD NET data by following the same procedure used for data preparation in the Heckman models. In this case however, the intake values are aggregated based on a weekly basis (instead of a two-week basis as was the case with the Heckman models) in order to exactly match price information from IRI and A.C. Nielsen. Then, NPD data were joined with the price information from IRI to study the price and expenditure effects within the fresh-meat group (pork, beef, chicken, and seafood). Further, NPD data were merged with the price information from

IRI, and A.C. Nielsen to investigate the price and expenditure effects among nine pork cuts, both fresh and processed.

We develop a three-step sample selection procedure to adjust for selectivity and censoring in a LA/AIDS models. Our procedure can be considered an extension of Shonkwiler and Yen's (1999) two-step procedure. The extension comes when we additionally adjust for missing observations of the budget share variables inherent in the LA/AIDS model.

Heckman Type Econometric Models with Zero Consumption Focusing on the Effect of Socio-demographic, Health, and Attitudinal Factors

This part of the study directly serves the needs of the first two objectives of the dissertation. Heckman sample selection models are used to analyze the socio-demographic, health, and attitudinal factors affecting the decision to eat and the actual at-home intake of the sixteen selected fresh and processed products. The fresh products are fresh pork, fresh beef, fresh chicken, fresh seafood, pork chops, pork ribs, and pork tenderloin. The processed products are processed pork, bacon, ham, canned ham, smoked ham, pork hotdogs, lunchmeat, and pork sausage. The NET data covering the six-year period from March 1996 to February 2002 are used in the Heckman models. The unit of observation in these models is a representative individual over 18 years of age. The total number of individuals in this analysis is about 17,600.

Zero levels of consumption are common in micro-level data (Park and Capps) and our study is not an exception. The NPD NET data we use contain large number of zeros for all sixteen products (see Table 2). Cheng and Capps mention that the reasons for non-consumption might be nonpreference, inventory effects, price effects, or the duration of the survey period. They suggest that the longer the period of survey, the higher the chance of revealing nonpreference toward a particular commodity. The fact that our data correspond to a two-week period allows us to assume that these zeros are primarily due to nonpreference. Not adjusting for sample selection may result in biased estimates of the demand parameters (Heckman (1976)).

Tobit, double-hurdle, and Heckman sample selection models are designed to deal with zero consumption. All these procedures are designed to model a two-stage decision process. The first stage (selection stage) models the decision to eat and the second stage (intake stage) models the decision about how much to eat. Double-hurdle and Tobit models may be used for corner solution problems. Park and Capps mention that this situation may arise from inventory effects, price effects, or the short length of the survey period. For example, individuals may not purchase pork, because they have some quantity of this product still waiting for consumption in their refrigerators. Also, zero purchase can be observed in situations when individuals face higher prices for pork than they are willing and able to pay for.

Further, many individuals may not have happened to eat pork during the survey period but these individuals prefer pork in general. Heckman sample selection model does not distinguish between nonpreference and corner solution.

There are two major estimation procedures facilitating Heckman-type correction: (1) Heckman's (1976, 1979) two-step procedure and (2) the full-information maximum likelihood estimator (Amemiya). Shonkwiler and Yen warn about relative inefficiency of two-step models compared to maximum likelihood procedures. Puhani however, recommended using Heckman's two-step procedure over the full-information maximum likelihood estimator under strong collinearity conditions. Puhani noted that strong collinearity is expected in models with a large number of same variables involved in both stages. Many of our socio-demographic factors appear in both the selection and intake stages of the two-stage decision model.

Hence, the two-step Heckman-type correction for zero consumption is preferred in our models. The two-step Heckman sample selection procedure adjusting for zero intakes is basically the single-equation version of Shonkwiler and Yen's (1999) procedure facilitating zero consumption in demand systems. This two-stage estimation technique requires two measures of products consumed: *the decision to eat the product in a two-week period* (in the selection stage) and *the two-week individual intake of product in grams* (in the intake stage).

Selection Stage: To Eat or Not to Eat

The selection stage of the two-stage Heckman sample selection procedure models the decision to eat or not to eat the selected product.

(1) $$y_{1k}^{*} = \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1} + \varepsilon_{1k} \qquad \textit{latent selection equation}$$

where y_{1k}^{*} represents a latent selection variable, x_{1k} is a vector of explanatory variables in the latent selection equation, β_1 is a vector of parameters in the latent selection equation, ε_{1k} represents the error term, and $k = 1, 2, ..., T$ is the number of observations in the sample. A binary variable are observed depending on the latent dependent variable being greater than zero or not.

(2) $$y_{1k} = \begin{cases} 1 & \text{if} \quad y_{1k}^{*} > 0 \\ 0 & \text{if} \quad y_{1k}^{*} \leq 0 \end{cases}$$ *selection equation*

The selection stage is estimated using a qualitative choice probit model (Heckman (1976)). The normal cumulative distribution (cdf) and the normal probability density (pdf) function are calculated in this stage and used to adjust for the sample selection (zero consumption) in the intake stage.

Intake Stage: Adjustment for Sample Selection

We use the results of the selection stage to adjust for zero consumption in the intake stage. The general framework of the intake stage is given by

(3) $$y_{2k}^{*} = \boldsymbol{x}_{2k}^{'}\boldsymbol{\beta}_{2} + \varepsilon_{2k}$$ *latent equation*

where y_{2k}^{*} is the latent intake variable, x_{2k} is a vector of explanatory variables in the latent intake equation, β_2 is a vector of parameters in the latent intake equation, ε_{2k} represents the error term, and $k = 1, 2, ..., T$ is the number of observations in the sample. We observe two types of measures for the dependent variables: (1) continuous values of intake are observed if an individual selects to consume the product and (2) zeros are observed if an individual does not prefer to eat the corresponding product. We also observe their corresponding probabilities of selecting the product or not selecting the product. This decision process can be presented by the following system:

$$(4) \qquad y_{2k} = \begin{cases} y_{2k}^{*} & \text{if} \quad y_{1k} = 1: \qquad \Pr ob(y_{1k} = 1\ ) \\ 0 & \text{if} \quad y_{1k} = 0: \qquad \Pr ob(y_{1k} = 0\ ) \end{cases}$$

where $corr(\varepsilon_{1k}, \varepsilon_{2k}) = \rho$. As discussed in the first stage, $\Pr ob(y_{1k} = 1\ )$ represents the probability of consuming the selected product and $\Pr ob(y_{1k} = 0\ )$ represents the probability of not consuming the selected product.

When $\rho = 0$, OLS regression provides unbiased estimates, when $\rho \neq 0$ the OLS estimates are biased (Heckman (1976)). The unbiased unconditional expectation of the consumption is

$$(5) \qquad E\left[y_{2k} \right] = \Phi\left(y_{1k} = 1 \right) * E\left[y_{2k} \mid y_{1k} = 1 \right] + \Phi\left(y_{1k} = 0 \right) * E\left[y_{2k} \mid y_{1k} = 0 \right].$$

where $\Phi\left(y_{1k} = 1 \right) \equiv \text{Prob}\left(y_{1k} = 1 \right)$, $\Phi\left(y_{1k} = 0 \right) \equiv \text{Prob}\left(y_{1k} = 0 \right)$. The expected value of y_{2k} conditional on $y_{1k} = 1$ is given by

$$(6) \qquad E\left[y_{2k} \mid y_{1k} = 1 \right] = \boldsymbol{x}_{2k}^{'} \beta_2 + \sigma_{\varepsilon_{1k}\varepsilon_{2k}} * \lambda_k$$

where $\lambda_k = \dfrac{\phi\left(y_{1k} = 1 \right)}{\Phi\left(y_{1k} = 1 \right)}$ is the Mills ratio (Heckman (1976)), $\sigma_{\varepsilon_{1k}\varepsilon_{2k}}$ is the parameter associated with the Mills ratio. It is critical to note that $E\left[y_{2k} \mid y_{1k} = 0 \right]$, the expected value of y_{2k} conditional on $y_{1k} = 0$, in our case is equal to zero, because nonparticipation means zero consumption of a good. As Shonkwiler and Yen presented, the final equation of the unconditional expectation will be

$$(7) \qquad \begin{aligned} E\left[y_{2k} \right] &= \Phi\left(y_{1k} = 1 \right) * E\left[y_{2k} \mid y_{1k} = 1 \right] \\ &= \Phi\left(y_{1k} = 1 \right) * \boldsymbol{x}_{2k}^{'} \beta_2 + \sigma_{\varepsilon_{1k}\varepsilon_{2k}} * \phi\left(y_{1k} = 1 \right). \end{aligned}$$

There are two empirically equivalent procedures that one could use to calculate $E\left[y_{2k}\right]$. In the first case, one could estimate (6) first and then insert it into (7). In the second, case one could directly estimated (7) and then calculate (6). We, arbitrarily, applied the first procedure.

Selection Stage Focusing on Socio-demographic, Health, and Attitudinal Factors Affecting the Decision to Eat the Selected Products

Here, we discuss a procedure based on a qualitative choice probit model to analyze the key factors affecting the selection stage of the two-step Heckman sample selection procedure. Each variable is scored one if consumption of the corresponding product occurred and scored zero if no consumption was registered in the 14-day period.

Long and Freese present a detailed discussion of the probit models. The probit model (as well as the logit model) is based on the following general framework of index function

(8) $$P(y=1 \mid x) = G(x\beta)$$

The probit model is a special case of equation (8) with

(9) $$G(x\beta) \equiv \Phi(x\beta) \equiv \int_{-\infty}^{x\beta} \phi(v)d(v)$$

where $\phi(\chi\beta)$ is the standard normal density

(10) $$\phi(xb) = (2\pi)^{-1/2} \exp(-(xb)^2/2)$$

The calculation of marginal effect of the kth factor is based on the following formula

$$\frac{\partial p(x)}{\partial x_k} = \frac{dG(x\beta)}{d(x\beta)}\beta_k$$

If the x_k is a binary explanatory variable, then the partial effect from changing x_k from zero to one, holding all other variable constant, is

$$\Phi(\beta_1 + \beta_2 x_2 + \cdots + \beta_{k-1}x_{k-1} + \beta_k) - \Phi(\beta_1 + \beta_2 x_2 + \cdots + \beta_{k-1}x_{k-1})$$

The estimation of the probit models is based on the following log-likelihood function

$$L = \sum_{k \in S} \ln\left\{\Phi\left(\boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_l\right)\right\} + \sum_{k \notin S} \ln\left\{1 - \Phi\left(\boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_l\right)\right\}. \quad (11)$$

One variable from each group of dummy variables is eliminated for estimation purposes so as to avoid the "dummy variable" trap. The reference or base categories are as follows: spring (spring); on a doctor prescribed diet (presdiet); have acceptable BMI index (bmiaccept); non-Hispanic (Hispanic = 0); male (femaleet = 0); the eater is between the ages of 30 and 39 (age30_39); belong to a household wherein the female head works 35 hours or more a week (o35uphrs); belong to a household wherein the female head has at most a high school education (somehs); reside in a non SMSA area (SMSA = 0); white (white); live in the New England region (neweng); belong to a two-member household (memb_2); and do not have children under 18.

This therefore leads to the following model:

$$\begin{aligned} Y_k = F(&\alpha_k + \beta_1 \mathit{income}_k + \beta_2 \mathit{inc\_2}_k + \beta_3 \mathit{Hispanic}_k + \beta_4 \mathit{summer}_k + \beta_5 \mathit{fall}_k \\ &+ \beta_6 \mathit{winter}_k + \beta_7 \mathit{femaleet}_k + \beta_8 \mathit{u35hrs}_k + \beta_9 \mathit{nefp}_k + \beta_{10} \mathit{somecol}_k \\ &+ \beta_{11} \mathit{postgcol}_k + \beta_{12} \mathit{smsa}_k + \beta_{13} \mathit{black}_k + \beta_{14} \mathit{Oriental}_k + \beta_{15} \mathit{other}_k \\ &+ \beta_{16} \mathit{midatl}_k + \beta_{17} \mathit{enc}_k + \beta_{18} \mathit{wnc}_k + \beta_{19} \mathit{satl}_k + \beta_{20} \mathit{esc}_k + \beta_{21} \mathit{wsc}_k + \beta_{22} \mathit{mount}_k \\ &+ \beta_{23} \mathit{pacific}_k + \beta_{24} \mathit{dietchc}_k + \beta_{25} \mathit{nodiet}_k + \beta_{26} \mathit{chk\_labels}_k + \beta_{27} \mathit{plan\_meals}_k \\ &+ \beta_{28} \mathit{cholest}_k + \beta_{29} \mathit{additives}_k + \beta_{30} \mathit{fat}_k + \beta_{31} \mathit{salt}_k + \beta_{32} \mathit{preserv}_k \\ &+ \beta_{33} \mathit{good\_taste}_k + \beta_{34} \mathit{age18\_24}_k + \beta_{35} \mathit{age25\_29}_k + \beta_{36} \mathit{age40\_49}_k \\ &+ \beta_{37} \mathit{age50\_59}_k + \beta_{38} \mathit{age60\_64}_k + \beta_{39} \mathit{age65up}_k + \beta_{40} \mathit{nochun18}_k \\ &+ \beta_{41} \mathit{memb\_1}_k + \beta_{42} \mathit{memb\_3up}_k + \beta_{43} \mathit{bmilow}_k + \beta_{44} \mathit{bmihigh}_k) \end{aligned} \quad (12)$$

where $k = 1,...,T$ is the number of observations in the model. Y_k corresponds to the decision to eat the selected product. The dependent variable is one of the following: psprk; fshpk; chfsh; bffsh; sffsh; pkch; pkrb; pkrst; pkltd; smkh; canh; ham; pkhtd; bacon; sausg; and lchmt. Variable names and definitions are exhibited In Table A.1 in Appendix A.

Marginal effects associated with each variable also are calculated. The only marginal effects discussed are those which have significant coefficients. For all statistical analysis the level of significance chosen is 0.05. Finally, the models are validated measuring their ability to forecast out of sample.

Focusing on Socio-demographic Factors in the Intake Stage

The second stage models the effects of the socio-demographic factors (except the presence of children under 18) and seasonality on the volume of consumption of the sixteen selected products. The dependent variables represent volumes of intakes per two-weeks. The second stage basically corresponds to ordinary least squares (OLS) estimation with an additional adjustment for sample selection using information from the selection stage.

In the intake stage, we also eliminate one variable from each group of dummy variables for the estimation purposes. In this stage, the reference categories are the following: spring (spring); not Hispanic (Hispanic = 0); male (femaleet = 0); the eater is between the ages of 30 and 39 (age30_39); reside in a non SMSA area (SMSA = 0);

white (white); reside in the New England region (neweng); belong to a two-member household (memb_2). The second stage model may be mathematically represented as:

$$
\begin{aligned}
(13)\quad Y_k = {} & \alpha_k + \beta_1 income_k + \beta_2 inc\_2_k + \beta_3 Hispanic_k + \beta_4 summer_k + \beta_5 fall_k + \beta_6 winter_k \\
& + \beta_7 femaleet_k + \beta_8 smsa_k + \beta_9 black_k + \beta_{10} Oriental_k + \beta_{11} other_k + \beta_{12} midatl_k \\
& + \beta_{13} enc_k + \beta_{14} wnc_k + \beta_{15} satl_k + \beta_{16} esc_k + \beta_{17} wsc_k + \beta_{18} mount_k + \beta_{19} pacific_k \\
& + \beta_{20} age18\_24_k + \beta_{21} age25\_29_k + \beta_{22} age40\_49_k + \beta_{23} age50\_59_k \\
& + \beta_{24} age60\_64_k + \beta_{25} age65up_k + \beta_{26} memb\_1_k + \beta_{27} memb\_3up_k \\
& + \beta_{28} m\_ratio_k
\end{aligned}
$$

where $k = 1,...,T$ is the number of observations in the model. Y_k corresponds to the volume of intake of the selected product. The dependent variable in this case is one of the following: psprkvol; fshpkvol; chfshvol; bffshvol; sffshvol; pkchvol; pkrbvol; pkrstvol; pkltdvol; smkhamvol; canhamvol; hamvol; pkhtdvol; baconvol; sausgvol; and lchmtvol. Variable names and definitions are exhibited In Table A.1 in Appendix A.

Similar to the selection stage, the importance of a particular variable is judged based on statistical significance of the estimated parameters. Conditional and unconditional marginal effects associated with each variable are calculated using the information from both stages. The calculation of marginal effects conditional on consuming the selected product is well documented by Byrne, Capps, and Saha and by Saha, Capps, and Byrne. The authors were the first to take into account the marginal effect associated with the inverse Mills ratio. The expression of the conditional marginal effect for single-equation demand models was based on Heckman's proposed formula for conditional expectation (Heckman (1976)).

The expression of the conditional marginal effect for demand systems was based on Hein and Wessells procedure, which is based on two steps. In the first step, each equation in the system is augmented by a selectivity regressor derived from probit estimates. In the second step, the system of equations is estimated with seemingly unrelated regression (SUR). Since their inception, the Byrne, Capps, and Saha expressions for the marginal effects have been extensively used. Shonkwiler and Yen however, demonstrated that there is an internal inconsistency in the Hein and Wessells model. Based on the results of Lee (1993) and Wales and Woodland, Shonkwiler and Yen proposed a consistent two-step estimation procedure to deal with censored demand systems. Vermeulen completely buried the Hein and Wessells procedure by proving it to be wrong. However, neither Shonkwiler and Yen nor Vermeulen presented an updated expression for the unconditional marginal effect. In the models with zero expenditure (or consumption), the calculation of the unconditional marginal effects should come directly from the formula of the unconditional expectation described by Shonkwiler and Yen.

However, the calculation of the unconditional marginal effects is based on extending their work. We have derived the exact formula for the unconditional marginal effect given that the *j*th regressor is common to both selection and consumption stages. Let X_{jk} denote the *j*th regressor that is common to the first stage variables $\left(X_1\right)$ and to the second stage variables $\left(X_2\right)$. The correct expression of the marginal effect (ME) conditional on consuming the good proposed by Byrne, Capps, and Saha and Saha, Capps, and Byrne is as follows:

$$\hat{ME}_{kj} = \hat{\beta}_{2j} - \hat{\sigma}_{\varepsilon_{1k}\varepsilon_{2k}}\hat{\beta}_{1j}\left\{X_{1k}^{'}\hat{\beta}_1\hat{\lambda}_k + \left(\hat{\lambda}_k\right)^2\right\}$$

The authors also offered an indirect way of getting the expression of the unconditional marginal effect. They proposed to take the weighted average of the marginal effect of expectation conditional consuming product and the marginal effect of expectation conditional not consuming product. The exact expression of the unconditional marginal effect however, can be calculated directly based on (7) as follows.

(14)

$$\hat{ME}_{kj}^{\text{unconditional}} = \frac{\partial E[y_{2k}]}{\partial x_j} = \frac{\partial\left(X_{2k}'\hat{\beta}_2 \cdot \Phi\left(X_{1k}'\hat{\beta}_1\right) + \hat{\sigma}_{\varepsilon_{1k}\varepsilon_{2k}}\phi\left(X_{1k}'\hat{\beta}_1\right)\right)}{\partial x_j}$$

$$= \frac{\partial\left(X_{2k}'\hat{\beta}_2 \cdot \Phi\left(X_{1k}'\hat{\beta}_1\right)\right)}{\partial x_j} + \hat{\sigma}_{\varepsilon_{1k}\varepsilon_{2k}} \cdot \frac{\partial\phi\left(X_{1k}'\hat{\beta}_1\right)}{\partial x_j}$$

$$= \phi\left(X_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{1j} \cdot X_{2k}'\hat{\beta}_2 + \Phi\left(X_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{2j} + \hat{\sigma}_{\varepsilon_{1k}\varepsilon_{2k}} \cdot X_1'\hat{\beta}_1 \cdot \phi\left(X_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{1j}$$

$$= \phi\left(X_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{1j} \cdot \left(X_{2k}'\hat{\beta}_2 + X_1'\hat{\beta}_1 \cdot \hat{\sigma}_{\varepsilon_{1k}\varepsilon_{2k}}\right) + \Phi\left(X_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{2j}.$$

The estimated value of the unconditional marginal effect at the sample means therefore, should be

(15)

$$\hat{ME}_{j}^{\text{unconditional}} \Big|_{\text{sample mean}} = \phi\left(\bar{X}_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{1j} \cdot \left(\bar{X}_{2k}'\hat{\beta}_2 + \bar{X}_1'\hat{\beta}_1 \cdot \hat{\sigma}_{\varepsilon_{1k}\varepsilon_{2k}}\right) + \Phi\left(\bar{X}_1'\hat{\beta}_1\right) \cdot \hat{\beta}_{2j}$$

One could easily decompose the unconditional marginal effect following the reasoning applied by McDonald and Moffitt

(16)

$$\hat{ME}_{kj}^{\text{unconditional}} = \frac{\partial E[y_{2k}]}{\partial x_j} = \frac{\partial \Phi(y_{1k}=1)}{\partial x_j} * E\left[y_{2k} \mid y_{1k}=1\right] + \Phi(y_{1k}=1) * \frac{\partial E\left[y_{2k} \mid y_{1k}=1\right]}{\partial x_j}.$$

We do not present a separate discussion of the decomposed effects. If needed, they can be easily calculated using (16).

Demand System Analysis — Selectivity-Adjusted Censored LA/AIDS Model

This part of the study serves the needs of the fourth and fifth objectives of the dissertation. We assumed that aggregate fresh meats (pork, beef, chicken and seafood) as well as fresh and processed pork products are separable groups. Here, we analyze the effects of prices and total expenditure on the selected products. In this research we developed a three-step procedure to adjust for selectivity and censoring in the LA/AIDS model.

The need for selectivity adjustment comes from the fact that a large number of individuals did not eat any product from the commodity group and, therefore, had zero values of total expenditure. The values for the budget shares do not exist (DNE) for zero total group expenditure, which means that these observations could not be included in the LA/AIDS model. Further, within the LA/AIDS system there are many observations of the dependent variables (budget shares) with zero values. This situation is due to the fact that many individuals preferred to consume at least one product from the category, but did not prefer to eat specific product(s) from the group. For example, an individual may have consumed fresh pork from the "fresh meats" group, but did not prefer to eat fresh seafood during the corresponding one-week period.

There are two LA/AIDS models estimated in this study. The first model analyzes price and expenditure effects on the intake within the fresh meat category covering fresh pork, fresh beef, fresh chicken, and fresh seafood. IRI data are merged with NPD NET data with the common time frame running from January 1998 to December 2001. A second model examines price and expenditure effects on the intake within the fresh and processed pork group, which includes roasts, chops, ribs, tenderloin, bacon, sausage, smoked ham, canned ham, and lunchmeat. All three data (NPD NET, IRI, and A.C. Nielsen) are joined together and cover the period from April 1999 to December 2001. In both models, the intake variables are represented in kg of intake in a one-week period. As mentioned previously, the individual intake variables (from NPD NET data) represented two-week consumption in grams. Hence, the two-week intake was decomposed into two one-week intakes resulting in a situation where each individual was represented by two observations. Further, we changed the metric of intake from grams per one-week to kg per one-week. We also transformed the measure of prices from $ per pound to $ per kilogram.

The general framework of calculating own-price, cross-price and expenditure elasticities are based on the formulas provided by Green and Alston. All elasticity estimates are evaluated at the sample means.

In the literature different procedures have been developed to deal with censored demand systems (i.e., demand systems involving zero budget shares), but no study considered an adjustment for DNE values of the budget share variable. These studies, described thoroughly by Yen, Lin, and Smallwood, can be broadly grouped into four categories. The first group includes the procedures developed by Amemyia (1974); Wales and Woodland (1983); Lee and Pitt (1986, 1987); and Lee (1993). Amemyia (1974) developed a full-information maximum likelihood estimation procedure to handle the censoring problem. Wales and Woodland (1983) built the likelihood function from the Kuhn-Tucker conditions of constrained maximization of a stochastic direct utility function. Lee and Pitt (1986, 1987), and Lee (1993) proposed a dual approach to Wales and Woodland's (1983) procedure. The common factor for those procedures is that all of them are based on the incorporation of multiple probability integrals in the likelihood function.

The second group of procedures produces consistent estimators based on two-step or multi-step estimation of a censored demand system. Hein and Wessells with their two-step censored-system estimator, Shonkwiler and Yen with their estimator based on probit estimation in the first stage and a selectivity-adjusted equation system in the second stage, and Perali and Chavas with their multi-step procedure belong to the second group.

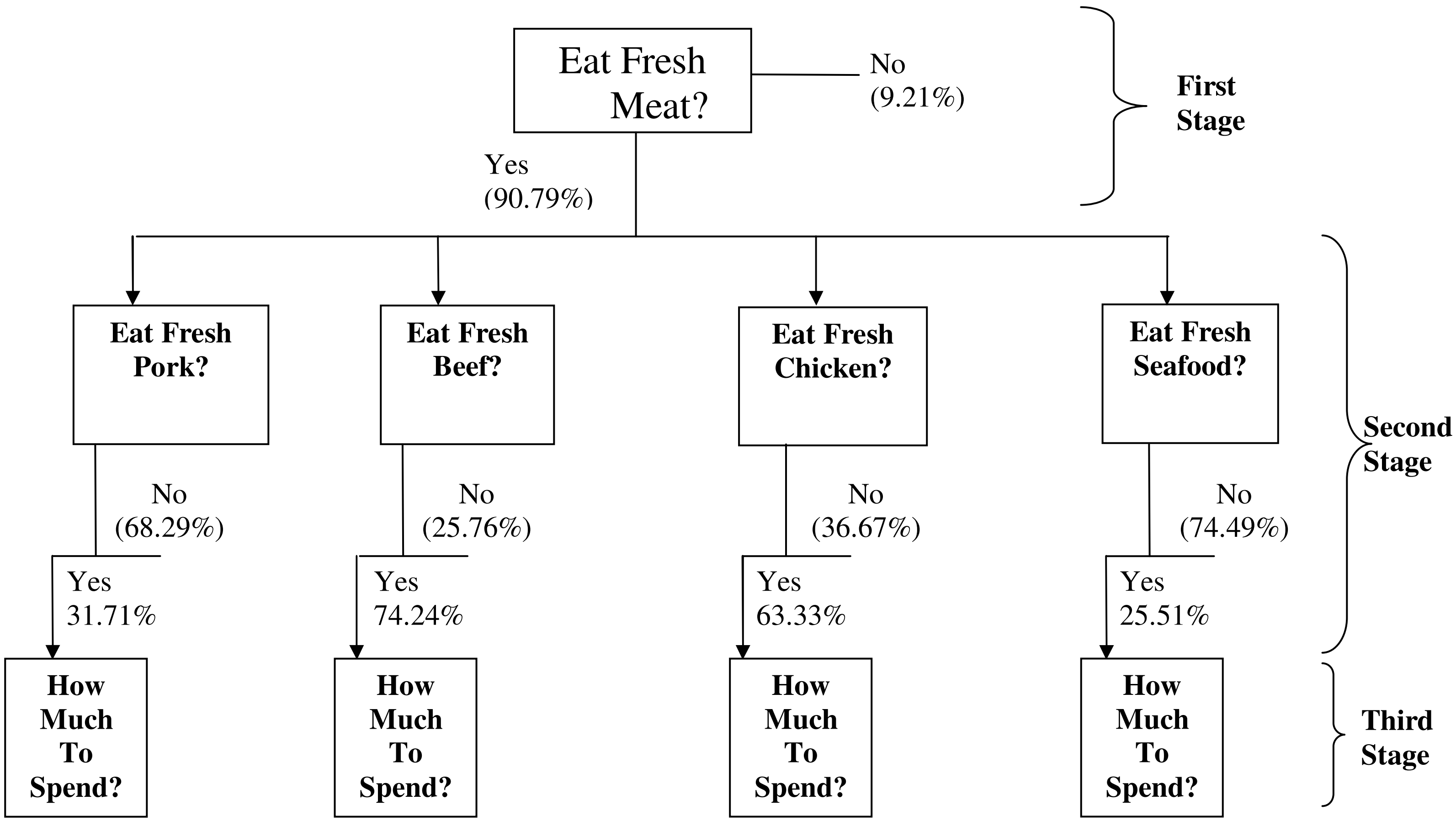
The third group of procedures, known as the simulated-maximum-likelihood (SML) techniques, were developed by Börch-Supan and Hajivassiliou, Geweke, and Keane. These methods are based on the simulation of the multivariate normal probabilities. An application of this approach is given in Kao, Lee, and Pitt.

The fourth group, known as quasi-maximum-likelihood methods (QML), was initiated by Avery, Hansen, and Hotz; and Avery and Hotz in the context of a multivariate probit model. These procedures are based on the approximation of the multivariate likelihood function with a sequence of bivariate specifications. Harris and Shonkwiler and Yen and Lin have used the QML approach in the estimation of a censored linear single-equation model. Yen, Lin, and Smallwood proposed and applied the QML approach to a censored Translog demand system for foods, using a sample of food stamp recipients in the United States. They found that the QML procedure produces remarkably close parameter and elasticity estimates to those of SML procedure. A two-step procedure also was considered but that procedure produced different elasticities from the QML method.

All these procedures were designed to estimate censored demand systems. None of these studies, however, addresses the sample selection problem when LA/AIDS model is applied to samples with large number of observations with zero total expenditure. The functional form of both the AIDS and the LA/AIDS models express total expenditure as a denominator in the calculation of the average budget shares. The average budget share is DNE for the zero values of total expenditure. Intuition suggests that the more disaggregate the group of products under investigation the higher the number of such observations. Our data sets show that the percentage of zero at-home total expenditure observations measured over a 7-day period among U.S. consumers above 18 years of age is about four times higher for the pork group (36.60%) compared to that of fresh meat group (9.21%) (see Figures 2 and 3). The LA/AIDS model is forced to be conditional on positive total expenditure. To prevent biased estimates, there must be an additional adjustment for sample selection (Heckman (1976)). A three-step procedure correcting for the censored demand system and sample selectivity is introduced in this study. This model is based on the ideas of Heckman (1976, 1977) and Shonkwiler and Yen (1991). It was demonstrated by Hartley and later demonstrated by Wales and Woodland that these estimators are lacking in efficiency. In this situation, one could create maximum likelihood (ML) estimators of the model parameters, which indeed might outperform this three-step procedure. However, our model estimation technique can be invaluable, because as Shonkwiler and Yen said, "direct ML estimation remains complicated for most empirical practitioners". Taking into account the immense popularity of the LA/AIDS model, this study makes a methodological contribution to econometrics by addressing this type of sample selection problem and providing a simple procedure for correction.

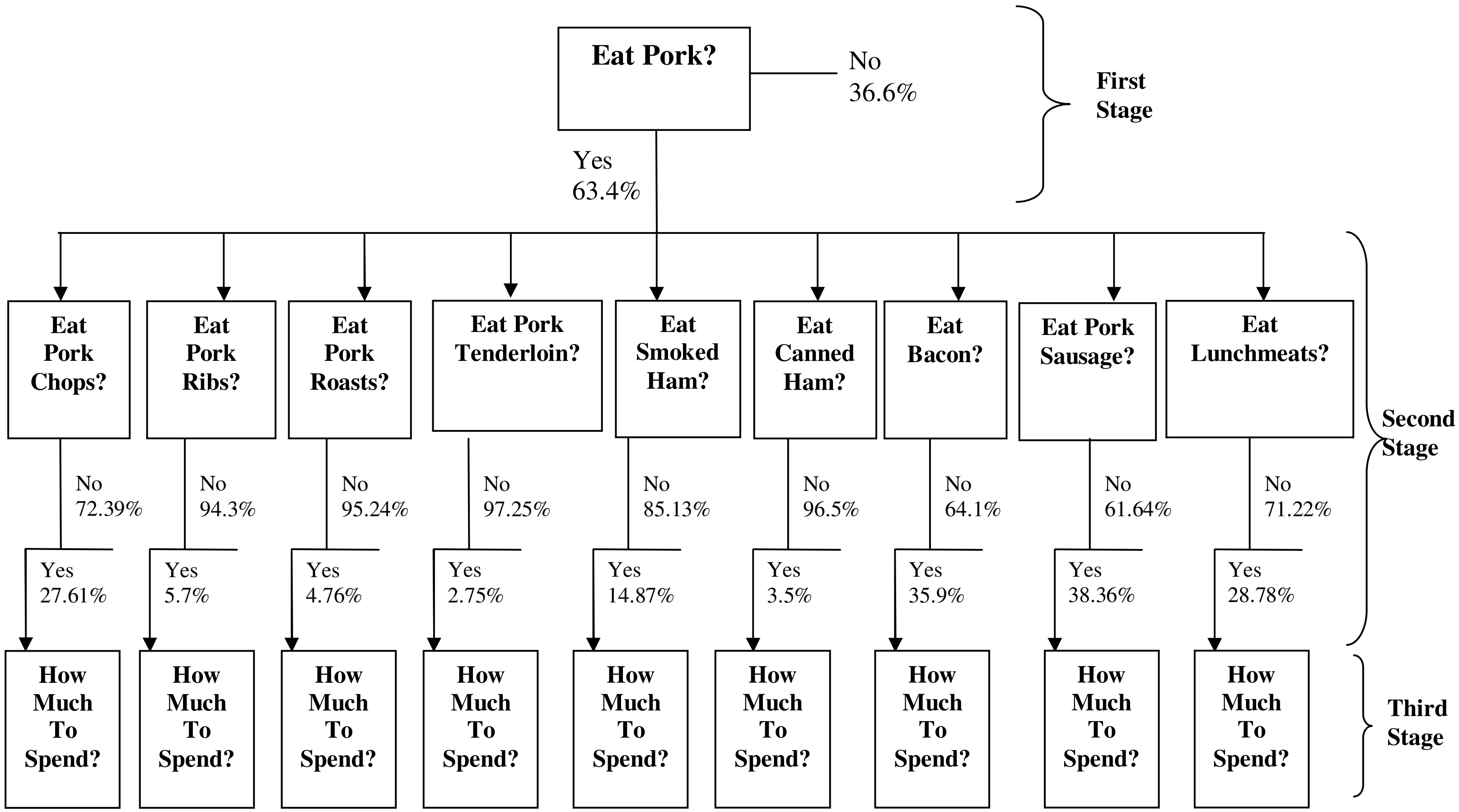
Moreover, our three-step procedure correcting for sample-selectivity and censoring can easily be applied to any demand system where the budget shares are acting as dependent variables. This contention means that the Rotterdam model, the CBS model, and the NBR model can be corrected for sample-selectivity and censoring through this three-step procedure.

In the next section we present the Almost Ideal Demand System (AIDS) model of Deaton and Muellbauer (1980a,b). We provide a detailed explanation of inability of this model to incorporate observations with zero total expenditure. Then, we provide a formal discussion of the inability of the two-step procedures (using the example of Shonkwiler and Yen) to correct for this situation. At the end, we present a three-step procedure to correct for sample selection and censoring in the linear approximate AIDS model.



Note: The percentages presented in the second section are conditional positive decision for eating at-home fresh meats.

Figure 2. Three-stage decision tree of the consumption of four at-home fresh meat products



Note: The percentages presented in the second section are conditional positive decision for eating at-home pork.

Figure 3. Three-stage decision tree of the consumption of nine at-home pork cuts

Complete Demand System

The AIDS model of Deaton and Muellbauer (1980a,b) has been very popular in applied demand analysis. It is derived from a specific cost function and consists of the share equations in an n-good system given by

(17) $$w_{ik} = \alpha_i + \sum_i \gamma_{ij} \ln p_{jk} + B_i \ln\left(y_k / P_k \right) + \varepsilon_{ik} ,$$

where

$k = 1, 2, ..., T$ is the number of observations
$i = 1, ..., N$ is the number goods in the system

y is the total expenditure on the system of goods given by $y_k = \sum_i p_{ik} q_{ik}$. P_k is the price index for the group is defined as

(18) $$\ln P_k = \alpha_0 + \sum_j \alpha_j \ln p_{jk} + \frac{1}{2} \sum_j \sum_i \gamma_{ij} \ln p_{ik} \ln p_{jk} ,$$

w_{ik} is the average budget share of associated with the good i given by

(19) $$w_{ik} = \frac{p_{ik} q_{ik}}{y_k} ,$$

α_i is the constant coefficient in the share equation i, γ_{ij} is the slope coefficient associated with good j in the share equation i, p_{jk} is the price on good j, and q_{ik} is the quantity consumed of the good i. The model implies non-linear Engel curves and automatically satisfies the adding-up restriction. Moreover, homogeneity and symmetry can be imposed through simple parametric restrictions. However, the fact that the price index is not linear in parameters makes the AIDS model difficult to estimate. Deaton and

Muellbauer (1980a) also suggested a linear approximation of the nonlinear AIDS model by replacing P_k with Stone's price index (P_k^*):

(19) $$\ln(P_k^*) = \sum_j w_{jk} \ln p_{jk} .$$

The model with Stone's index is known as linear approximate AIDS (LA/AIDS) (Blanciforti and Green) and is simple to estimate. Both models imply the following restrictions on the parameters:

(20) $$\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \gamma_{ij} = 0$$

Homogeneity is satisfied if and only if, for all i $\sum_{j=1}^{n} \gamma_{ij} = 0$, and symmetry is satisfied if and only if $\gamma_{ij} = \gamma_{ji}$.

As mentioned previously, the total expenditure, y_k, acts as a denominator in calculation of the average budget share (see equation 18). Consequently, only observations corresponding to non-zero total expenditures can be used in the empirical estimation of the AIDS model. That is, the AIDS model is designed to be conditional on total expenditure being positive. Having zero total expenditure is equivalent to not consuming any product from the group of goods. The expected value of the average budget share is, therefore, forced to be conditional on positive total expenditure, i.e. $E\left[w_{ik} \mid y_k > 0 \right]$. There must be an additional adjustment for sample selection. Not adjusting for this situation may render bias estimates (Heckman (1976)). Until now no known study to date has discussed and/or offered a correction for this kind of selection bias in models with the budget share acting as a dependent variable.

We developed a three-step procedure (using a three-stage decision process) to adjust for sample selectivity in this situation. Our three-step model is an extension of the two-step procedure, developed by Shonkwiler and Yen. We have discussed the single-equation version of it in investigating the effect of socio-demographic, health and attitudinal/lifestyle factors on the volume of intake. Next we formally show the limitation of the two-stage adjustment.

First (or Selection) Stage: Estimate Probit Models for Each Good

In the first stage Shonkwiler and Yen suggest estimating the probability of consuming each individual product in the system of goods through qualitative choice probit models. The qualitative choice models can be represented by this general form

$$y_{1ik}^{*} = \boldsymbol{x}_{1ik}^{'}\boldsymbol{\beta}_{1i} + \varepsilon_{1ik} \qquad \textit{latent selection equations}$$

where $i = 1,...,N$ is the number of goods in the system, and $k = 1,2,...,T$ is the number of observations in the sample, y_{1ik}^{*} represents a latent selection variable for good i, $\boldsymbol{x}_{1ik}$ is a vector of explanatory variables in the latent selection equation for good i, $\boldsymbol{\beta}_{1i}$ is a vector of parameters in the latent selection equation for good i, and the error term in the latent selection equation for good i has a standard normal distribution (i.e., ε_{1ik} ~N(0,1)).

Hence, we observe only

$$y_{1ik} = \begin{cases} 1 & \text{if} \quad y_{1ik}^{*} > 0 \\ 0 & \text{if} \quad y_{1ik}^{*} \le 0 \end{cases} \qquad \textit{probit selection equations}$$

The cumulative distribution function and the probability distribution function are calculated in this stage and further applied in the second stage.

Second (or Intake) Stage: Adjust for Zero Consumption in the System of Equations Model

$$y_{2ik}^{*} = \boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} + \varepsilon_{2ik} \qquad \textit{latent equations}$$

$$y_{2ik} = \begin{cases} y_{2ik}^{*} & \text{if} \quad y_{1ik} = 1: \quad \Pr ob(y_{1ik} = 1\ ) \\ 0 & \text{if} \quad y_{1ik} = 0: \quad \Pr ob(y_{1ik} = 0\ ) \end{cases} \qquad \textit{System of equations}$$

where $i = 1,...,N$ is the number of goods in the system, and $k = 1,2,...,T$ is the number of observations in the sample, y_{2ik}^{*} is the latent intake variable for good i, $\boldsymbol{x}_{2ik}$ is a vector of explanatory variables in the latent intake equation for good i, $\boldsymbol{\beta}_{2i}$ is a vector of parameters in the latent intake equation for good i, and ε_{2ik} represents the error term in the latent intake equation for good i.

The expectation of y_{2ik} conditional on $y_{1ik} = 1$ for the ith product is

$$E\left[\, y_{2ik} \mid y_{1ik} = 1 \right] = \boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} + \sigma_{\varepsilon_{1ik}\varepsilon_{2ik}} * \frac{\phi\left(y_{1ik} = 1\right)}{\Phi\left(y_{1ik} = 1\right)}$$

where $\Phi\left(y_{1ik} = 1\right) \equiv \text{Prob}\left(y_{1ik} = 1\right)$ is the cumulative distribution function (cdf) for good i, $\phi\left(y_{1ik} = 1\right)$ is the probability distribution function (pdf) for good i, $\dfrac{\phi\left(y_{1ik} = 1\right)}{\Phi\left(y_{1ik} = 1\right)}$ is the Mills ratio representing good i (Heckman (1976)), $\sigma_{\varepsilon_{1ik}\varepsilon_{2ik}}$ is the parameter associated with the Mills ratio for good i, and $E\left[y_{2ik} \mid y_{1ik}=1\right]$ is the expected value of y_{2ik} conditional on $y_{1ik}=1$. The expectation of y_{2ik} conditional on $y_{1ik}=0$ is $E\left[y_{2ik} \mid y_{1ik}=0\right]=0$, because nonparticipation is reflected in zero consumption of a good. Then, the unconditional expectation of the good i involved in Seemingly Unrelated Regressions is

(21)
$$\begin{aligned} E\left[y_{2ik}\right] &= \Phi\left(y_{1ik}=1\right) * E\left[y_{2ik} \mid y_{1ik}=1\right]+\Phi\left(y_{1ik}=0\right) * E\left[y_{2ik} \mid y_{1ik}=0\right] \\ &= \Phi\left(y_{1ik}=1\right) * \boldsymbol{x}_{2ik}^{'} \boldsymbol{\beta}_{2i}+\sigma_{\varepsilon_{1ik}\varepsilon_{2ik}} * \phi\left(y_{1ik}=1\right) \end{aligned}$$

where $\Phi\left(y_{1ik}=0\right) \equiv \operatorname{Prob}\left(y_{1ik}=0\right)$.

This model presumes that the same number of observations is present in both selection and intake stages. The AIDS model (and other demand systems with budget shares as dependent variables) however, forces out the observations with zero total expenditure. The estimation in the second stage therefore, is based on a smaller number of observations. This exclusion is a result of the self-selection of consumers. Adjustment for this situation is necessary so as to avoid the potential of inconsistent parameter estimates.

We discussed previously that the other procedures for correcting zero consumption in the demand systems also are incapable of adjusting for this type of sample selection. To adjust for zero total consumption and for the zero individual product consumption, we recommend an alternative three-step selection model (or three-stage decision process), which can be considered as an extension of the procedure described by Shonkwiler and Yen.

A Three-Step Procedure Adjusting for Selectivity and Censoring in the Demand Systems

To motivate our three-step procedure we start from the assumption that an individual (or a household) has a three-stage decision making process for consumption of a commodity belonging to the same group (for fresh meat group and pork group see Figures 2 and 3). The compact form of the model is give by

$$y_{1k}^{*} = \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{I} + \varepsilon_{1k}$$

$$y_{2ik}^{*} = \boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} + \varepsilon_{2ik}$$

$$w_{ik}^{*} = \boldsymbol{x}_{3ik}^{'}\boldsymbol{\beta}_{3i} + \varepsilon_{3ik}$$

$$y_{1k} = \begin{cases} 1 \quad \text{if} \quad y_{1k}^{*} > 0: & \Pr ob(y_{1k} = 1) \\ 0 \quad \text{if} \quad y_{1k}^{*} \leq 0: & \Pr ob(y_{1k} = 0) \end{cases} \qquad \text{First Stage}$$

$$y_{2ik} = \begin{cases} 1 \quad \text{if} \quad \left(y_{2ik}^{*} > 0 \ \text{ and } \ y_{1k} = 1\right): & \Pr ob(y_{2ik} = 1\ ,\ y_{1k} = 1) \\ 0 \quad \text{if} \quad \left(y_{2ik}^{*} \leq 0 \ \text{ and } \ y_{1k} = 1\right): & \Pr ob(y_{2ik} = 0\ ,\ y_{1k} = 1) \\ 0 \qquad\qquad \text{if} \quad y_{1k} = 0: & \Pr ob(y_{1k} = 0) \end{cases} \qquad \text{Second Stage}$$

$$w_{ik} = \begin{cases} w_{ik}^{*} \quad \text{if} \ \left(\mathrm{y}_{2ik} = 1 \ \text{ given } \ \mathrm{y}_{1k} = 1\right): & \mathrm{Prob}\left(\mathrm{y}_{2ik} = 1 \mid y_{1k} = 1\right) \\ w_{ik}^{*} \quad \text{if} \ \left(\mathrm{y}_{2ik} = 0 \ \text{ given } \ \mathrm{y}_{1k} = 1\right): & \mathrm{Prob}\left(\mathrm{y}_{2ik} = 0 \mid y_{1k} = 1\right) \\ \quad \text{DNE} \quad \text{if} \quad \mathrm{y}_{1k} = 0: & \mathrm{Prob}\left(y_{1k} = 0\right) \end{cases} \qquad \text{Third Stage}$$

$$i = 1, \ldots, N$$

$$k = 1, 2 \ldots, T$$

where i and k are the indexes representing the individual product and the individual, respectively. This model assumes that it is a N good model with sample size equal to T .

y_{1k}^*, y_{2ik}^*, and w_{ik}^* are the latent variables associated with consumption of the group of products, consumption of good i from the group, and average budget share spent on good i, respectively. $y_{1k} = 1$ if individual k eats at least one product in a group and zero otherwise. $y_{2ik} = 1$ if individual k eats the good i from the group and zero otherwise. w_{ik} represents the average budget share which the individual k decided to spend on good i. It exists if and only if individual k consumes at least one product from the group. $\boldsymbol{x}_{1k}$, $\boldsymbol{x}_{2ik}$, and $\boldsymbol{x}_{3ik}$ are vectors of explanatory variables of the latent equations associated with consumption of the group of products, consumption of good i from the group, and average budget share spent on good i, respectively. $\boldsymbol{\beta}_1$, $\boldsymbol{\beta}_{2i}$, and $\boldsymbol{\beta}_{3i}$ are vectors of parameters of the latent equations associated with consumption of the group of products, consumption of good i from the group, and average budget share spent on good i, respectively. ε_{1k}, ε_{2ik}, and ε_{3ik} represent the error terms of the latent equations associated with consumption of the group of products, consumption of good i from the group, and average budget share spent on good i, respectively.

In the first stage, the individual decides whether or not to consume any product from a group of similar commodities. This stage is estimated using a probit model. The second stage represents the decision by the individuals to consume or not to consume a specific product from that group given that the decision to consume any product from that group was positive. This stage is estimated using a probit model with sample selection. In the third stage, we model the individual’s decision of what share of the total budget to allocate for the consumption of the product i given the decision to consume any product from the group of similar commodities and the decision to consume that specific product were positive. This stage is the final framework of the selectivity-adjusted censored LA/AIDS model. Let's study these stages and the estimation procedures accompanying them.

First Stage

In the first stage the individual/household selects whether to eat or not to eat any commodity from a group of similar products. For example, Figures 2 and 3 show that in the first stage, the individual has to decide whether or not to consume fresh meat at home and whether or not to consume pork at home respectively. These situations could be represented by a binary choice probit model discussed previously

$$y_{1k}^{*} = \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{I} + \varepsilon_{1k} \qquad \textit{latent selection equation}$$

where

$k = 1, 2, ..., T$ is the number of observations

$\varepsilon_{1k} \sim N(0,1)$

Hence, we observe only a discrete dependent variable

$$y_{1k} = \begin{cases} 1 & \text{if} \quad y_{1k}^{*} > 0 \\ 0 & \text{if} \quad y_{1k}^{*} \leq 0 \end{cases} \qquad \textit{selection equation}$$

where, $y_{1k} = 1$ if individual k eats at least one product in a group and zero otherwise.

The log-likelihood function for probit is

$$L = \sum_{k \in S} \ln\left\{\Phi\left(\boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{I}\right)\right\} + \sum_{k \notin S} \ln\left\{1 - \Phi\left(\boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{I}\right)\right\}. \tag{22}$$

The univariate standard normal cumulative distribution function (cdf), $\Pr ob(y_{1k}=1)\equiv\Phi\left(y_{1k}=1\right)$, are estimated in this stage using the probit model and is used further in the second and third stages.

This stage is estimated using all socio-demographic, health, attitudinal/lifestyle information about individuals (available from NPD NET Survey). The reference or base category in this stage are: spring (spring); on a doctor prescribed diet (presdiet); not Hispanic (Hispanic = 0); male (femaleet = 0); the female head is between the ages of 30 and 39 (age30_39); the female head works 35 hours and more a week (o35uphrs); the female head has grade school; some high school education; or has graduated high school (somehs); reside in a non SMSA area (SMSA = 0); white (white); reside in the New England region (neweng); belong to a two-member household (memb_2); have children under 18; and have acceptable BMI index (bmiaccept).

This therefore leads to the following model:

$$\begin{aligned}(23)\quad Y_k = F(&\alpha_k + \beta_1 income_k + \beta_2 inc\_2_k + \beta_3 Hispanic_k + \beta_4 summer_k + \beta_5 fall_k \\ &+ \beta_6 winter_k + \beta_7 femaleet_k + \beta_8 u35hrs_k + \beta_9 nefp_k + \beta_{10} somecol_k \\ &+ \beta_{11} postgcol_k + \beta_{12} smsa_k + \beta_{13} black_k + \beta_{14} Oriental_k + \beta_{15} other_k \\ &+ \beta_{16} midatl_k + \beta_{17} enc_k + \beta_{18} wnc_k + \beta_{19} satl_k + \beta_{20} esc_k + \beta_{21} wsc_k + \beta_{22} mount_k \\ &+ \beta_{23} pacific_k + \beta_{24} dietchc_k + \beta_{25} nodiet_k + \beta_{26} chk\_labels_k + \beta_{27} plan\_meals_k \\ &+ \beta_{28} cholest_k + \beta_{29} fat_k + \beta_{30} good\_taste_k + \beta_{31} age18\_24_k + \beta_{32} age25\_29_k \\ &+ \beta_{33} age40\_49_k + \beta_{34} age50\_59_k + \beta_{35} age60\_64_k + \beta_{36} age65up_k \\ &+ \beta_{37} nochun18_k + \beta_{38} memb\_1_k + \beta_{39} memb\_3up_k + \beta_{40} bmilow_k \\ &+ \beta_{41} bmihigh_k)\end{aligned}$$

and where Y_k corresponds to the decision to eat at-home fresh meat. The dependent variable in this case is 1 if fresh meat consumption occurred at home, 0 otherwise. Variable names and definitions are exhibited In Table A.1 in Appendix A.

For the at-home pork group, the model is given by

$$\begin{aligned}
Y_k = F(&\alpha_k + \beta_1 income_k + \beta_2 inc_2_k + \beta_3 Hispanic_k + \beta_4 summer_k + \beta_5 fall_k \\
&+ \beta_6 winter_k + \beta_7 femaleet_k + \beta_8 u35hrs_k + \beta_9 nefp_k + \beta_{10} somecol_k \\
&+ \beta_{11} postgcol_k + \beta_{12} smsa_k + \beta_{13} black_k + \beta_{14} Oriental_k + \beta_{15} other_k \\
&+ \beta_{16} midatl_k + \beta_{17} enc_k + \beta_{18} wnc_k + \beta_{19} satl_k + \beta_{20} esc_k + \beta_{21} wsc_k + \beta_{22} mount_k \\
&+ \beta_{23} pacific_k + \beta_{24} dietchc_k + \beta_{25} nodiet_k + \beta_{26} chk_labels_k + \beta_{27} plan_meals_k \\
&+ \beta_{28} cholest_k + \beta_{29} additives_k + \beta_{30} fat_k + \beta_{31} salt_k + \beta_{32} preserv_k \\
&+ \beta_{33} good_taste_k + \beta_{34} age18_24_k + \beta_{35} age25_29_k + \beta_{36} age40_49_k \\
&+ \beta_{37} age50_59_k + \beta_{38} age60_64_k + \beta_{39} age65up_k + \beta_{40} nochun18_k \\
&+ \beta_{41} memb_1_k + \beta_{42} memb_3up_k + \beta_{43} bmilow_k + \beta_{44} bmihigh_k)
\end{aligned} \tag{24}$$

where Y_k corresponds to the decision to consume pork at home. The dependent variable in this case is 1 if pork consumption occurred at home, 0 otherwise. Variable names and definitions are exhibited In Table A.1 in Appendix A. Note that the model for fresh meats does not have factors such as the presence of additives ($additives_i$), the presence of salt ($salt_i$), and the presence of preservatives ($preserve_i$). We have excluded them, because single-equation Heckman models to be discussed in Chapter V show that these factors are not important determinants in the decision to consume any of the aggregate fresh meat products.

Second Stage

In the second stage the individual (household) selects to consume a specific product or not given that the decision to consume at least one product in the group. A probit model with sample selection (Van de Ven and Van Pragg) or semi- and non-parametric approaches (Olsen; Lee (1982); and Duan and Li (1987)) would be appropriate to assess the decision to consume an individual product from a group of similar goods given that the individual (household) decided to consume at least one commodity from that group. The general structure of binary model with sample selection is given by

(25)
$$y_{2ik}^{*} = \boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} + \varepsilon_{2ik} \qquad \textit{latent equations}$$

$$y_{1k}^{select} = \left(\boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1} + \varepsilon_{1k} \succ 0\right) \qquad \textit{selection equation}$$

$$y_{2ik}^{probit} = \left(y_{2ik}^{*} \succ 0\right) \qquad \textit{probit equations}$$

where

$i = 1,...,N$ is the number of the goods in the group.

$k = 1,2,...,T$ is the number of the observations in the sample.

$\varepsilon_{2ik} \sim N(0,1)$

We observe three types of observations and their corresponding (unconditional) probabilities:

(26)
$$y_{2ik} = \begin{cases} 1 \quad \text{if} \quad \left(y_{2ik}^{*} > 0 \text{ and } y_{1k} = 1\right): & \Pr ob(y_{2ik} = 1 \,, y_{1k} = 1) \\ 0 \quad \text{if} \quad \left(y_{2ik}^{*} \leq 0 \text{ and } y_{1k} = 1\right): & \Pr ob(y_{2ik} = 0 \,, y_{1k} = 1) \\ 0 \qquad\qquad \text{if} \quad y_{1k} = 0: & \Pr ob(y_{1k} = 0) \end{cases}$$

The log likelihood function based on these probabilities is:

(27)
$$L_i = \sum_{\substack{k \in S \\ y_{2ik} \neq 0}} \ln\left\{\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i}, \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}, \rho_i\right)\right\} + \sum_{\substack{k \in S \\ y_{2ik} = 0}} \ln\left\{\Phi_2\left(-\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i}, \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}, -\rho_i\right)\right\} + \sum_{k \notin S} \ln\left\{1 - \Phi\left(\boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right)\right\}$$

where $\rho_i = corr(\varepsilon_{1k}, \varepsilon_{2ik})$, S is the set of observations for which y_{2ij} is observed, $\Phi_2(\ )$ is the cumulative bivariate normal distribution function with mean $[0 \quad 0]'$, $\Phi(\ )$ is the standard cumulative normal distribution function. Where, $y_{2ik} = 1$, if individual k decides to eat ith product in a group and zero otherwise.

The conditional bivariate normal cdf,

$\text{Prob}(y_{2ik} = 1 \mid y_{1k} = 1) \equiv \Phi_2(y_{2ik} = 1 \mid y_{1k} = 1)$, the conditional bivariate normal pdf $\phi_2(y_{2ik} = 1 \mid y_{1k} = 1)$, and the univariate normal cdf, $\text{Prob}(y_{2ik} = 1) \equiv \Phi(y_{2ik} = 1)$, are estimated in this stage and are used in the third stage. The conditional probability distribution function is given by

$$\phi_2\left(\boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}'\boldsymbol{\beta}_1\right) = \frac{\phi\left(\boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i}\right)}{\Phi\left(\boldsymbol{x}_{1k}'\boldsymbol{\beta}_1\right)} * \Phi\left(\frac{\boldsymbol{x}_{1k}'\boldsymbol{\beta}_1 - \rho_i * \boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i}}{\sqrt{1-\rho_i^2}}\right) \qquad (28)$$

The application of equation (25) to this analysis is given by:

$$\begin{aligned} Y_{ik} = F(&\alpha_{ik} + \beta_1 income_{ik} + \beta_2 inc\_2_{ik} + \beta_3 Hispanic_{ik} + \beta_4 summer_{ik} + \beta_5 fall_{ik} \\ &+ \beta_6 winter_{ik} + \beta_7 femaleet_{ik} + \beta_8 u35hrs_{ik} + \beta_9 nefp_{ik} + \beta_{10} somecol_{ik} \\ &+ \beta_{11} postgcol_{ik} + \beta_{12} smsa_{ik} + \beta_{13} black_{ik} + \beta_{14} Oriental_{ik} + \beta_{15} other_{ik} \\ &+ \beta_{16} midatl_{ik} + \beta_{17} enc_{ik} + \beta_{18} wnc_{ik} + \beta_{19} satl_{ik} + \beta_{20} esc_{ik} + \beta_{21} wsc_{ik} \\ &+ \beta_{22} mount_{ik} + \beta_{23} pacific_{ik} + \beta_{24} dietchc_{ik} + \beta_{25} nodiet_{ik} + \beta_{26} chk\_labels_{ik} \\ &+ \beta_{27} plan\_meals_{ik} + \beta_{28} cholest_{ik} + \beta_{29} fat_{ik} + \beta_{30} good\_taste_{ik} + \beta_{31} age18\_24_{ik} \\ &+ \beta_{32} age25\_29_{ik} + \beta_{33} age40\_49_{ik} + \beta_{34} age50\_59_{ik} + \beta_{35} age60\_64_{ik} \\ &+ \beta_{36} age65up_{ik} + \beta_{37} bmilow_{ik} + \beta_{38} bmihigh_{ik}) \end{aligned} \qquad (29)$$

where $i =$ fresh pork, fresh beef, fresh chicken, and fresh seafood. Y_{ik} corresponds to the eating or non-eating of fresh meat products. The dependent variable in this case is one of the following: fshpk; chfsh; bffsh; and sffsh. Variable names and definitions are exhibited In Table A.1 in Appendix A.

For the at-home pork group, the presence of additives ($additives_i$), the presence of salt ($salt_i$), and the presence of preservatives ($preserve_i$) are added to the model as explanatory variables.

$$\begin{aligned}(30)\quad Y_{ik} = F(&\alpha_{ik} + \beta_1 income_{ik} + \beta_2 inc\_2_{ik} + \beta_3 Hispanic_{ik} + \beta_4 summer_{ik} + \beta_5 fall_{ik} \\ &+ \beta_6 winter_{ik} + \beta_7 femaleet_{ik} + \beta_8 u35hrs_{ik} + \beta_9 nefp_{ik} + \beta_{10} somecol_{ik} \\ &+ \beta_{11} postgcol_{ik} + \beta_{12} smsa_{ik} + \beta_{13} black_{ik} + \beta_{14} Oriental_{ik} + \beta_{15} other_{ik} \\ &+ \beta_{16} midatl_{ik} + \beta_{17} enc_{ik} + \beta_{18} wnc_{ik} + \beta_{19} satl_{ik} + \beta_{20} esc_{ik} + \beta_{21} wsc_{ik} \\ &+ \beta_{22} mount_{ik} + \beta_{23} pacific_{ik} + \beta_{24} dietchc_{ik} + \beta_{25} nodiet_{ik} + \beta_{26} chk\_labels_{ik} \\ &+ \beta_{27} plan\_meals_{ik} + \beta_{28} cholest_{ik} + \beta_{29} additives_{ik} + \beta_{30} fat_{ik} + \beta_{31} salt_{ik} \\ &+ \beta_{32} preserv_{ik} + \beta_{33} good\_taste_{ik} + \beta_{34} age18\_24_{ik} + \beta_{35} age25\_29_{ik} \\ &+ \beta_{36} age40\_49_{ik} + \beta_{37} age50\_59_{ik} + \beta_{38} age60\_64_{ik} + \beta_{39} age65up_{ik} \\ &+ \beta_{40} bmilow_{ik} + \beta_{41} bmihigh_{ik})\end{aligned}$$

where $i =$ pork chops, pork ribs, pork roasts, pork tenderloin, bacon, canned ham, smoked ham, pork sausage, pork lunchmeat. Y_{ik} corresponds to the eating or non-eating of fresh and processed pork cuts at home. The dependent variable is one of the following: pkch; pkrb; pkrst; pkltd; smkh; canh; bacon; sausg; and lchmt. Variable names and definitions are exhibited In Table A.1 in Appendix A.

Third Stage

This stage includes only those individuals who have decided to consume at least one product from the group, i.e., given that $y_{1k} = 1$. The mathematical model of this stage is given by

$$(31)\qquad w_{ik}^{*} = \boldsymbol{x}_{3ik}^{'} \boldsymbol{\beta}_{3i} + \varepsilon_{3ik}$$

where w_{ik}^{*} is the latent average budget share that individual k spends on good i. We observe three types of observations of average budget share and their corresponding probabilities:

(32) $$w_{ik} = \begin{cases} w_{ik}^{*} & \text{if } \left(\mathrm{y_{2ik}} = 1 \text{ given } \mathrm{y_{1k}} = 1\right): \quad \mathrm{Prob}\left(\mathrm{y_{2ik}} = 1 \mid y_{1k} = 1\right) \\ w_{ik}^{*} & \text{if } \left(\mathrm{y_{2ik}} = 0 \text{ given } \mathrm{y_{1k}} = 1\right): \quad \mathrm{Prob}\left(\mathrm{y_{2ik}} = 0 \mid y_{1k} = 1\right) \\ \text{DNE} & \text{if } \mathrm{y_{1k}} = 0: \quad \mathrm{Prob}\left(y_{1k} = 0\right) \end{cases}$$

where w_{ik} represents the observed average budget share that individual k decided to spend on good i. Note we observe a continuous values of the average budget share if and only if $y_{1k} = 1$ (individual k eats at least one product in the group) and $y_{2ik} = 1$ (individual k eats the good i from the group). We observe zero values of the average budget share if and only if $y_{1k} = 1$ (individual k eats at least one product in the group) and $y_{2ik} = 0$ (individual k does not eat the good i from the group). We observe DNE values of the average budget share if and only if $y_{1k} = 0$ (individual k does not eat at least one product in the group). Further, note that the actual value of the average budget share is not available due to a division by zero problem in equation (19). This does not permit us to calculate the unconditional expectation of the average budget share allocated to good i, $E\left[w_{ik}\right]$. The best we can do is to estimate a model conditional on positive expenditure, i.e. $E\left[w_{ik} \mid y_{1k} = 1\right]$. The correct conditional expectation of average budget share that individual k spends on good i given that the individual decided to consume at least one product from the group of products and as well decided to consume the ith product is as follows:

$$E\left[\left(w_{ik} \mid y_{2ik}=1\right) \mid y_{1k}=1\right]=\boldsymbol{x}_{3ik}^{'}\boldsymbol{\beta}_{3k}+\boldsymbol{\sigma}_{\varepsilon_{1k}\varepsilon_{2ik}\varepsilon_{3ik}} * \frac{\phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right)}{\Phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right)}. \tag{33}$$

Given that the consumption of at least one product from group of products occurs, nonparticipation is reflected in zero consumption of a good and zero expected value of budget share (i.e., $E\left[\left(w_{ik} \mid y_{2ik}=0\right) \mid y_{1k}=1\right]=0$). Then, the expected value of the average budget share allocated to good i conditional on consumption at least one product from that group will be

$$\begin{aligned} E\left[w_{ik} \mid y_{1k}=1\right] &= E\left[\left(w_{ik} \mid y_{2ik}=1\right) \mid y_{1k}=1\right] * \Phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right) \\ &\quad + \underbrace{E\left[\left(w_{ik} \mid y_{2ik}=0\right) \mid y_{1k}=1\right]}_{0} * \Phi_2\left(y_{2ik}=0 \mid y_{1k}=1\right) \\ &= E\left[\left(w_{ik} \mid y_{2ik}=1\right) \mid y_{1k}=1\right] * \Phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right) \\ &= \Phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right) * \boldsymbol{x}_{3ik}^{'}\boldsymbol{\beta}_{3k}+\boldsymbol{\sigma}_{\varepsilon_{1k}\varepsilon_{2ik}\varepsilon_{3ik}} * \phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right) \end{aligned} \tag{34}$$

The equations from (34) comprise the selectivity-adjusted censored LA/AIDS model. In the framework of LA/AIDS model the selectivity-adjusted censored model has this final form

$$\begin{aligned} E\left[w_{ik} \mid y_{1k}=1\right] &= \Phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right) * \left(\alpha_i+\sum_i \gamma_{ij}\ln p_{jk}+B_i\ln\left(y_k/P_k\right)\right) \\ &\quad + \boldsymbol{\sigma}_{\varepsilon_{1k}\varepsilon_{2ik}\varepsilon_{3ik}} * \phi_2\left(y_{2ik}=1 \mid y_{1k}=1\right) \end{aligned} \tag{35}$$

$$\Leftrightarrow \quad \begin{aligned} E\left[w_{ik} \mid y_{1k}=1\right] &= \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right) * \left(\alpha_i+\sum_i \gamma_{ij}\ln p_{jk}+B_i\ln\left(y_k/P_k\right)\right) \\ &\quad + \boldsymbol{\sigma}_{\varepsilon_{1k}\varepsilon_{2ik}\varepsilon_{3ik}} * \phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right) \end{aligned}$$

As mentioned previously, two demand systems are built applying this procedure. In the first case we model the demand for at-home fresh meats (pork, beef, chicken, and seafood). In the second LA/AIDS model, we study the price relationships among at-home pork cuts (pork chops, pork ribs, pork roasts, pork tenderloin, bacon, canned ham, smoked ham, pork sausage, and pork lunchmeat). Variable names and definitions are exhibited In Table A.1 in Appendix A. The parameter estimates of the demand models are presented in Appendixes E.

In the next section we derive the expressions of marginal effects and elasticities of the prices and expenditures for the selectivity-adjusted censored LA/AIDS model. Model (iii) of Green and Alston, i.e. treating shares as exogenous, is used in the elasticity calculation. For good i, the expressions of conditional marginal effects corresponding to own-price, cross-price (with good j), and expenditure effects in this situation are given by

Own-price effect

(36) $$\frac{E\left[w_{ik} \mid y_{1k}=1\right]}{\partial p_{ik}} = \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ii}}{p_{ik}} - \frac{B_i w_{ik}}{p_{ik}}\right)$$

Cross-price effect

(37) $$\frac{E\left[w_{ik} \mid y_{1k}=1\right]}{\partial p_{jk}} = \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ij}}{p_{jk}} - \frac{B_i w_{jk}}{p_{jk}}\right)$$

Expenditure effect

(38) $$\frac{E\left[w_{ik} \mid y_{1k}=1\right]}{\partial y_k} = \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \frac{B_i}{y_k}$$

It should be noted that $\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right)$ is not a function of prices, because the first two stages did not include prices. The expressions of the marginal effects for average budget shares are given by

(39) $$\frac{\partial w_{ik}}{\partial p_{ik}} = \frac{\partial\left[\frac{p_{ik}q_{ik}}{y_k}\right]}{\partial p_{ik}} = \frac{p_{ik}}{y_k} * \frac{\partial q_{ik}}{\partial p_{ik}} + \frac{q_{ik}}{y_k}$$ *Own-price effect*

(40) $$\frac{\partial w_{ik}}{\partial p_{jk}} = \frac{\partial\left[\frac{p_{ik}q_{ik}}{y_k}\right]}{\partial p_{jk}} = \frac{p_{ik}}{y_k} * \frac{\partial q_{ik}}{\partial p_{jk}}$$ *Cross-price effect*

(41) $$\frac{\partial w_i}{\partial y} = \frac{\partial\left[\frac{p_i q_i}{y}\right]}{\partial y} = \frac{y * \left[p_i * \frac{\partial q_i}{\partial y}\right] - p_i q_i}{y^2}$$ *Expenditure effect*

To derive the expressions of the own-price, cross-price, and expenditure elasticities, we need to equate the corresponding expressions.

The uncompensated own-price elasticity is derived by equating (36) and (39).

(42) $$\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ii}}{p_{ik}} - \frac{B_i w_{ik}}{p_{ik}}\right) = \frac{p_{ik}}{y_k} * \frac{\partial q_{ik}}{\partial p_{ik}} + \frac{q_{ik}}{y_k}$$

$$\Leftrightarrow \quad \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \left(\frac{y\gamma_{ii}}{p_i} - \frac{yB_i w_i}{p_i}\right) = p_i * \frac{\partial q_i}{\partial p_i} + q_i$$

$$\Leftrightarrow \quad \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \left(\frac{y\gamma_{ii}}{p_i q_i} - \frac{yB_i w_i}{p_i q_i}\right) = \varepsilon_{ii} + 1$$

(43) $$\varepsilon_{ii} = \Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ii}}{w_i} - B_i\right) - 1$$ *Own-price Elasticity*

The value of the average own-price elasticity at the mean average budget share is calculated by

(44) $$\hat{\varepsilon}_{ii} = \Phi_2\left(\bar{\boldsymbol{x}}_{2i}'\hat{\boldsymbol{\beta}}_{2i} \mid \bar{\boldsymbol{x}}_1'\hat{\boldsymbol{\beta}}_1\right) * \left(\frac{\hat{\gamma}_{ii}}{\bar{w}_i} - \hat{B}_i\right) - 1$$

Cross-price Elasticity

The uncompensated cross-price elasticity between ith and jth commodities is derived by equating (37) and (40).

(45) $$\Phi_2\left(\boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}'\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ij}}{p_j} - \frac{B_i w_j}{p_j}\right) = \frac{p_i}{y} * \frac{\partial q_i}{\partial p_j}$$

$$\Leftrightarrow \quad \Phi_2\left(\boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}'\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ij}}{p_j} - \frac{B_i w_j}{p_j}\right) * \frac{p_j y}{q_i p_i} = \frac{p_i}{y} * \frac{\partial q_i}{\partial p_j} * \frac{p_j y}{q_i p_i}$$

$$\Leftrightarrow \quad \Phi_2\left(\boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}'\boldsymbol{\beta}_1\right) * \left(\frac{\gamma_{ij}}{w_i} - \frac{B_i w_j}{w_i}\right) = \frac{\partial q_i}{\partial p_j} * \frac{p_j}{q_i} = \varepsilon_{ij}$$

(46) $$\varepsilon_{ij} = \Phi_2\left(\boldsymbol{x}_{2ik}'\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}'\boldsymbol{\beta}_1\right) * \frac{\gamma_{ij} - B_i w_j}{w_i}$$ *Cross-price Elasticity*

The value of the average cross-price elasticity at the mean average budget share is calculated by

(47) $$\hat{\varepsilon}_{ij} = \Phi_2\left(\bar{\boldsymbol{x}}_{2i}'\hat{\boldsymbol{\beta}}_{2i} \mid \bar{\boldsymbol{x}}_1'\hat{\boldsymbol{\beta}}_1\right) * \frac{\hat{\gamma}_{ij} - \hat{B}_i \bar{w}_j}{\bar{w}_i}$$

Compensated cross-price elasticities are calculated based on Slutsky's equation

$$\varepsilon_{ij}^{\bullet} = \varepsilon_{ij} + w_j \eta_i \, .$$

Expenditure Elasticity

The expenditure elasticity is derived by equating (38) and (41).

(48) $$\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right)*\frac{B_i}{y}=\frac{p_i}{y}*\frac{\partial q_i}{\partial y}-\frac{p_i q_i}{y^2}$$

⇔ $$\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right)*B_i = p_i*\frac{\partial q_i}{\partial y}-w_i$$

⇔ $$\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right)*B_i + w_i = p_i*\frac{\partial q_i}{\partial y}=w_i\eta_i$$

(49) $$\eta_i=\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_{1}\right)*\frac{B_i}{w_i}+1$$ *Expenditure Elasticity*

The value of the average cross-price elasticity at the mean average budget share is calculated by

(50) $$\hat{\eta}_i=\Phi_2\left(\overline{\boldsymbol{x}}_{2i}^{'}\hat{\boldsymbol{\beta}}_{2i} \mid \overline{\boldsymbol{x}}_{1}^{'}\hat{\boldsymbol{\beta}}_{1}\right)*\frac{\hat{B}_i}{\overline{w}_i}+1\,.$$

CHAPTER III

DATA

Introduction

As mentioned previously, the cross-sectional data used within this study are based on three separate datasets obtained by NPB: (1) National Eating Trends (NET) data on individual intake and socio-demographic, health, attitudinal/lifestyle characteristics collected by the National Panel Diary Group, Inc. (NPD); (2) weekly retail price data on at-home fresh meats and fresh pork cuts collected by FreshLook Marketing Group, LLC; and (3) the A.C. Nielsen data pertaining to weekly prices of the selected processed pork cuts. A brief description of each of the respective data sets is presented.

1. *NET Data*: Data on individual intake, measured in grams, over two consecutive weeks for selected fresh meat categories as well as fresh and processed pork products are available from the National Panel Diary Group, Inc. (NPD). NPD specializes in collecting very detailed data on individual and/or household consumption of various food products. The NPD data correspond to the NET Survey. The NET data cover the six-year period from March 1996 to February 2002. Over this period, the NET data encompasses 31,946 individuals and allows for a cross-sectional analysis of the number of eatings of various kinds of pork as well as the volume (in grams) of pork eaten. The Census regions indigenous to the

NET data are: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central Mountain, and Pacific. The Survey tracks all food and beverages prepared and/or consumed in the home except water, salt, and pepper. Participants in the Survey report both at-home and away-from-home consumption for all family members for a 14-day period through a paper diary. At any point in time there are about 2,000 households or about 5,000 individuals participating in the Survey. This data set contains not only consumption information on pork items but also socio-demographic, attitudinal/lifestyle, and health information on participants.

2. *FreshLook Scanner Data*: Scanner data on weekly at-home prices, measured in U.S. dollars per pound ($/pound) of the selected fresh products come from FreshLook, a subsidiary of Information Resources, Inc. (IRI). The IRI data pertain to: beef, pork chops, chicken, pork ribs, pork, pork roasts, seafood, pork sausage, and pork tenderloin and run from January 1998 to December 2001. The IRI regions are the total U.S., Northeast, Great Lakes, California, West, Southeast, South Central, Mid South, and Plains. The IRI regions do not much exactly the Census regions indigenous to the NET data. We reconciled the price data to match exactly the NET data (see Appendixes C). Subsequently, the weekly price data are merged with the NET data to analyze the effect of prices on the volume of intake of the selected fresh meat products.

3. *A.C. Nielsen Data*: A.C. Nielsen data, also weekly in frequency, include at-home prices, measured in $/pound, of the selected processed pork products. These data

pertain to: bacon, sausage, ham, and lunchmeat and run from April 1999 to February 2002. The A.C. Nielsen data also include both national and regional information. The regions in the A.C. Nielsen data match exactly the Census regions indigenous to the NET data.

For the purposes of this study we have developed three data sets using different combinations of the available data. First, the NET data alone are used to analyze the socio-demographic, attitudinal factors that drive the decision made by consumers to eat the selected products and their associated intake through Heckman sample selection models. Second, the NET data are merged with the IRI data to analyze the effect of prices on the volume of at-home intake of fresh pork, fresh beef, fresh chicken, and fresh seafood through the use of the selectivity-adjusted censored LA/AIDS. Third, all three data sets are merged to analyze the effect of prices on the volume of at-home intake of the selected fresh and processed pork cuts through the use of selectivity-adjusted LA/AIDS. The merging process of price data with the individual intake data is explained in detail in the methods and procedures section.

Cleaning and Reorganization of the NPD NET Data for the Heckman Models

The investigation of raw secondary data requires much effort, initially on cleaning and reorganization of the data. We went through several steps to bring the raw NPD NET data into a usable format. The original NPD NET data included 526,506 lines of daily records of protein consumed by specific commodities for 30,144 individuals. The first step was to aggregate the specific commodities into sixteen products and reorganize the intake information based on two consecutive weeks. This aggregation level was associated with the intention of matching the price information obtained from IRI and A.C. Nielsen.

The constructed sixteen products can be broken down into two categories: (1) fresh meat products and (2) fresh and processed pork products. Fresh meats include fresh pork, beef, chicken, and seafood. Fresh pork cuts comprise pork chops, pork ribs, pork roasts, and pork tenderloin. Processed pork products consist of processed pork, bacon, ham, smoked ham, canned ham, pork sausage, pork hotdogs, and luncheon meats. Table 3 and Table 4 list the products included in the fresh meat products and fresh and processed pork products, respectively. For example, pork chops, pork ribs, pork roasts, pork tenderloin, fresh chicken (chicken entrée/ingred), bacon (nsf/'pork' bacon), canned ham (canned entrée ham), and smoked ham (entrée ham excluding canned) were represented by one category each. Others however, were constructed by aggregating the commodities presented in the NET Survey. For example, pork sausage consists of smoked sausage, kielbasa sausage, polish sausage, bratwurst sausage, hot sausage, Italian sausage, mild sausage, pork sausage, and all other 'pork' sausage. The volume of intake of the selected products corresponds to a two-week consumption period (consecutive weeks).

The cleaning process of the NPD data is the next step in our research. The data were filtered based on the following process. First, all individuals under 18 years of age were taken out from the sample. Then, individuals with DNE values for the explanatory variables and those with outlier intakes (i.e., intakes more than the mean intake plus five standard deviations) were dropped from the sample.

Table 3. Distinction Between Fresh Meat Products

FRESH PORK	FRESH BEEF	FRESH CHICKEN	FRESH SEAFOOD
• Pork Chops	• Ground Beef	• Chicken Entrée / Ingred	• Finfish (Excluding Tuna)
• Pork Ribs	• Beef Roast		• Shellfish
• Pork Roast	• Beef Steak		
• Pork Loin	• All Other Beef		

Table 4. Distinction Between Processed Pork Products

HAM	PORK SAUSAGE	PORK LUNCHMEAT
• Ham Lunchmeat	• Smoked Sausage	• NSF/'Pork' Bologna
• Entrée Ham (Excluding Canned)	• Kielbasa Sausage	• NSF/'Pork' Salami
• Canned Entrée Ham	• Polish Sausage	• Cotto Salami
• Ham Sandwich	• Bratwurst Sausage	• Hard Salami
• Pork/Ham Combo Dish	• Hot Sausage	• Pepperoni
	• Italian Sausage	• All Other 'Pork' Lunchmeat
	• Mild Sausage	• Pork Lunchmeat Sandwich
PORK HOTDOGS		
• NSF/'Pork' Hot Dogs	• Pork Sausage	
• Hot Dog Sandwich	• All Other 'Pork' Sausage	
BACON	**CANNED HAM**	**SMOKED HAM**
• NSF/'Pork' Bacon	• Canned Entrée Ham	• Entrée Ham (Excluding Canned)

For the Heckman models, we treated each model separately in terms of screening out the outliers, because each selected product is considered individually through a separate model. As a result, we obtained sixteen separate data sets (one for each product) with sample sizes ranging from 17,564 individuals (fresh chicken) to 17,605 individuals (pork tenderloin) for the Heckman sample selection models (see Table 5).

Table 5. Sample Sizes for the Selected Heckman Models

Model	Number of individuals	Model	Number of individuals
FRESH AGGREGATE MEATS		*PROCESSED PORK CUTS*	
Fresh Pork	17,581	**Processed Pork**	17,581
Fresh Beef	17,576	**Bacon**	17,586
Fresh Chicken	17,564	**Ham**	17,578
Fresh Seafood	17,589	**Canned Ham**	17,601
FRESH PORK CUTS		**Smoked Ham**	17,596
Pork Chops	17,585	**Pork Hotdogs**	17,585
Pork Ribs	17,601	**Luncheon Meats**	17,591
Pork Roasts	17,602	**Pork Sausage**	17,580
Pork Tenderloin	17,605		

Cleaning and Reorganization of the NPD NET Data for Use in the LA/AIDS Models

As mentioned previously, there are two LA/AIDS models constructed in this study. The first model is used to study price sensitivities among fresh pork, beef, chicken, and seafood (further referred as “fresh meats”). The second LA/AIDS model is used to derive price relationships among nine fresh and processed pork products (pork chops, pork ribs, pork roasts, pork tenderloin, bacon, pork sausage, smoked ham, canned ham, and lunchmeats) further referred as “pork cuts”. The NPD data used in the LA/AIDS models are reorganized to correspond to weekly intakes (instead of two-week intakes in the Heckman models). Then, the NPD NET data are merged with the weekly price data to study the price sensitivity of the demand of the selected products.

The transformation of the two-week intake information into one-week intake information is done as follows. All three data sets have a variable (*wave*), which is coded in a way to include information about the year, month, and the week of the reported data. In both FreshLook scanner data and the A.C. Nielsen data, the *wave* column shows the exact week when the average scanner price of the selected products was recorded. In the NPD NET data, the *wave* column represents the first week of the two-week period. In the NPD NET data a column exists labeled *day*, which ranges from one to fourteen, showing the day of consumption (in the NPD NET Survey, the intake is reported on a daily bases over the fourteen day period). To calculate the exact week of consumption, a new variable (*week*) was developed for the NPD NET data, which is equal to the value of the *wave* (i) if the value of the *day* is less than or equal to 7 and the value of *week* is equal to *wave* (i + 1) if the value of the *day* is greater than 7.

After merging the NPD data with the price data, the resulting data set is cleaned of missing observations and outlier intakes and reorganized (in the same way as was done for the Heckman analysis). This process significantly reduced the samples in both demand systems. Table 6 shows a step-by-step reduction of the sample size for the two LA/AIDS models. After merging NPD NET data with price information, the sample size in the original NPD NET data declined from 60,288 observations (or 30,144 individuals) to 30,219 and 21,775 observations (two observations per individual) for the fresh meat and the pork cut models, respectively. Another major reduction in the sample size was due to deleting missing observations of the explanatory variables except total expenditure. These variables include all the factors used in the three-step procedure. About 6,700 and 6,100 observations were deleted in the “fresh meats” and “pork cuts” samples, respectively. The number of observations dropped due to outliers is relatively small. As mentioned previously, intake of the selected product was considered an outlier if the intake was greater than the mean intake plus 5 standard deviations. The final sample sizes used in the first two stages of selectivity-adjusted censored LA/AIDS models are, respectively, 23,419 and 15,619 for "fresh meats" and "pork cuts" samples. It was mentioned in the beginning of Chapter II that the demand systems were conditional on having positive total expenditures. Approximately 2,200 individuals (or 9 percent of the final sample) did not prefer to eat any products from the "fresh meats" group and were dropped. In the "pork cuts" sample, about 36 percent of the individuals did not consume any product from the "pork cuts" group. The final sample in this case consisted of 9,902 observations.

Table 6. Number of Observations in the "Fresh Meats" and "Pork Cuts" Samples after Each Step of Data Cleaning and Reorganization

	LA/AIDS MODELS (number of observations)	
Stages of Cleaning and Reorganization	**FRESH MEATS**	**PORK CUTS**
After Merging with price data	30,219	21,775
After Deleting Missing Observations	23,534	15,672
After Dropping Outliers	23,419	15,619
After Dropping Individuals with Zero Total Expenditures	21,264	9,902

Development and Use of the Candidate Variables in the Heckman Models

The literature review shows that socio-demographic, health, and attitudinal/lifestyle, as well as characteristics of the female head and seasonality factors comprise the core of potential factors affecting the probability of eating. These five factors are included in the selection stage of the Heckman models and are outlined in Figure 4. The intake stage of the two-stage decision process is modeled based on the same socio-demographic factors (except for presence of children under 18). Let's have a detailed discussion of these variables.

Eat or Not Eat Product in a Two-week Period: Sixteen variables (one for each product) are developed and coded one if the decision to consume during two consecutive weeks of survey was positive; otherwise these variables are coded zero. These variables are used as dependent variables in the selection stage (probit models) of the Heckman models.

Two-week Intake of Product in Grams: As described previously, sixteen variables pertaining to the volumes of intakes (grams per two-weeks) of the selected products are developed for the Heckman sample selection models. These variables are used as dependent variables in the intake stage of the Heckman models.

Socio-Demographic Factors: In our models, the socio-demographic factors are: region; Hispanic; gender of individual; age of individual; household income; household size; market size; race; and presence of children under 18 years of age.

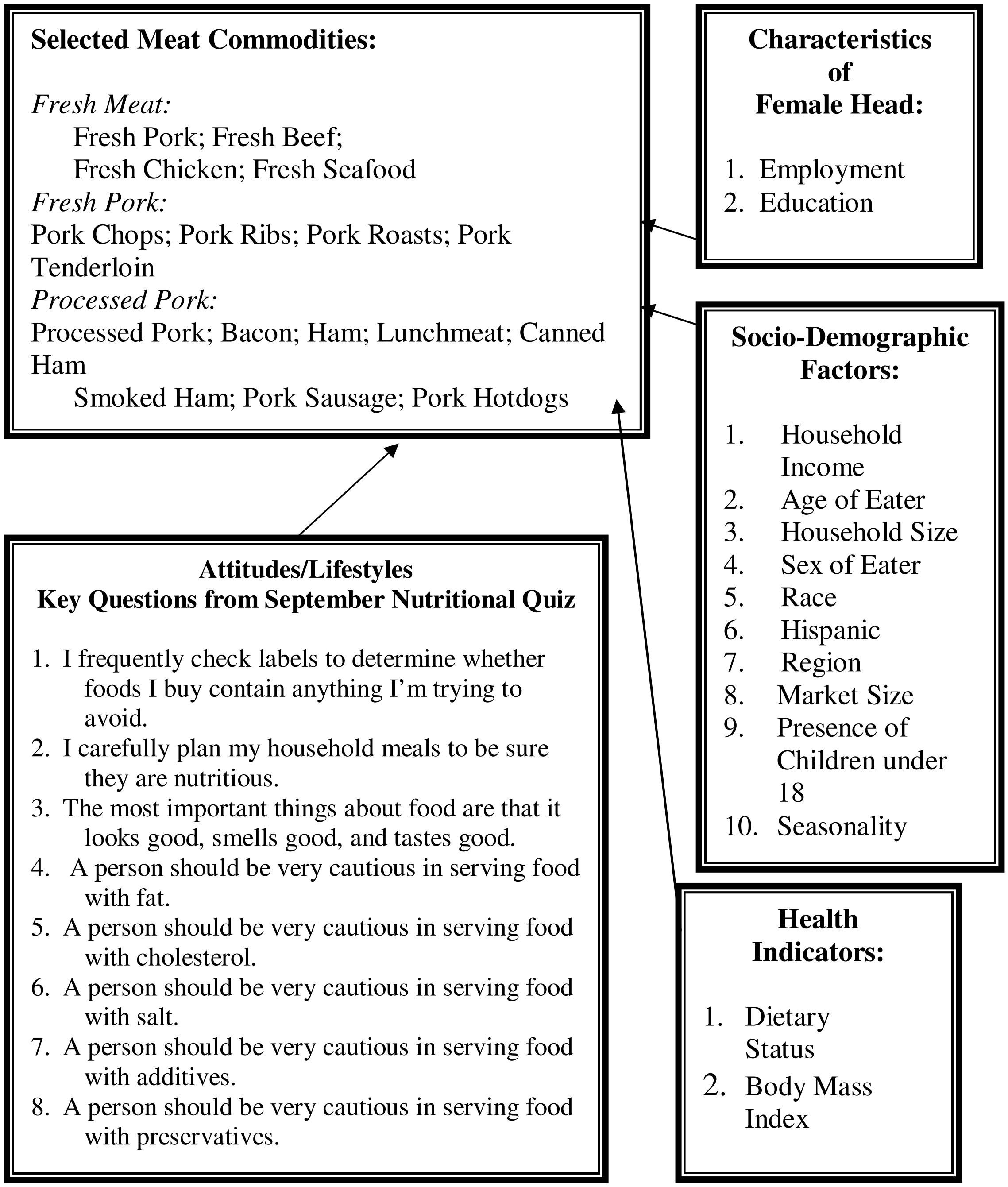


Figure 4. Outline of socio-demographic, health, attitudinal/lifestyle and other factors that are considered in the model development for the decision to eat selected meat commodities at home

Region: The NPD NET Survey report nine regions which correspond to the Bureau of the Census regions: (1) New England; (2) Middle Atlantic; (3) Mountain; (4) Pacific; (5) East South Central; (6) West South Central; (7) South Atlantic; (8) East North Central; and (9) West North Central. The breakdown of states by the regions is listed in Table 7.

For the econometric models, each of the nine regions is represented as a separate binary variable coded as one if the region matches to the respondent's region and zero otherwise. New England, arbitrarily, is used as the base region for the econometric models.

Ethnicity (Hispanic/non-Hispanic): The NPD NET Survey report Hispanics as either Yes or No/not reported. A binary variable labeled Hispanic is developed to represent ethnicity, coded one if the individual responded yes and zero otherwise. Hispanics are considered to be an ethnic group rather than a racial group. A Hispanic could therefore be white, black or any other race. It should be noted that the structure of the NPD survey questionnaire includes not reported in the same category as not Hispanic; therefore, the wording of this question might lead to underestimation of the Hispanic population. The base category for the models is "non-Hispanics".

Table 7. The Nine Regions and Their Corresponding States

New England Region	**Middle Atlantic Region**	**East North Central Region**
• Maine • New Hampshire • Vermont • Massachusetts • Rhode Island • Connecticut	• New York • New Jersey • Pennsylvania	• Ohio • Indiana • Illinois • Michigan • Wisconsin
West North Central Region	**South Atlantic Region**	**East South Central Region**
• Minnesota • Iowa • Missouri • Nebraska • Kansas • North Dakota • South Dakota	• Maryland • Delaware • Washington D.C. • Virginia • West Virginia • North Carolina • South Carolina • Florida	• Kentucky • Tennessee • Alabama • Mississippi • Georgia
West South Central Region	**Mountain Region**	**Pacific Region**
• Arkansas • Louisiana • Oklahoma • Texas	• Montana • Wyoming • Colorado • Idaho • New Mexico • Nevada • Arizona • Utah	• Washington • Oregon • California

Gender: Male, Female is reported by the NPD NET Survey. A binary variable labeled femaleet is generated to represent gender, coded one if the individual is a female and zero otherwise. Male eaters are the based category.

<u>*Household Income Brackets*</u>: The NPD NET Survey report household income by eighteen brackets: (1) Under $7,500; (2) $7,500 to $9,999; (3) $10,000 to $12,499; (4) $12,500 to $14,999; (5) $15,000 to $19,999; (6) $20,000 to $24,999; (7) $25,000 to $29,999; (8) $30,000 to $34,999; (9) $35,000 to $39,999; (10) $40,000 to $44,999; (11) $45,000 to $49,999; (12) $50,000 to $59,999; (13) $60,000 to $69,999; (14) $70,000 to $74,999; (15) $75,000 to $99,999; (16) $100,000 to $149,999; (17) $150,000 to $199,999; and (18) $200,000 and over. However, for the econometric models income is classified as a single number through the use of midpoints of the respective brackets. For the $200,000 and over category, $200,000 is used.

<u>*Household Size*</u>: The NPD NET Survey report household size by seven groups: 1 member; 2 members; 3 members; 4 members; 5 members; 6 members; 7+ members. Three binary variables are generated to represent household size: member_1; member_2; and member_3up. The member_1, member_2, and member_3up represent one member, two-member, and three-and-more-member households, respectively. These variables are scored one if the household size represented by them matches the respondent's household size and zero otherwise. The base category for the models is "member_2".

<u>*Age of Individual*</u>: The NPD NET Survey reports age of individual as a continuous variable. This study has excluded those eaters who are under 18 years of age. This research also segmented the eaters into seven groups: 18-24; 25-29; 30-39; 40-49; 50-59; 60-64; 65 and over. Each category is represented as a separate binary variable coded one if its category matches the respondent's category in the Survey and zero otherwise. In the econometric models "25_29" is used as the base category for age of the eater.

Market Size: The market size variable follows the Standard Metropolitan Statistical Area (SMSA) measure of population in the NPD NET Survey. The SMSA variable includes the following population sizes: 50,000 to 249,999; 250,000 to 499,999; 500,000 to 999,999; 1,000,000 to 2,499,999; 2,500,000 and over. The statistical/econometric models entertain only SMSA and Non-SMSA classifications. Hence, a binary variable is generated to represent market size and coded one if the respondent is from a SMSA and zero otherwise. The base category consequently is Non-SMSA.

Race: White, Black, Oriental, and Other categories are reported by NPD NET Survey. This study represents each race category as a separate variable and scored one if the respondent belongs to that group and zero otherwise. “White” is the base category for the models.

Age and Presence of Children: The NPD NET Survey reports the following categories: Under 6 only; 6-12 only; 13-17 only; 6-12 and 13-17; under 6 and 6-12; under 6 and 13-17; all three groups; no children under 18. A binary variable representing the presence of children under 18 is constructed and coded one if there are children under 18 in the household and zero otherwise. The base category is no children under 18.

Seasonality: The NPD NET Survey reports seasonality on monthly basis. The study aggregated them into 4 seasons. Spring (April to June), Summer (July to September), Fall (December to December), and Winter (January to March). Each season is represented as a separate variable and scored one if it matches the season when the Survey was filled out and zero otherwise. “Spring” is the base category for the models.

*Characteristics of Female Head***:** Characteristics of female head used in this study are employment and education.

Employment of Female Head: Under 35 hours per week; 35 and up hours per week; not employed for pay. Each category is represented as a separate variable scored one if its category matches the respondent's response in the Survey and zero otherwise. "35 and up hours per week" is used as the base category in the econometric models.

Education of Female Head: At most a high school education; At most an undergraduate degree but at least a high school education; Post college graduate. Each category is represented as a separate variable scored one if its category matches the respondent's report in the Survey and zero otherwise. "At most an undergraduate degree but at least a high school education" is the base category for the models.

Health Indicators: The health indicators are body mass index and diet status.

BMI (Body Mass Index): The NPD NET Survey reports the height and weight for each individual. From this information, we calculate the body mass index, which is equal to an individual's height in meters divided by their weight in kg squared. Body mass index is one indicator of an individual's health. Based on recommended body mass indices for men and women (USDA), it is determined whether the individual meets the guidelines (acceptable BMI), is higher than the standards (high BMI), or is lower than the standards (low BMI). Binary variables representing each BMI category are produced and coded one if the person belongs to that group and zero otherwise. The base category for BMI is that the individual meets the dietary guidelines.

Diet Status: Diet by choice; Doctor prescribed diet; Not on a diet or not reported. Each diet status is represented as separate binary variable in the models. The variables are scored one if the diet status matches the respondent's diet status and zero otherwise. Doctor prescribed diet is used as a base dietary status in the econometric models.

Attitudinal/lifestyle Factors: Attitudinal variables correspond to questions from the September Nutritional Quiz indigenous to the NPD NET data. The variables include use of food labels, nutrition-consciousness, taste versus nutrition, and nutrition-health awareness.

Use of Food Labels - "I frequently check labels to determine whether the foods I buy contain anything I'm trying to avoid";

Nutrition-Consciousness - "Household meals should be planned to make sure they are nutritious");

Taste versus Nutrition - "How food tastes is more important than how nutritious it is";

Nutrition-Health Awareness - "A person should be very cautious in serving foods with…cholesterol, additives, fat, salt, and preservatives".

The nutrition-health awareness questions consist of five separate questions. The responses for these questions range from agree completely to disagree mostly and are coded from one (agree completely) to six (disagree mostly) respectfully. Non-responses to these questions also are possible. The September Nutritional Quiz (SNQ), however, was sent randomly to about 90% of individuals participating in the Survey. In order to study the effects of attitudinal factors, individuals not participating in the SNQ are dropped from the analysis. The order and coding of the responses to those questions are reversed for ease of interpretation. The updated ranges of responses start from disagree mostly to agree completely: 1 – Disagree Mostly; 2 - Disagree Somewhat; 3 – Neither Agree Nor Disagree; 4 – Agree Somewhat; 5 – Agree Mostly; and 6 – Completely Agree.

Development and Use of the Candidate Variables in the LA/AIDS Models

The potential determinants used in the selectivity-adjusted censored LA/AIDS models are similar to those discussed in the literature review related to demand systems. The factors used to build the models are volume of intakes (kg of intake over a one-week period) and prices of the selected products ($/kg). Further, total expenditure and average budget shares are calculated based on the information on prices and volume of intakes. We also used the same socio-demographic and other information outlined in Figure 4 to adjust for sample selectivity and censoring in our models.

CHAPTER IV

DESCRIPTIVE STATISTICS

Introduction

Descriptive statistics of the three final data are presented in two sections in this chapter. The first section is focused on the discussion of the NET data, which are the only information used in the sixteen Heckman models. The second section discusses the two data sets (created through joining the NPD NET data with price information from FreshLook and A.C. Nielsen) used to estimate the two LA/AIDS models. The first data set is constructed by merging NPD data with FreshLook data and used in to investigate the price effects on the demand for fresh meats. The descriptive statistics related to penetration, intakes, prices and budget shares of these data are discussed. The second data set is based on the merger of all three data sets (NPD, FreshLook , and A.C. Nielsen) and is used in the investigation of price effects on the pork cuts.

Descriptive Statistics of the Cleaned NPD NET Data

As discussed previously, the original NPD NET data was cleaned and reorganized. First, daily intakes were aggregated to represent consumption per two weeks. Second, individuals 18 years of age and under were dropped from the sample. Third, observations with DNE values for the explanatory variables were dropped from the data leaving about 17,600 individuals in the sample. Fourth, for each of the sixteen Heckman models, individuals with intakes deemed outliers (intakes that are greater than mean intake plus five standard deviations) were dropped. The number of individuals dropped due to being an outlier varies from model to model. However, those numbers are insignificant relative to the sample sizes of the data (see Chapter II for more discussion) and, therefore, do not substantially change the descriptive statistics of the explanatory variables. Hence, the comparative descriptive statistics of the data including the outliers is discussed in this chapter. Table B.1 in Appendix B shows that the cleaning of the NPD NET data did not change dramatically the descriptive statistics of most of the explanatory variables. Relatively visible changes however, are seen in ethnicity and race composition of the sample. The percent of Hispanics is the sample was reduced from about 6.7% (original sample) to roughly 5.5% after the dropping individuals under 18 years of age and observations with DNE values of explanatory variables. The percentage of black individuals after the third stage (7.6%) also is lower by 0.9% relative to the percentage of blacks in the original data.

The means of discrete variables used in the probit and Heckman models are exhibited in Table 8. Means of zero-one variables show the percentage of individuals that fall into particular categories. Seasonality variables are essentially evenly distributed across the sample (variable abbreviations are presented in Chapter II). About 26% of the individuals in our sample are on a diet. Approximately 16% are on a diet by their own choice and 10% are on a diet that is doctor prescribed. Hispanics make up about 5.5% of the sample. Roughly 53% of the sample consists of female eaters. Individuals from households wherein the female head is not employed for pay are about 45% of the sample, while about 34% are those from households wherein the female head works 35 hours or more a week.

Table 8. Means of the Discrete Variables over the Entire Sample from March 1996 to February 2002

Variable	Mean	Variable	Mean
HISPANIC		*REGION*	
Hispanic	0.055	neweng[a]	0.049
nonhisp[a]	0.945	midatl	0.156
SEASON		enc	0.176
spring[a]	0.242	wnc	0.079
summer	0.250	satl	0.169
fall	0.255	esc	0.072
winter	0.254	wsc	0.106
GENDER OF INDIVIDUAL		mount	0.060
femaleet	0.534	pacific	0.132
maleet[a]	0.466	*DIET*	
EMPLOYMENT OF FEMALE HEAD		dietchc	0.156
u35hrs	0.210	presdiet[a]	0.106
o35uphrs[a]	0.341	nodiet	0.738
nefp	0.449	*AGE OF INDIVIDUAL*	
EDUCATION OF FEMALE HEAD		age18_24	0.068
somehs[a]	0.377	age25_29	0.068
somecol	0.508	age30_39[a]	0.204
postgcol	0.115	age40_49	0.235
MARKET SIZE		age50_59	0.185
smsa	0.738	age60_64	0.068
nonsmsa[a]	0.262	age65up	0.172
RACE		*BODY MASS INDEX*	
white[a]	0.886	bmilow	0.190
black	0.076	bmiaccept[a]	0.400
Oriental	0.014	bmihigh	0.410
other	0.025	*SIZE OF THE HOUSEHOLD*	
PRESENCE OF CHILDREN UNDER 18		memb_1	0.129
nochun18	0.609	memb_2[a]	0.360
chun18[a]	0.391	memb_3up	0.510

Notes: [a] indicates the omitted variables used in the analysis.
Italicized letters denote the heading for the group of variables.
The range of these variables is 0-1.
Number of observations is 17,607.
Refer to equation 5 for definitions to the variable abbreviations.

Individuals from households wherein the female head has some college education or has graduated from college are more than half (50.8%) of the sample. The smallest cluster in this category is the group of individuals from households wherein the female head has either graduated from college or has a post college education (about 11%).

Hispanics represent 5.5% of the sample. This ethnic group is underrepresented in the sample, because non-Hispanics and those not reported were put into one group. Individuals who live in non-SMSA areas are about one third of the sample. Whites and blacks represent roughly 96% of the sample, 88% whites and 8% blacks. Orientals and other races make up the remaining 4%. The distribution of individuals by regions ranges from 4.9% (New England) to 17.6% (East North Central). About 61% of the sample are represented by individuals from households wherein there is no children under 18 years of age. Eaters 30 to 39, 40-49, 50-59, and 65 and up comprise about 80% of the sample. Approximately 23% are in age group 40-49, 20% are in age group 30-39, 18% are in age group 50-59, and 17% are in age group 65 and up. The rest of the eaters are distributed equally with roughly 7% within each of age groups of 18-24, 25-29, and 60-64. About 60% of the sample have a Body Mass Index which is out of the recommended range. Approximately 41% are overweight (have higher than acceptable BMI) and 19% are underweight (have lower than acceptable BMI). Roughly 51% of the individuals are from three-or-more member households. Individuals from two-member households comprise about 36% of the sample, and single-member households comprise 13% of the sample.

The descriptive statistics of the non-binary variables used in the Heckman models are exhibited in Table 9. The average income of the sample is about $47,543. The responses from the September Nutritional Quiz range from one (Disagree Mostly) to six (Agree Completely). The description of these questions is provided in Chapter II. The average responses to these questions are between Agree Somewhat (4) and Agree Mostly (5) in the sample. Respondents in the sample are concerned mostly about serving food with fat and cholesterol (with average responses being about 4.8 and about 4.7, respectively). The relatively lowest concern is about serving food with preservatives (4.4). On average, respondents emphasize the importance of planning meals carefully (about 4), believe that “the most important things about food are that it looks good, smells good, and tastes good” (about 4.1), and believe in frequent label checking to determine whether foods they buy contain anything they are trying to avoid (4.4).

Table 9. Descriptive Statistics of the Non-Binary Independent Variables for the Entire Sample from March 1996 to February 2002

Variable	Mean	Standard Deviation	Minimum	Maximum
income	$47,543	$35,369	$3,750	$200,000
chk_labels	4.4	1.5	1	6
plan_meals	4.0	1.2	1	6
cholest	4.7	1.2	1	6
additives	4.5	1.3	1	6
fat	4.8	1.2	1	6
salt	4.6	1.2	1	6
preserv	4.4	1.3	1	6
good_taste	4.1	1.5	1	6

Notes: Number of observations is 17,607.
The ranges of values for the attitudinal/lifestyle variables start from disagree mostly to agree completely: 1 – Disagree Mostly; 2 - Disagree Somewhat; 3 – Neither Agree Nor Disagree; 4 – Agree Somewhat; 5 – Agree Mostly; and 6 – Completely Agree.
Variable names and definition are exhibited In Table A.1 in Appendix A.

Means of the dependent variables are reported in Tables 10 and 11. Intakes of the corresponding products are reported over two consecutive weeks. Table 4.4 shows that the average two-week intakes range from 147.7 grams (chicken) to 261.9 grams (fresh beef) for aggregate fresh meats, from 3.6 grams (pork tenderloin) to 37.9 grams (pork chops) for disaggregate fresh pork cuts and from 12.3 (bacon) to 79.3 grams (ham) for disaggregate processed pork products. On average, the two-week intake of aggregate fresh pork and processed pork are, respectively, 71.8 grams and 203.5 grams. The average intake for all individuals is the product of penetration and average intake of those who consumed the product. For eaters, average two-week intake ranges from 40.1 grams (bacon) to 328.8 grams (fresh beef).

Table 10. Average Individual Intakes (in Grams per Two Weeks) over Entire Sample March 1996 to February 2002

Variable	All Individuals	Individuals with Product Intake	Variable	All Individuals	Individuals with Product Intake
fshpkvol	71.8	175.1	**pkltdvol**	3.6	119.7
bffshvol	261.9	328.8	**baconvol**	12.3	40.1
chfshvol	147.7	203.2	**sausgvol**	42.4	118.2
sffshvol	64.7	196.2	**smkhamvol**	18.8	114.4
psprkvol	203.5	240.4	**canhamvol**	4.0	121.3
pkchvol	37.9	143.6	**lchmtvol**	28.6	110.2
pkrbvol	7.5	133.4	**hamvol**	79.3	155.6
pkrstvol	7.0	150.6	**pkhtdvol**	30.0	128.0

Notes: Number of observations is 17,607.
These variables are used as dependent variables in the intake stage of the Heckman models.
Variable names and definition are exhibited In Table A.1 in Appendix A.

Table 11 shows the penetration based on two-week consumption. The penetration values range from about 33 percent (seafood) to roughly 80 percent (beef) for aggregate fresh meats, from about 3 percent (pork tenderloin) to roughly 26 percent (pork chops) for fresh pork cuts, and from about 3 percent (canned ham) to roughly 36 percent (pork sausage). On average, about 41 percent and 85 percent of the individuals eat fresh pork and processed pork, respectively.

Table 11. Penetration Based on Two Consecutive Weeks over Entire Sample March 1996 to February 2002

Variable	Penetration in %	Variable	Penetration in %
fshpk	40.98%	**pkltd**	3.02%
bffsh	79.66%	**bacon**	30.80%
chfsh	72.70%	**sausg**	35.92%
sffsh	32.98%	**smkh**	16.46%
psprk	84.61%	**canh**	3.27%
pkch	26.39%	**lchmt**	25.94%
pkrb	5.61%	**ham**	50.99%
pkrst	4.66%	**pkhtd**	23.45%

Note: Number of observations is 17,607.
These variables are used as dependent variables in the selection stage of the Heckman models.
Variable names and definition are exhibited In Table A.1 in Appendix A.

Descriptive Statistics of the Variables Used in the LA/AIDS Models

In this section we consider the descriptive statistics of the variables used in the three-stage LA/AIDS models for at-home fresh meats (pork, beef, chicken, and seafood) and pork cuts (pork chops, pork ribs, pork roasts, pork tenderloin, bacon, pork sausage, smoked ham, canned ham, and lunchmeat). The variables used in the first two stages are the same as those used in the Heckman models. The descriptive statistics of socio-demographic variables used in the first two stages is presented in Section I of Chapter III. Here, we focus on intakes, prices, and mean budget shares of the products entering the demand systems. We first discuss the descriptive statistics related to the demand system of aggregate fresh meats and then move to the discussion of the descriptive statistics related to the demand system for pork cuts.

Descriptive Statistics of the Variables Used in the Demand System for Fresh Meats

Table 12 shows the percentage of zero intakes, mean intake, mean total prices, and mean budget shares of at-home fresh meats. The prices are represented in dollars per kilogram and the intakes are measured in kilograms per week. Fresh beef is the most important in terms of consumption. On average, consumption per week per individual is roughly 0.158 kg of fresh beef, 0.089 kg for fresh chicken, about 0.044 kg for fresh pork, and 0.039 kg for fresh seafood. Mean average budget shares range from 12 percent (fresh pork) to 47% (fresh beef). For each dollar spent on the "fresh meats" group, only about 12 cents is allocated to purchasing fresh pork and 47 cents is spent on fresh beef. In terms of prices, seafood is the most expensive item ($6.36 per kilogram on average) while fresh chicken ($2.13 per kilogram) is the least expensive commodity. Beef price and pork price are, respectively, $2.13 and $2.13 per kilogram. Total weekly expenditure on fresh meats, on average, is about $2.20 on average.

Table 12. Percent of Zero Intakes, Average Consumption, Average Prices of the At-Home Fresh Meat Products and Average Budget Shares

Meat Items	% of zero Intakes	Mean Intake in kg per week	Mean Price in $ per kg	Budget % of Share
Fresh Pork	68%	0.044	5.91	12%
Fresh Beef	26%	0.158	6.39	47%
Fresh Chicken	37%	0.089	4.23	25%
Fresh Seafood	74%	0.039	13.32	15%

Note: The data run from January 1998 to December 2001
Number of observations is 21,264.
All numbers are conditional on eating at least one product from at-home pork group.
9.2% of individuals did not eat any commodity from at-home fresh meats group.

Descriptive Statistics of the Variables Used in the Demand System for Fresh and Processed Pork Cuts

Table 13 shows the percentage of zero intakes, mean intake, mean total prices, and mean average budget shares of nine at-home disaggregate pork products used in the LA/AIDS model. As well, prices and intakes are measured in $ per kilogram and kg per week, respectively. Pork chops and pork sausage are the most important in terms of consumption. On average, consumption of at-home pork ranges from about 0.003 kg (pork tenderloin) to 0.034 kg (pork chops and pork sausage). In terms of prices, lunchmeats is the most expensive item ($20.04 per kilogram on average) while smoked ham ($4.68 per kilogram) is the least expensive commodity. For each dollar spent on the "pork cuts" group, roughly 80 cents is spent on three products: pork sausage (23 cents), pork lunchmeat (22 cents), pork chops (20 cents), and bacon (16 cents). Pork tenderloin (2 %) is least important in terms of budget on at-home pork cuts. The average total expenditure was about $1.2.

Table 13. Percent of Zero Intakes, Average Budget Shares, Average Consumption and Average Prices of the At-Home Pork Products

Meat Items	% of zero Intakes	Mean Intake in kg per week	Mean Price in $ per kg	Budget % of Share
Pork Chops	72%	0.036	7.48	20%
Pork Ribs	94%	0.007	5.48	4%
Pork Roasts	95%	0.006	4.78	3%
Pork Tenderloin	97%	0.003	11.41	2%
Bacon	64%	0.011	6.14	16%
Pork Sausage	62%	0.034	5.59	23%
Smoked Ham	85%	0.013	4.68	8%
Canned Ham	96%	0.004	5.29	2%
Lunchmeats	71%	0.024	20.49	23%

Note: The data period covers April 1999 to December 2001
Number of observations is 9,902.
63.4% of individuals did not consume any commodity from at-home pork group.
All findings are conditional on eating at least one commodity from at-home pork group.
Total expenditure per individual per week is about $1.2.

CHAPTER V

EMPIRICAL RESULTS ASSOCIATED WITH THE HECKMAN SAMPLE SELECTION MODELS

Introduction

In this chapter, we discuss the results of the sixteen two-stage Heckman sample selection models, concerning the consumption of fresh and processed pork products as well as fresh beef, chicken, and seafood. Fresh pork products are fresh pork, pork chops, pork ribs, pork roasts, and pork tenderloin. Processed pork products are processed pork, bacon, ham, canned ham, smoked ham, pork sausage, lunchmeat, and pork hotdogs.

The models are estimated using NPD NET data pertaining to individual intakes (in grams per two-weeks) of the selected products. The NET data covers the six-year period from March 1996 to February 2002. The market considered is the at-home market in the United States. The unit of observation in these models is a representative individual over 18 years of age. The total number of individuals in the samples is about 17,600.

The results are compared to those in the literature. It is possible to have different results. Some of the reasons for this situation are as follows:

- Different data sets are used
    - a. Completely different databases
    - b. Additional observations (larger sample)

- Different variables are considered
- Different functional forms are applied
- Different methods are used

This work is most closely related to Briggeman. The author also examined the key socio-demographic factors affecting the decision to eat fresh and processed pork at home. Further, Briggeman also used data from NPD NET.

The differences in the results that could be pointed out could be due to three major differences in the final samples used in this study and Briggeman's analysis. First, fresh and processed pork products categories do not match perfectly. Second, the data used in this analysis covers larger period relative to sample used in Briggeman's research. Third, this study included eight attitudinal/lifestyle factors corresponding to the questions from the September Nutritional Quiz (SNQ) in addition to the factors considered by Briggeman.

In the first stage, we model the participation (or selection) decision of individuals (i.e., to eat or not to eat the selected products) using probit models. Drivers considered in the first stage are income, seasonality, characteristics of individual (ethnicity, gender, race, and age), characteristics of the female head (employment and education), market size, region, household size, presence of children under 18, health indicators (diet and Body Mass Index), and eight attitudinal/lifestyle indicators. The selection stage results include the estimated parameters of the models and their corresponding p-values and marginal effects.

We also report two goodness-of-fit measures of the selection stage of the Heckman models. These measures are McFadden R^2 (developed by McFadden) and likelihood-ratio (χ^2) test statistic. McFadden R^2 (or Pseudo R2) is given by

$$\text{Pseudo R2} = \frac{-2*\log\left(L_0\right)-\left(-2*\log\left(L_1\right)\right)}{-2*\log\left(L_1\right)}$$

and the likelihood-ratio (χ^2) test statistic is given by

$$\text{LR chi2} = -2*\log\left(L_0\right)-\left(-2*\log\left(L_1\right)\right)$$

where log (L_0) is the value of log likelihood at iteration 0 and log (L_1) is the value of log likelihood at final iteration. McFadden R^2 is a pseudo measure of the percentage of the variation in the dependent variable explained by the dependent variables. The likelihood-ratio (χ^2) test statistic tests the NULL hypothesis that the parameters of all explanatory variables are not significantly different from zero. If rejected it means there is at least one explanatory variable with a statistically significant parameter.

In the second stage, we model actual consumption of the selected products. Drivers considered in the second stage are income, seasonality, characteristics of individual (ethnicity, gender, race, and age), market size, region, and household size. We assume that income has a nonlinear effect on the consumption of selected products. Two variables describing income (income and income squared) therefore, are included in the models to capture this nonlinear relationship. The second stage results include the estimated parameters of the models, their corresponding p-values, and both conditional and unconditional marginal effects. We also report two goodness-of-fit measures of the intake stage of the Heckman models. These measures are squared correlation of predicted and actual values of the dependent variables (further referred as R^2_c) and Wald (χ^2) test statistic.

It is important to mention that the Heckman model allows for different directional effects, magnitudes, and significance levels for the same determinants appearing in both stages (selection and intake). Moreover, for each factor appearing in the intake stage, we calculated two sets of marginal effects: for eaters only (i.e., conditional) and for all individuals (i.e., unconditional). These marginal effects also can have different directional impacts on the consumption of the selected products. This situation can be easily explained looking at the McDonald and Moffitt decomposition of the unconditional marginal effect. As mentioned in Chapter II, the unconditional marginal effect can be decomposed into two parts:

$$\hat{ME}_{kj}^{\text{unconditional}} = \frac{\partial \Phi\left(y_{1k}=1\right)}{\partial x_j} * E\left[y_{2k} \mid y_{1k}=1\right] + \Phi\left(y_{1k}=1\right) * \hat{ME}_{kj}^{\text{conditional}}$$

The first part represents the expected intake of the eaters of the corresponding product multiplied with the marginal effect of the likelihood of eating the product. The second part represents the conditional marginal effect multiplied with the probability of eating. Hence, if the absolute value of the first part is bigger that that of the second part and the signs of these two parts are different, then the sign of the unconditional marginal effect will be different from that of conditional marginal effect.

This chapter is divided into three sections. The first section discusses the participation stage results, and the second section discusses the consumption stage results. Each section is further divided into three parts. In the first part, we discuss the results associated with at-home fresh meats (i.e., fresh pork, fresh beef, fresh chicken, and fresh seafood). In the second part, we present the key findings associated with fresh pork cuts (i.e., pork chops, pork ribs, pork roasts, and pork tenderloin). In the third part, we discuss the results associated with processed pork category. Specifically, drivers of consumption of processed pork, ham, bacon, smoked ham, canned ham, pork hotdogs, and pork lunchmeat are discussed in this section. This separation allows for comparative discussion of the effects of the key factors on the consumption of products within the categories. For all statistical analysis, the level of significance chosen is 0.05. The marginal effects are discussed if their corresponding parameters are significantly different from zero.

At-Home Fresh Meats (Pork, Beef, Chicken, and Seafood)

Selection Stage Results

This part of the study discusses the profile of individuals who are likely to eat at-home fresh pork, beef, chicken, and seafood. As described previously, separate discussion of results for this stage is provided for each of three product categories.

The parameter estimates and their significance levels and the marginal effects of the probit models are presented in Tables 14 and 15. The likelihood-ratio (χ^2) test statistics indicate that the coefficients are statistically different from zero at the 0.05 level. The McFadden R^2 ranges from 0.0322 (fresh pork) to 0.0746 (fresh beef). Such low values of McFadden R^2 statistic are common with individual based data.

Table 14. First Stage Heckman Model Results for At-Home Fresh Pork, Beef, Chicken, and Seafood

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
income	1.33E-06	9.91E-07	1.99E-06	2.77E-06
	(0.124)	(0.309)	(0.030)	(0.002)
inc_2	-7.65E-12	-1.14E-11	-6.93E-12	-3.97E-12
	(0.132)	(0.041)	(0.198)	(0.440)
ETHNICITY				
Hispanic	0.0981	-0.0288	0.0150	0.1044
	(0.031)	(0.586)	(0.760)	(0.028)
SEASON				
summer	-0.0651	0.0257	0.0494	-0.0842
	(0.019)	(0.420)	(0.095)	(0.003)
fall	0.0169	0.1023	0.1106	-0.1153
	(0.539)	(0.001)	(0.000)	(0.000)
winter	-0.1042	-0.0572	-0.1324	-0.0637
	(0.000)	(0.069)	(0.000)	(0.026)
GENDER				
femaleet	0.0056	-0.0434	0.0740	0.0070
	(0.777)	(0.056)	(0.000)	(0.731)
EMPLOYMENT OF FEMALE HEAD				
u35hrs	-0.0223	0.0252	0.0475	-0.0218
	(0.425)	(0.430)	(0.109)	(0.456)
nefp	0.0113	0.1023	0.0974	0.0739
	(0.648)	(0.000)	(0.000)	(0.004)
EDUCATION OF FEMALE HEAD				
somecol	-0.0905	-0.1436	0.0147	0.0295
	(0.000)	(0.000)	(0.539)	(0.209)
postgcol	-0.2957	-0.3591	-0.1237	0.0813
	(0.000)	(0.000)	(0.001)	(0.030)

Table 14. Continued

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
MARKET SIZE				
smsa	-0.0831	-0.1141	0.0459	-0.0224
	(0.000)	(0.000)	(0.067)	(0.367)
RACE				
black	0.1832	-0.0638	0.3879	0.4927
	(0.000)	(0.140)	(0.000)	(0.000)
Oriental	0.3443	-0.4360	0.2237	0.5252
	(0.000)	(0.000)	(0.018)	(0.000)
other	0.1141	-0.0630	-0.0281	-0.0697
	(0.083)	(0.402)	(0.690)	(0.319)
REGION				
midatl	0.0004	-0.1727	-0.0733	-0.0318
	(0.993)	(0.004)	(0.184)	(0.535)
enc	-0.0016	-0.0790	-0.1975	-0.2523
	(0.974)	(0.180)	(0.000)	(0.000)
wnc	0.0390	-0.0164	-0.3535	-0.3005
	(0.485)	(0.808)	(0.000)	(0.000)
satl	-0.0508	-0.2197	-0.1644	-0.0092
	(0.308)	(0.000)	(0.003)	(0.856)
esc	-0.0419	-0.1171	-0.2251	-0.2337
	(0.463)	(0.085)	(0.000)	(0.000)
wsc	-0.0623	-0.0335	-0.1841	-0.2071
	(0.242)	(0.598)	(0.002)	(0.000)
mount	-0.1297	-0.0270	-0.1919	-0.1789
	(0.029)	(0.703)	(0.003)	(0.003)
pacific	-0.2407	-0.3239	-0.2307	-0.1103
	(0.000)	(0.000)	(0.000)	(0.036)
DIET				
dietchc	-0.0651	-0.1140	-0.1570	-0.0336
	(0.096)	(0.010)	(0.000)	(0.395)
nodiet	0.0379	0.0082	-0.1112	-0.0760
	(0.257)	(0.832)	(0.002)	(0.025)

Table 14. Continued

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
ATTITUDE/LIFESTYLE				
chk_labels	-0.0473	-0.0524	0.0092	0.0306
	(0.000)	(0.000)	(0.268)	(0.000)
plan_meals	0.0486	0.0257	0.0620	0.0717
	(0.000)	(0.015)	(0.000)	(0.000)
cholest	0.0117	-0.0092	0.0144	-0.0031
	(0.395)	(0.561)	(0.316)	(0.827)
additives	0.0267	0.0438	-0.0083	0.0326
	(0.082)	(0.013)	(0.607)	(0.040)
fat	-0.0164	-0.0210	-0.0183	0.0081
	(0.290)	(0.235)	(0.262)	(0.614)
salt	-0.0125	-0.0111	0.0061	-0.0263
	(0.357)	(0.474)	(0.668)	(0.060)
preserv	-0.0099	-0.0314	0.0262	-0.0098
	(0.509)	(0.068)	(0.098)	(0.526)
good_taste	0.0001	0.0089	-0.0007	-0.0135
	(0.986)	(0.249)	(0.927)	(0.052)
AGE OF INDIVIDUAL				
age18_24	-0.0492	-0.1114	-0.0201	-0.1350
	(0.262)	(0.027)	(0.666)	(0.005)
age25_29	-0.1841	-0.2588	-0.0302	-0.2171
	(0.000)	(0.000)	(0.510)	(0.000)
age40_49	0.0965	0.0767	-0.0211	0.0671
	(0.001)	(0.028)	(0.507)	(0.032)
age50_59	0.2554	0.1876	0.0313	0.1662
	(0.000)	(0.000)	(0.386)	(0.000)
age60_64	0.3224	0.0916	-0.0293	0.2643
	(0.000)	(0.079)	(0.547)	(0.000)
age65up	0.3656	0.1616	-0.0696	0.3671
	(0.000)	(0.000)	(0.080)	(0.000)

Table 14. Continued

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
PRESENCE OF CHILDREN				
nochun18	0.0226	-0.0664	-0.0892	0.0965
	(0.471)	(0.078)	(0.009)	(0.003)
HOUSEHOLD SIZE				
memb_1	-0.4355	-0.5646	-0.3705	-0.2482
	(0.000)	(0.000)	(0.000)	(0.000)
memb_3up	0.0896	0.2189	0.0554	-0.0888
	(0.004)	(0.000)	(0.096)	(0.005)
BODY MASS INDEX				
bmilow	0.0602	0.0334	-0.0336	-0.0793
	(0.027)	(0.283)	(0.242)	(0.005)
bmihigh	0.0614	0.0864	0.0544	-0.0409
	(0.005)	(0.001)	(0.020)	(0.073)
_cons	-0.2522	1.3169	0.3834	-0.8357
	(0.010)	(0.000)	(0.000)	(0.000)
Number of obs	17,581	17,576	17,564	17,589
LR chi2(44)	765.35	1325.71	757.84	1319.38
Prob > chi2	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R2	0.0322	0.0746	0.0368	0.0592

Notes: The p-values are presented in parentheses below the parameter estimates
Variable names and definition are exhibited In Table A.1 in Appendix A.

Table 15. Marginal Effects for First Stage Heckman Models for At-Home Fresh Pork, Beef, Chicken, and Seafood

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
income	4.97E-07	2.59E-07	6.37E-07	9.39E-07
ETHNICITY				
Hispanic*	0.0384	-0.0078	0.0049	0.0381
SEASON				
summer*	-0.0251	0.0069	0.0161	-0.0298
fall*	0.0066	0.0269	0.0357	-0.0406
winter*	-0.0401	-0.0156	-0.0443	-0.0226
GENDER				
femaleet*	0.0022	-0.0117	0.0243	0.0025
MARKET SIZE				
smsa*	-0.0323	-0.0300	0.0152	-0.0080
RACE				
black*	0.0720	-0.0176	0.1131	0.1882
Oriental*	0.1363	-0.1380	0.0682	0.2025
other*	0.0447	-0.0174	-0.0093	-0.0245
REGION				
midatl*	0.0002	-0.0489	-0.0244	-0.0113
enc*	-0.0006	-0.0218	-0.0673	-0.0863
wnc*	0.0152	-0.0044	-0.1255	-0.1001
satl*	-0.0196	-0.0629	-0.0557	-0.0033
esc*	-0.0162	-0.0329	-0.0780	-0.0791
wsc*	-0.0240	-0.0091	-0.0630	-0.0709
mount*	-0.0495	-0.0073	-0.0661	-0.0613
pacific*	-0.0908	-0.0961	-0.0795	-0.0386
AGE OF INDIVIDUAL				
age18_24*	-0.0190	-0.0313	-0.0067	-0.0468
age25_29*	-0.0697	-0.0764	-0.0100	-0.0738
age40_49*	0.0376	0.0203	-0.0069	0.0241
age50_59*	0.1003	0.0479	0.0102	0.0607
age60_64*	0.1274	0.0238	-0.0097	0.0987
age65up*	0.1440	0.0415	-0.0232	0.1371

Table 15. Continued

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
HOUSEHOLD SIZE				
memb_1*	-0.1592	-0.1778	-0.1308	-0.0844
memb_3up*	0.0347	0.0591	0.0182	-0.0317
EMPLOYMENT OF FEMALE HEAD				
u35hrs*	-0.0086	0.0067	0.0155	-0.0078
nefp*	0.0044	0.0274	0.0319	0.0264
EDUCATION OF FEMALE HEAD				
somecol*	-0.0351	-0.0386	0.0048	0.0105
postgcol*	-0.1104	-0.1080	-0.0418	0.0294
DIET				
dietchc*	-0.0251	-0.0318	-0.0532	-0.0119
nodiet*	0.0147	0.0022	-0.0359	-0.0274
ATTITUDE/LIFESTYLE				
chk_labels	-0.0183	-0.0141	0.0030	0.0109
plan_meals	0.0188	0.0069	0.0204	0.0256
cholest	0.0045	-0.0025	0.0047	-0.0011
additives	0.0103	0.0118	-0.0027	0.0116
fat	-0.0064	-0.0057	-0.0060	0.0029
salt	-0.0048	-0.0030	0.0020	-0.0094
preserv	-0.0038	-0.0085	0.0086	-0.0035
good_taste	4.46E-05	0.0024	-0.0002	-0.0048
PRESENCE OF CHILDREN				
nochun18*	0.0087	-0.0178	-0.0291	0.0343
BODY MASS INDEX				
bmilow*	0.0234	0.0089	-0.0111	-0.0280
bmihigh*	0.0238	0.0231	0.0178	-0.0146

Notes: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1.
Variable names and definition are exhibited In Table A.1 in Appendix A.

All drivers are important in terms of the decision to eat at-home fresh meats except concerns about serving food with cholesterol, fat, salt, and preservatives as well as the belief that the most important things about food are that it looks good, smells good, and tastes good.

Income is a statistically significant factor positively affecting the decision to eat at-home fresh meats, except at-home fresh pork. This finding is of contrast to that of Briggeman. Briggeman reported that income has a significantly positive impact on the decision to eat at-home fresh pork. The magnitude of the impact is very small though (ranging from 2.59E-07 (fresh beef) to 9.39E-07 (fresh seafood).

Ethnicity plays a role in the probability of eating at-home pork and seafood. Hispanics have a higher probability consuming at-home fresh pork (0.0384 basis points) and seafood (0.0381 basis points) relative to non-Hispanics. Briggeman however found that ethnicity does not have a significant affect on the decision to eat at-home fresh pork.

Seasonality affects the likelihood of eating at-home fresh meats. This finding is consistent with the finding is in agreement with that of Briggeman. Individuals in the summer and winter have a lower likelihood, ranging from 0.0251 to 0.0401 basis points, of eating at-home fresh pork relative to the spring. The likelihood of eating at-home fresh beef is higher by 0.0269 basis points in the fall relative to the spring. Relative to the spring, the probability of eating at-home fresh chicken is higher in the fall by 0.0357 basis points and lower in the winter by 0.0443 basis points. The likelihood of eating at-home fresh seafood is lower in the summer, in the fall, and in the winter by 0.0226 to 0.0406 basis points relative to spring.

Gender is a key driver for the decision to eat at-home fresh chicken but does not have a statistically significant impact on the selection of at-home fresh pork, beef, and seafood. This result is in contrast with the finding of Briggeman. He shows that female eaters have significantly higher likelihood of eating at-home fresh pork. Female eaters have a higher probability of 0.0243 basis points of eating at-home fresh chicken relative to male eaters.

Employment of the female head plays a role in the likelihood of eating at-home fresh beef, chicken, and seafood. This factor however, does not have a statistically significant impact on the decision to eat at-home fresh pork. This result is in contrast with the finding of Briggeman. He shows the employment of the female head has a positive impact on the likelihood of eating at-home fresh pork. Individuals in households wherein the female head is not employed for pay have a higher likelihood, ranging from 0.0264 to 0.0319 basis points, of eating at-home fresh beef, chicken, and seafood relative to individuals in households wherein the female head is employed 35 hours or more per week. Individuals in households wherein the female head is employed less than 35 hours per week are not statistically different from those in households wherein the female head is employed 35 hours or more per week in terms of likelihood of eating any of the four at-home fresh meats.

Individuals in households wherein the female head has some college education or has graduated college have a lower probability, ranging from of 0.0351 to 0.0386 basis points, of eating at-home fresh pork and beef. Individuals in households wherein the female head has a post-college education have a lower probability of 0.0418 to

0.1104 basis points of eating at-home fresh pork, beef, and chicken, but a higher probability of 0.0294 basis points of eating at-home fresh seafood. Briggeman also shows that education of female head has a negative association with likelihood of eating at-home fresh pork.

Market size is an important factor in affecting the decision to eat at-home fresh pork and beef. Individuals from SMSAs have a lower likelihood of 0.0323 to 0.0300 basis points of consuming at-home fresh pork and beef relative those from non-SMSAs. This result is in agreement with the finding of Briggeman.

Race plays a role in the likelihood of eating fresh meats. Relative to whites, blacks have a higher the probability of 0.0720 to 0.1882 basis points of eating at-home fresh pork, chicken, and seafood. This result is in agreement with the finding of Briggeman. Orientals have a higher likelihood of 0.0682 to 0.2025 basis points of eating at-home fresh pork, chicken, and seafood, but a lower likelihood of 0.1380 basis points of eating at-home fresh beef than whites. Other individuals do not have a significantly different probability of eating fresh meats relative to whites.

There are regional differences in the consumption of at-home fresh pork, beef, chicken, and seafood. On average, individuals residing in the New England region have the highest likelihood of eating at-home fresh meats. Further, individuals residing in the Pacific region have the lowest likelihood of eating at-home fresh pork, beef, and chicken. Individuals residing in the West North Central region have the lowest likelihood of eating at-home fresh seafood. Individuals from the New England region have a higher probability of 0.0495 to 0.0908 basis points of eating at-home fresh pork relative to those living in the Mountain and Pacific regions. Briggeman also finds individuals from Pacific region have the lowest likelihood of eating at-home fresh pork. Individuals who live in the Middle Atlantic, South Atlantic, and Pacific regions have a lower probability of 0.0489 to 0.0961 basis points of eating at-home fresh beef relative to those from the New England. Individuals residing in the New England region have a higher probability of 0.0557 to 0.1255 basis points of eating at-home fresh chicken relative to those living in other regions, except the Middle Atlantic region. Individuals living in the East North Central, West North Central, East South Central, West South Central, Mountain, and Pacific regions have a lower probability of 0.0386 to 0.1001 basis points of eating at-home fresh seafood than those from the New England.

Not all attitudinal/lifestyle factors are drivers of the decision to eat at-home fresh meats. Concerns about serving foods with cholesterol, fat, salt, and preservatives (represented by *cholest*, *fat*, *salt*, and *preserve* variables) and the belief about how food tastes is more important than how nutritious it is (represented by *good_taste* variable) do not significantly affect the decision to eat at-home fresh meats. It should be noted that the responses to the September Nutritional Quiz are measured on a six-scale basis (from one “Disagree Mostly” to six “Agree Completely”). The level of individuals’ cautiousness about serving foods with additives is positively associated with the higher the probability of eating at-home fresh beef and seafood (with marginal effects of 0.0118 and 0.0116 basis points, respectively). Hence, the likelihood of eating at-home fresh beef and seafood increases by 0.0118 and 0.0116 basis points, respectively, with each unit increase in the concern about serving foods with additives. Checking labels is negatively associated with the likelihood of eating at-home fresh pork and beef. The marginal effects are 0.0183 and 0.0141basis points, respectively. Checking labels, however, is positively associated with the likelihood of eating at-home fresh seafood. Those individuals who stress the importance of planning meals to make sure they are nutritious have a higher probability of eating any of four at-home fresh products. The marginal effects are 0.0188 basis points for pork, 0.069 basis points for beef, 0.0204 basis points for chicken, and 0.0256 basis points for seafood.

Age of individual is an important factor in the decision to eat at-home fresh pork, beef, and seafood, but is not important in the decision to eat at-home fresh chicken. In general, as individuals get older they have a higher likelihood of eating at-home fresh pork, beef, and seafood. This finding is in agreement with that of Briggeman. Individuals 65 and more have the highest likelihood of eating at-home fresh pork and seafood. They have a higher likelihood of 0.1371 to 0.1440 basis points of eating these products relative to those between 30 and 39 years of age. Individuals between 50 and 59 years of age have the highest likelihood of eating at-home fresh beef. They have a higher likelihood of 0.0479 basis points of eating at-home fresh beef relative to those between 30 and 39 years of age. Individuals between 25 and 29 years of age have the lowest likelihood of eating at-home fresh pork, beef, and seafood. They have a lower likelihood of 0.0697 to 0.0764 basis points of eating these products relative to those between 30 and 39 years of age.

The presence of children under 18 is an important determinant of the decision to consume at-home fresh chicken and at-home fresh seafood, but does not affect the decision to eat at-home fresh pork and beef. Individuals in households wherein there are no children under 18 have lower probability of 0.0291 basis points of eating at-home fresh chicken and a higher probability of 0.0343 basis points of eating fresh seafood, respectively, relative to those from households wherein there are children under 18.

Household size plays a role in the decision to eat any of the four at-home fresh meats. In general, larger households have higher likelihood of eating at-home fresh pork and beef. Individuals from one-member households have a lower likelihood of 0.0844 to 0.1778 basis points of eating at-home fresh meats relative to those from two-member households. Individuals from households with at least three members have a higher likelihood of 0.0347 basis points of eating at-home fresh pork and beef, respectively, but have a lower likelihood of 0.0317 basis points of eating at-home fresh seafood relative to those from two-member households.

Moreover, health indicators (dieting and Body Mass Index) are important factors in the decision to eat at-home fresh meats. Dieting however, does not affect the decision to eat at-home fresh pork. This result is in contrast with the finding of Briggeman. Briggeman shows that being on diet by own choice lowers the likelihood of eating at-home fresh pork. Individuals who are on a diet by choice have a lower probability of 0.0318 basis points of eating at-home fresh beef and a lower probability of 0.0532 basis points of eating at-home fresh chicken relative to individuals who are on a doctor prescribed diet. Individuals who are not on diet have a lower likelihood of 0.0359 basis points of eating at-home fresh chicken and a lower likelihood of 0.0274 basis points of eating at-home fresh seafood relative to individuals who are on a doctor prescribed diet.

Individuals with higher than recommended BMI have a higher probability of 0.0178 to 0.0238 basis points of eating at-home fresh pork, beef and chicken relative to those who are within recommended standards of BMI. This result is in ageement with the finding of Briggeman. Briggeman shows that BMI is positively associated with the likelihood of eating at-home fresh pork. Individuals with lower than recommended BMI have a higher likelihood of 0.0234 basis points of eating at-home fresh pork and a lower likelihood of 0.0280 basis points of eating at-home fresh seafood relative to those who are within recommended standards of BMI.

Intake Stage Results

This part of the study discusses the key factors affecting the volume of intake of at-home fresh pork, beef, chicken, and seafood. As described previously, separate discussion of results for this stage is provided for each of three product categories.

The parameter estimates and measures of fit of the second stage of the Heckman sample selection models for fresh meats are presented in Table 16. The squared correlations (R^2_c) between actual and predicted intakes range from 0.0509 (fresh pork) to 0.1192 (fresh beef), reasonable with individual based data. The Wald χ^2 test statistics are statistically significant in all four models, indicating that the coefficients Heckman models are statistically different from zero at 0.05 level.

Table 16. Second Stage Heckman Model Results for At-Home Fresh Meats (Pork, Beef, Chicken, and Seafood)

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
income	-3.42E-04	-1.17E-03	-2.58E-04	-3.71E-04
	(0.002)	(0.000)	(0.037)	(0.020)
inc_2	1.60E-09	4.31E-09	8.55E-10	1.76E-09
	(0.021)	(0.000)	(0.253)	(0.047)
ETHNICITY				
Hispanic	7.1233	-12.8211	-3.0587	-6.4326
	(0.248)	(0.180)	(0.653)	(0.469)
SEASON				
summer	6.0294	11.0517	5.3693	-2.5817
	(0.116)	(0.058)	(0.200)	(0.633)
fall	6.0463	-9.4877	-2.6526	-3.7688
	(0.097)	(0.106)	(0.535)	(0.498)
winter	3.6570	-2.6867	11.0754	-2.6973
	(0.354)	(0.647)	(0.014)	(0.616)
GENDER				
femaleet	-61.5150	-113.6548	-52.3062	-33.7060
	(0.000)	(0.000)	(0.000)	(0.000)
MARKET SIZE				
smsa	-2.3416	-2.6934	-3.2276	-0.9241
	(0.479)	(0.598)	(0.373)	(0.845)
RACE				
black	21.3140	-19.8964	32.3003	3.6902
	(0.000)	(0.014)	(0.000)	(0.681)
Oriental	42.4823	25.1706	65.0965	-8.9232
	(0.000)	(0.233)	(0.000)	(0.556)
other	0.8583	-1.6897	19.5992	10.0101
	(0.923)	(0.904)	(0.049)	(0.461)
REGION				
midatl	12.5319	-8.6568	-14.1448	3.6765
	(0.060)	(0.418)	(0.059)	(0.691)
enc	25.8042	0.7566	-12.5883	-5.1367
	(0.000)	(0.942)	(0.100)	(0.606)
wnc	37.2070	25.8282	-4.4790	3.2307
	(0.000)	(0.026)	(0.633)	(0.786)

Table 16. Continued

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
satl	22.4532	-1.4536	-0.5859	-0.1936
	(0.001)	(0.892)	(0.939)	(0.983)
esc	24.2287	-2.7294	-8.2790	-25.9376
	(0.002)	(0.820)	(0.350)	(0.024)
wsc	39.5951	9.5765	7.6750	3.0414
	(0.000)	(0.388)	(0.349)	(0.772)
mount	9.9472	-8.9802	-8.8426	-22.5305
	(0.222)	(0.464)	(0.331)	(0.051)
pacific	22.2372	-0.3384	2.3137	-0.9059
	(0.004)	(0.977)	(0.775)	(0.925)
AGE OF INDIVIDUAL				
age18_24	-6.6059	21.6306	-21.3173	-4.1524
	(0.274)	(0.018)	(0.001)	(0.674)
age25_29	6.0227	3.9858	-7.5713	7.8438
	(0.371)	(0.685)	(0.246)	(0.457)
age40_49	-8.8682	3.7197	4.1258	1.1664
	(0.034)	(0.548)	(0.352)	(0.852)
age50_59	-13.4905	7.1332	-14.2799	-15.0338
	(0.009)	(0.307)	(0.003)	(0.035)
age60_64	-22.8547	13.7667	-34.0273	-8.4717
	(0.001)	(0.146)	(0.000)	(0.375)
age65up	-36.8845	-36.4044	-33.6257	-20.0102
	(0.000)	(0.000)	(0.000)	(0.029)
HOUSEHOLD SIZE				
memb_1	21.0724	7.4955	45.8087	22.7552
	(0.006)	(0.532)	(0.000)	(0.002)
memb_3up	-15.3666	24.8983	-11.0640	-3.6718
	(0.000)	(0.000)	(0.004)	(0.463)
_cons	271.2787	475.8618	323.2831	346.4613
	(0.000)	(0.000)	(0.000)	(0.000)
mills Lambda	-69.1714	-182.0893	-165.9329	-107.1511
	(0.000)	(0.000)	(0.000)	(0.000)

Table 16. Continued

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
Number of obs	17,581	17,576	17,564	17,589
Censored obs	10,391	3,581	4,807	11,800
Uncensored obs	7,190	13,995	12,757	5,789
Wald chi2(52)	1226.60	1599.87	962.52	699.55
Prob > chi2	(0.000)	(0.000)	(0.000)	(0.000)
R^2_c	0.0509	0.1192	0.0568	0.0772

Notes: The p-values are presented in parentheses below the parameter estimates. R^2_c represents the squared correlation between actual and predicted intakes for all individuals.
Variable names and definition are exhibited In Table A.1 in Appendix A.

The key drivers of the absolute amount of at-home fresh meats intake are income, season, gender of eater, race of eater, region, age of eater, and household size. The mills ratio (*mills lambda*) is statistically significant in all four models. This finding emphases that our approach to adjust for sample selection was the correct one to follow.

The marginal effects for all individuals and for individuals who ate the selected products are presented in Table 17 and Table 18, respectively. Both conditional and unconditional measures of marginal intake are presented based on two consecutive weeks of consumption. Key drivers of the absolute amount of at-home fresh meats are income, gender of eater, race of eater, region, age of eater, and household size. Market size does not play a key role in the actual intake of at-home fresh meats. Income plays a role in the consumption of at-home fresh meats. For all individuals, household income yields a low marginal effect. For all individuals, the income elasticities for the fresh meats are -0.01 (pork), -0.16 (beef), -0.02 (chicken), and income elasticities for the fresh

Table 17. Marginal Effects and Elasticities for All Individuals after the Second Stage of the Heckman Models for At-Home Fresh Pork, Beef, Chicken, and Seafood

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
income	-1.55E-05	-8.64E-04	-6.00E-05	1.92E-04
income (elasticity)	-0.01	-0.16	-0.02	0.14
ETHNICITY				
Hispanic*	11.72	-14.57	-0.40	7.64
SEASON				
summer*	-3.16	12.77	10.10	-8.32
fall*	3.92	6.97	11.65	-11.38
winter*	-7.39	-10.62	-8.63	-6.55
GENDER				
femaleet*	-24.42	-98.77	-29.09	-10.10
MARKET SIZE				
smsa*	-8.18	-18.71	3.36	-2.35
RACE				
black*	26.24	-25.36	72.42	54.13
Oriental*	54.55	-52.53	79.03	52.75
other*	10.44	-10.73	10.71	-3.20
REGION				
midatl*	5.11	-32.84	-19.27	-1.73
enc*	10.30	-11.15	-33.38	-22.65
wnc*	18.91	18.47	-47.03	-23.48
satl*	4.49	-34.53	-20.95	-0.90
esc*	5.92	-19.78	-33.73	-25.90
wsc*	10.02	2.75	-17.80	-16.69
mount*	-7.15	-11.22	-30.02	-21.12
pacific*	-11.99	-50.41	-27.32	-9.95
AGE OF INDIVIDUAL				
age18_24*	-6.73	0.22	-18.02	-12.82
age25_29*	-12.95	-37.05	-9.25	-16.10
age40_49*	4.61	14.19	0.39	6.60
age50_59*	16.42	32.57	-6.69	10.46
age60_64*	17.62	24.60	-28.32	23.00
age65up*	14.60	-7.56	-32.83	28.61
HOUSEHOLD SIZE				
memb_1*	-27.40	-84.48	-17.22	-14.89
memb_3up*	1.46	52.28	-1.23	-9.27

Note: Variable names and definition are exhibited In Table A.1 in Appendix A.

Table 18. Marginal Effects and Elasticities for Eaters Only after the Second Stage of Heckman Models for At-Home Fresh Pork, Beef, Chicken, and Seafood

Variable	Fresh Pork	Fresh Beef	Fresh Chicken	Fresh Seafood
income	-2.72E-04	-1.09E-03	-9.27E-05	-9.13E-05
income (elasticity)	-0.07	-0.16	-0.02	-0.02
ETHNICITY				
Hispanic*	11.72	-14.96	-1.87	1.61
SEASON				
summer*	2.93	12.93	9.27	-9.17
fall*	6.85	-2.10	6.01	-12.81
winter*	-1.32	-6.93	0.34	-7.67
GENDER				
femaleet*	-61.25	-116.84	-46.41	-33.16
MARKET SIZE				
smsa*	-6.26	-10.92	0.45	-2.67
RACE				
black*	29.81	-24.68	60.12	40.04
Oriental*	58.00	-11.74	81.75	29.32
other*	6.19	-6.42	17.35	4.55
REGION				
midatl*	12.55	-21.90	-20.06	1.19
enc*	25.73	-5.16	-28.89	-25.13
wnc*	39.05	24.62	-34.99	-20.81
satl*	20.03	-18.46	-14.08	-0.91
esc*	22.23	-11.66	-27.19	-44.53
wsc*	36.62	7.09	-7.59	-13.37
mount*	3.70	-10.98	-24.86	-36.70
pacific*	10.55	-26.20	-16.94	-9.57
AGE OF INDIVIDUAL				
age18_24*	-8.95	13.15	-22.93	-14.80
age25_29*	-2.90	-16.58	-10.00	-9.41
age40_49*	-4.32	9.28	2.44	6.37
age50_59*	-1.66	20.33	-11.80	-2.25
age60_64*	-8.19	20.31	-36.38	11.55
age65up*	-20.15	-24.98	-39.24	7.74
HOUSEHOLD SIZE				
memb_1*	-0.45	-40.18	14.02	3.04
memb_3up*	-11.11	41.02	-6.65	-10.58

Notes: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1

Variable names and definition are exhibited In Table A.1 in Appendix A.

meats are -0.01 (pork), -0.16 (beef), -0.02 (chicken), and 0.14 (seafood). A 10 percent increase in income will result a 0.1 percent decrease in the consumption of at-home fresh pork, a 1.6 percent decrease in the consumption of fresh beef, a 0.2 percent decrease in the consumption of fresh chicken, and a 1.4 percent increase in the consumption of fresh seafood. For those who consumed the corresponding products, the income elasticity ranges from -0.16 (beef), -0.07 (pork) to -0.02 (chicken and seafood). These negative relationships do not necessarily mean that individuals consume less fresh meats in total. These results could mean that as individuals' income increases they divert their fresh meat consumption from at-home to away-from-home.

Seasonality does not affect the actual intake of any of at-home fresh meats except chicken. Conditional on eating at-home fresh chicken, individuals consume 0.34 more grams of at-home fresh chicken in the winter relative to the spring. For all individuals however, individuals consume 8.63 less grams of at-home fresh chicken in the winter relative to the spring.

Gender plays a role in the intake of any of the four fresh products. Both conditional and unconditional intakes of the four selected at-home fresh meats are lower for female eaters relative to male eaters. When the consumption of the at-home fresh meats occurs, female eaters on average consume 61.25 less grams of at-home fresh pork, 116.84 less grams of at-home fresh chicken, 46.41 less grams of at-home fresh chicken, and 33.16 less grams of at-home fresh seafood relative to male eaters over a two-week period. For all individuals however, female eaters on average consume 24.42 less grams of at-home fresh pork, 98.77 less grams of at-home fresh chicken, 29.09 less grams of at-home fresh chicken, and 10.10 less grams of at-home fresh seafood per two weeks relative to male eaters.

Race is an important determinant in the consumption of the at-home meats except seafood. For all individuals, whites consume 26.54 to 54.55 less grams of at-home fresh pork relative to blacks and Orientals. Conditional on eating at-home fresh pork, blacks and Orientals consume 29.81 to 58.00 more grams of at-home fresh pork than whites. For all individuals, blacks consume 25.34 less grams of at-home fresh beef than whites. Conditional on consuming at-home fresh beef, blacks consume 24.68 less grams of at-home fresh beef relative to whites. When at-home fresh chicken consumption occurs, it is higher by 17.35 grams for other races relative to whites, 60.12 grams for blacks relative to whites, and 81.75 grams for Orientals relative to whites. For all individuals however, whites eat 10.71 to 79.03 less grams of at-home fresh chicken relative to blacks, Orientals, and others.

Region plays an important role in the consumption stage of at-home fresh meats except for chicken. Individuals residing in the West North Central region have the highest intake of at-home fresh pork. For all individuals, individuals living in the East North Central, the West North Central, the South Atlantic, the East South Central, and the West South Central regions consume 4.49 grams to 18.91 more grams of at-home fresh pork than individuals residing in New England. For all individuals, individuals residing in the Mountain and Pacific regions consume 7.15 grams to 11.99 less grams of at-home fresh pork relative to those from the New England region.

Except for the West North Central region, other regions are not statistically different from the New England region in terms of actual intake of at-home fresh beef. For eaters of fresh beef at home, intake is higher in the West North Central region by 24.62 grams than in the New England region. Further, for all individuals, those residing in the West North Central region consume about 18.47 more grams of at-home fresh beef than individuals from the New England region.

The East South Central region is the only region, which is statistically different from the base region of New England in terms of intake of at-home fresh seafood. For eaters of fresh seafood at home, individuals residing in the East South Central region consume 44.53 less grams of at-home fresh seafood than those from the New England region. For all individuals, individuals living in the East South Central region consume about 25.90 less grams of at-home fresh seafood relative to the individuals residing in New England.

Age of individual is a key determinant in the consumption of at-home fresh meats. Individuals between 60 and 64 years of age and those 65 and older have the highest intakes of at-home fresh pork and seafood, respectively. Individuals 65 and older have the lowest intake of at-home fresh beef and chicken. For all individuals, individuals between 40 and 49 years of age eat 4.61 more grams of at-home fresh pork and those who are at least 50 years of age consume 14.60 to 17.62 more grams of at-home fresh pork than individuals between 30 and 39 years of age. For eaters of fresh pork, intake is higher by 1.66 grams to 20.15 grams for the base group of individuals between 30 and 39 years of age relative to those 40 years of age and older.

For all individuals, the intake of at-home beef is 0.22 grams more for individuals between 18 and 24 years of age and 7.56 grams less for individuals 65 and more relative to those between 30 and 39 years of age. For eaters of fresh beef, intake is higher by 13.15 grams for individuals between 18 and 24 years of age and lower by 24.98 grams for individuals 65 and older relative to those between 30 and 39 years of age. For all individuals, those between 18 and 24 years of age and those 50 and older eat 6.69 to 32.83 less grams of at-home fresh chicken relative to those between 30 and 39 years of age. For eaters of fresh chicken, intake is less by 11.80 grams to 39.24 grams for individuals between 18 and 24 years of age and those 50 and more relative to those between 30 and 39 years of age.

For all individuals, individuals between 30 and 39 years of age eat 10.46 to 28.61 less grams of at-home fresh seafood than those between 50 and 59 years of age and those 65 and more. For eaters of fresh seafood, intake is lower by 7.74 grams for individuals between 30 and 39 years of age relative to those 65 and older. However, intake is higher by 2.25 grams for individuals between 30 and 39 years of age relative to those between 50 and 59 years of age.

Household size plays a role in the consumption of any of the four at-home fresh meats. For all individuals, household size is positively associated with the consumption of at-home fresh pork and beef. For eaters of fresh meats at home, household size is positively associated with the intake of at-home fresh beef but negatively related with the intake of at-home fresh pork, chicken and seafood. Conditional on eating at-home fresh meats, individuals from one-member households have a lower intake of 0.45 grams of at-home fresh pork but a higher intake of 14.02 grams and 3.04 grams of at-home fresh chicken and seafood, respectively relative to two-member households. Further, for all individuals, the consumption of at-home fresh pork, chicken, and seafood is 14.89 grams to 27.40 grams lower for individuals from one-member households relative to those from two-member households. For all individuals, those from households with at least three members have a higher intake of 1.46 grams and 52.28 grams for at-home fresh pork and beef, respectively, but a lower intake of 1.23 grams for at-home fresh chicken. Conditional of eating at-home fresh meats, individuals from two-member households have a lower intake of 11.11 grams of at-home fresh pork, a higher intake of 44.02 grams of at-home fresh beef, and a lower intake of 6.65 grams of at-home fresh chicken relative two-member households.

Disaggregated At-Home Fresh Pork Products (Pork Chops, Pork Ribs, Pork Roasts, and Pork Tenderloin)

Selection Stage Results

This part of the study discusses the profile of individuals who are likely to eat at-home pork chops, pork ribs, pork roasts, and pork tenderloin. The parameter estimates and their associated p-values of the probit models are presented in Table 19. The marginal effects are presented in Table 20. The likelihood-ratio (χ^2) test statistics indicate that the coefficients are statistically different from zero at 0.05 level. The Pseudo R2 ranges from 0.0249 (pork ribs) to 0.0481 (pork tenderloin).

Table 19. First Stage Heckman Model Results for At-Home Fresh Pork Cuts (Pork Chops, Pork Ribs, Pork Roasts, and Pork Tenderloin)

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
income	1.26E-06	2.80E-06	8.19E-07	8.22E-06
	(0.176)	(0.041)	(0.587)	(0.000)
inc_2	-1.11E-11	-9.39E-12	-6.18E-12	-3.19E-11
	(0.047)	(0.236)	(0.495)	(0.001)
ETHNICITY				
Hispanic	0.0602	0.1044	0.0534	0.0192
	(0.213)	(0.140)	(0.505)	(0.842)
SEASON				
summer	-0.0083	-0.0670	-0.1962	0.0056
	(0.777)	(0.129)	(0.000)	(0.921)
fall	0.0297	-0.0141	-0.0668	0.1160
	(0.308)	(0.744)	(0.153)	(0.033)
winter	-0.0911	-0.1512	-0.0034	-0.0443
	(0.002)	(0.001)	(0.941)	(0.441)
GENDER				
femaleet	0.0145	0.0264	0.0012	-0.0137
	(0.490)	(0.406)	(0.972)	(0.729)
EMPLOYMENT OF FEMALE HEAD				
u35hrs	-0.0771	0.0249	0.0539	0.0730
	(0.010)	(0.575)	(0.262)	(0.200)
nefp	0.0024	-0.0182	0.0018	0.1423
	(0.928)	(0.649)	(0.967)	(0.005)
EDUCATION OF FEMALE HEAD				
somecol	-0.0932	-0.0395	0.0266	0.0244
	(0.000)	(0.274)	(0.488)	(0.596)
postgcol	-0.3504	-0.1498	-0.0234	-0.1610
	(0.000)	(0.013)	(0.715)	(0.032)

Table 19. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
MARKET SIZE				
smsa	-0.0266	0.0117	-0.0405	0.0640
	(0.290)	(0.763)	(0.313)	(0.200)
RACE				
black	0.1855	0.2332	-0.0297	-0.2818
	(0.000)	(0.000)	(0.666)	(0.006)
Oriental	0.0026	0.4649	0.1422	-0.0211
	(0.978)	(0.000)	(0.322)	(0.900)
other	0.0940	-0.1127	-0.1128	0.0497
	(0.176)	(0.319)	(0.380)	(0.724)
REGION				
midatl	0.2005	0.0343	-0.1289	-0.2286
	(0.000)	(0.684)	(0.131)	(0.017)
enc	0.0689	0.0696	0.0961	-0.0090
	(0.199)	(0.401)	(0.235)	(0.920)
wnc	0.0418	0.0952	0.1230	-0.1421
	(0.491)	(0.310)	(0.176)	(0.189)
satl	0.0889	0.0861	-0.1704	-0.1054
	(0.100)	(0.302)	(0.045)	(0.253)
esc	0.1491	-0.0718	-0.1703	0.0003
	(0.015)	(0.470)	(0.091)	(0.998)
wsc	0.0696	0.1530	-0.0149	-0.2590
	(0.227)	(0.082)	(0.867)	(0.015)
mount	-0.0723	0.2720	-0.0930	-0.1976
	(0.265)	(0.004)	(0.357)	(0.085)
pacific	-0.1542	0.0922	-0.1303	-0.0890
	(0.007)	(0.281)	(0.135)	(0.344)
DIET				
dietchc	-0.1165	0.0689	0.0045	0.0673
	(0.005)	(0.288)	(0.948)	(0.386)

Table 19. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
nodiet	0.0011	0.1532	0.1095	0.0619
	(0.976)	(0.006)	(0.058)	(0.362)
ATTITUDE/LIFESTYLE				
chk_labels	-0.0424	-0.0058	-0.0272	-0.0149
	(0.000)	(0.646)	(0.043)	(0.352)
plan_meals	0.0156	0.0388	0.0656	0.0726
	(0.113)	(0.009)	(0.000)	(0.000)
cholest	0.0129	0.0522	-0.0293	0.0253
	(0.380)	(0.020)	(0.205)	(0.356)
additives	0.0319	0.0342	0.0160	-0.0036
	(0.053)	(0.163)	(0.539)	(0.905)
fat	0.0134	-0.0629	-0.0150	-0.0486
	(0.422)	(0.012)	(0.571)	(0.107)
salt	-0.0228	0.0236	-0.0052	-0.0010
	(0.118)	(0.276)	(0.825)	(0.971)
preserv	-0.0030	-0.0325	-0.0013	-0.0002
	(0.853)	(0.169)	(0.959)	(0.995)
good_taste	0.0007	0.0065	0.0174	-0.0025
	(0.918)	(0.550)	(0.134)	(0.851)
AGE OF INDIVIDUAL				
age18_24	-0.0982	0.0432	-0.1560	-0.0425
	(0.036)	(0.553)	(0.062)	(0.696)
age25_29	-0.1327	-0.1883	-0.3897	0.0077
	(0.005)	(0.022)	(0.000)	(0.940)
age40_49	0.0060	0.1264	0.0213	0.1527
	(0.849)	(0.011)	(0.687)	(0.018)
age50_59	0.1610	0.1476	0.1307	0.2683
	(0.000)	(0.007)	(0.027)	(0.000)
age60_64	0.1643	0.2994	0.3024	0.3809
	(0.001)	(0.000)	(0.000)	(0.000)

Table 19. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
age65up	0.1786	0.1146	0.3766	0.2490
	(0.000)	(0.064)	(0.000)	(0.002)
PRESENCE OF CHILDREN				
nochun18	0.0275	0.1165	0.0748	-0.2626
	(0.402)	(0.020)	(0.165)	(0.000)
HOUSEHOLD SIZE				
memb_1	-0.3837	-0.1710	-0.2294	-0.1537
	(0.000)	(0.004)	(0.000)	(0.036)
memb_3up	0.1054	0.0401	0.1441	-0.3398
	(0.001)	(0.400)	(0.005)	(0.000)
BODY MASS INDEX				
bmilow	0.0244	0.0261	0.0576	-0.0635
	(0.401)	(0.556)	(0.220)	(0.256)
bmihigh	0.0315	0.0959	0.0901	0.0006
	(0.179)	(0.007)	(0.018)	(0.989)
_cons	-0.7282	-2.3003	-1.9688	-2.1594
	(0.000)	(0.000)	(0.000)	(0.000)
Number of obs	17,585	17,601	17,602	17,605
LR chi2(44)	597.25	188.63	231.15	229.04
Prob > chi2	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R2	0.0295	0.0249	0.0350	0.0481

Notes: The p-values are presented in parentheses below the parameter estimates. Variable names and definition are exhibited In Table A.1 in Appendix A.

Table 20. Marginal Effects after First Stage Heckman Models for At-Home Fresh Pork Cuts (Pork Chops, Pork Ribs, Pork Roasts, and Pork Tenderloin)

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
income	3.99E-07	3.08E-07	7.70E-08	5.38E-07
ETHNICITY				
Hispanic*	0.0197	0.0120	0.0049	0.0011
SEASON				
summer*	-0.0027	-0.0069	-0.0159	0.0003
fall*	0.0096	-0.0015	-0.0057	0.0071
winter*	-0.0289	-0.0151	-0.0003	-0.0025
GENDER				
femaleet*	0.0047	0.0028	0.0001	-0.0008
MARKET SIZE				
smsa*	-0.0086	0.0012	-0.0036	0.0036
RACE				
black*	0.0626	0.0290	-0.0026	-0.0130
Oriental*	0.0008	0.0701	0.0141	-0.0012
other*	0.0311	-0.0110	-0.0091	0.0030
REGION				
midatl*	0.0672	0.0037	-0.0105	-0.0114
enc*	0.0225	0.0077	0.0089	-0.0005
wnc*	0.0136	0.0108	0.0119	-0.0074
satl*	0.0291	0.0096	-0.0136	-0.0057
esc*	0.0499	-0.0073	-0.0132	0.0000
wsc*	0.0228	0.0179	-0.0013	-0.0124
mount*	-0.0228	0.0350	-0.0076	-0.0097
pacific*	-0.0477	0.0103	-0.0106	-0.0049
AGE OF INDIVIDUAL				
age18_24*	-0.0307	0.0047	-0.0122	-0.0024
age25_29*	-0.0410	-0.0175	-0.0257	0.0005
age40_49*	0.0019	0.0142	0.0019	0.0096
age50_59*	0.0534	0.0169	0.0124	0.0185
age60_64*	0.0552	0.0391	0.0333	0.0306

Table 20. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
age65up*	0.0595	0.0129	0.0412	0.0171
HOUSEHOLD SIZE				
memb_1*	-0.1110	-0.0164	-0.0175	-0.0080
memb_3up*	0.0339	0.0043	0.0127	-0.0202
EMPLOYMENT OF FEMALE HEAD				
u35hrs*	-0.0244	0.0027	0.0049	0.0044
nefp*	0.0008	-0.0019	0.0002	0.0084
EDUCATION OF FEMALE HEAD				
somecol*	-0.0300	-0.0042	0.0023	0.0014
postgcol*	-0.1020	-0.0145	-0.0020	-0.0083
DIET				
dietchc*	-0.0365	0.0076	0.0004	0.0041
nodiet*	0.0003	0.0154	0.0092	0.0035
ATTITUDE/LIFESTYLE				
chk_labels	-0.0136	-0.0006	-0.0024	-0.0009
plan_meals	0.0050	0.0041	0.0058	0.0042
cholest	0.0041	0.0055	-0.0026	0.0015
additives	0.0103	0.0036	0.0014	-0.0002
fat	0.0043	-0.0067	-0.0013	-0.0028
salt	-0.0073	0.0025	-0.0005	-0.0001
preserv	-0.0010	-0.0034	-0.0001	0.0000
good_taste	0.0002	0.0007	0.0015	-0.0001
PRESENCE OF CHILDREN				
nochun18*	0.0088	0.0121	0.0065	-0.0163
BODY MASS INDEX				
bmilow*	0.0079	0.0028	0.0052	-0.0036
bmihigh*	0.0101	0.0103	0.0081	0.0000

Note: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1.
Variable names and definition are exhibited In Table A.1 in Appendix A.

All the factors are key drivers of the decision to eat at-home fresh pork cuts except ethnicity of eater, gender of eater, market size, concerns about serving food with additives, salt, and preservatives, and the belief that the most important things about food are that it looks good, smells good, and tastes good.

Income is a statistically significant factor affecting the decision to eat at-home fresh pork cuts, except for pork roasts. Income is positively associated with the likelihood of eating at-home pork chops, pork ribs and pork tenderloin. The magnitude of the impact is very small though (ranging from 3.08E-07 to 5.38E-07 basis points per dollar of change in income).

Seasonality affects the likelihood of eating at-home fresh pork products. The consumption of at-home pork chops and pork ribs is less likely in the winter relative to the base season of spring by 0.0289 and 0.0151 basis points, respectively. Individuals have a higher probability of 0.0071 basis points of eating at-home pork tenderloin in the fall relative to the spring. Relative to the spring, the likelihood of eating at-home pork roasts is lower in the summer by 0.0357 basis points.

Characteristics of the female head (employment and education) play a role in the likelihood of eating at-home fresh pork chops, pork ribs, and pork tenderloin, but do not affect the decision to eat at-home fresh pork roasts. Therefore, employment of the female head does not have a statistically significant impact on the decision to eat at-home pork ribs. Individuals in households wherein the female head is not employed for pay have a higher likelihood of 0.0084 basis points of eating at-home pork tenderloin relative to those employed 35 hours or more. Individuals in households wherein the female head has some college education or has graduated from college have a lower probability of 0.0300 basis points of eating at-home pork chops relative to those in households wherein the female head has at most a high school education. Further, individuals in households wherein the female head has a post-college education have a lower probability of 0.1020 basis points of eating at-home pork chops, a lower probability of 0.0145 basis points of consuming at-home pork ribs, and a lower probability of 0.0083 basis points of eating at-home pork tenderloin relative to individuals in households wherein the female head has at most a high school education.

Race plays a role in the likelihood of eating at-home pork chops, pork ribs, and pork tenderloin, but does not affect the likelihood of eating at-home pork roasts. Relative to whites, blacks have a higher probability of 0.0626 of eating at-home pork chops, a higher probability of 0.0290 of eating at-home pork ribs, but a lower probability of 0.0130 of eating at-home pork tenderloin. Orientals have a higher likelihood of 0.0701 basis points of eating at-home pork ribs relative to whites. Other individuals do not have significantly different probabilities of eating any of the four at-home fresh pork products relative to whites.

Regional differences exist in the likelihood of eating at-home fresh pork cuts. The Middle Atlantic, the East South Central and Pacific are the only regions where individuals have a significantly different likelihood of eating at-home pork chops relative to those residing in the New England region. Individuals from the Middle Atlantic and the East South Central regions have a higher probability of 0.0672 and 0.0499 basis points, respectively of eating at-home pork chops relative to those living in the New England. Individuals from the Pacific region however, have a lower probability of 0.0477 basis points of eating at-home pork chops relative to those living in the New England.

The Mountain region is the only region where individuals have a significantly different likelihood of eating at-home pork ribs relative to those residing in the New England region. Individuals living in the Mountain region have a higher probability of 0.0350 basis points of consuming at-home pork ribs relative to those residing in the New England region.

Further, the South Atlantic region is the only region where individuals have a significantly different likelihood of eating at-home pork roasts relative to the New England region. Individuals residing in the South Atlantic region have a lower likelihood of 0.0136 basis points of eating at-home pork roasts relative to the New England region. The Middle Atlantic and the West South Central are the only regions where individuals have a significantly different likelihood of eating at-home pork tenderloin relative to those residing in the New England region. The likelihood of eating at-home pork tenderloin is lower in the Middle Atlantic by 0.0114 basis points and lower in the West South Central regions by 0.0124 basis points relative to the New England region.

As discussed previously, not all attitudinal/lifestyle factors affect the decision to eat at-home fresh pork products. Concerns about serving foods with salt, preservatives, and additives and the attitude towards taste versus nutrition do not significantly affect the decision to eat any of the at-home pork cuts. However, the more cautious individuals are about serving foods with fat, the lower their probability of eating at-home pork ribs.

The marginal effect is 0.0067 basis points. Hence, the likelihood of eating at-home pork ribs declines by 0.0067, with each unit increase in the concern about serving foods with fat. The level of the cautiousness about serving foods with cholesterol is positively associated with the probability of eating at-home pork ribs. The likelihood of eating at-home pork ribs increases by 0.0055 basis points, with each unit increase in the concern about serving foods with cholesterol. Checking labels is negatively associated with the likelihood of eating at-home pork chops and pork roasts with marginal effects of 0.0136 and 0.0024 basis points, respectively. Those individuals who stress the importance of planning meals to make sure they are nutritious have a higher probability of eating at-home pork ribs, pork roasts, and pork tenderloin. The marginal effects are 0.0041, 0.0058, and 0.0042 basis points, respectively.

Age of individual is an important factor in the decision to eat any of the four at-home fresh pork products. Age of individual, in general, is positively associated with the probability of eating at-home fresh pork cuts. Individuals 65 and more have the highest likelihood of eating at-home pork chops and pork roasts. These individuals have a higher probability of 0.0595 basis points of eating at-home pork chops and higher probability of 0.0412 basis points of eating at-home pork roasts relative to those between 30 and 39 years of age. Individuals who are between 60 and 64 years of age have the highest likelihood of eating at-home pork ribs and pork tenderloin. These individuals have a higher probability of 0.0552, 0.0391, 0.0333 and 0.0306 basis points of eating at-home pork chops, pork ribs, pork roasts and pork tenderloin, respectively relative to those between 30 and 39 years of age. Individuals between 50 and 59 years of age have a higher likelihood of 0.0124 to 0.0534 basis points of eating at-home pork chops, pork ribs, pork roasts, and pork tenderloin, respectively, relative to those who are between 30 and 39 years of age. Individuals between 40 and 49 years of age have a higher likelihood of 0.0142 basis points of eating at-home pork ribs and a higher likelihood of 0.0096 basis points of eating at-home pork tenderloin relative to individuals between 30 and 39 years of age. Individuals between 25 and 29 years of age have the lowest likelihood of eating at-home pork chops, pork ribs, and pork roasts. These individuals have a lower probability of 0.0175 to 0.0410 basis points of eating at-home pork chops, pork ribs, and pork roasts relative to relative to individuals between 30 and 39 years of age. Individuals between 18 and 24 years of age have a lower likelihood of 0.0307 basis points of eating at-home pork chops relative to the individuals between 30 and 39 years of age.

The presence of children under 18 is key determinant in the decision to consume at-home pork ribs and pork tenderloin, but does not affect the decision to eat at-home pork chops and pork roasts. Individuals in households wherein there are no children under 18 have a higher probability of 0.0121 basis points of eating at-home pork ribs but a lower probability of 0.0163 basis points of eating at-home pork tenderloin relative to individuals in households wherein there are children under 18.

Household size plays a role in the decision to eat any of the four at-home fresh pork products. Household size is positively associated with the likelihood of eating at-home pork cuts, except for pork tenderloin. Individuals from one-member households have a lower likelihood of eating any of the four at-home fresh pork products relative to those from two-member households. The marginal effects are 0.1110, 0.0164, 0.0175, and 0.0080 basis points for at-home pork chops, pork ribs, pork roasts, and pork tenderloin, respectively. Individuals from households with at least three members have a higher likelihood of 0.0339 basis points of eating at-home pork chops, a higher likelihood of 0.0127 basis points of pork roasts, respectively, and a lower likelihood of 0.0202 basis points of eating at-home pork tenderloin relative to individuals from two-member households.

Dieting is an important factor in the decision to eat at-home pork chops and pork ribs but does not affect the decision to eat at-home pork roasts and pork tenderloin. Individuals who are on a diet by choice have a lower probability of 0.0365 basis points of eating at-home pork chops relative to individuals who are on a doctor prescribed diet. Individuals who are not on diet have a higher likelihood of 0.0154 basis points of eating at-home pork ribs relative to those on a doctor prescribed diet.

Body Mass Index is an important factor in the decision to eat at-home fresh pork ribs and pork roasts. Individuals with higher than recommended BMI have a higher probability of 0.0103 basis points of eating at-home pork ribs and a higher probability of 0.0081 basis points of eating at-home pork roasts relative to those within recommended standards of BMI. Individuals with lower than recommended BMI are not significantly different from those who are within recommended standards of BMI in terms of the likelihood of eating any of the four at-home fresh pork cuts.

Intake Stage Results

This part of the study discusses the key determinants of the volume of intake of at-home fresh pork cuts. The parameter estimates of the second stage of the four Heckman sample selection models are presented in Table 21. Key drivers of the absolute amount of at-home fresh meats intake are income, season, gender of eater, race of eater, region, age of eater, and household size. The mills ratio is not statistically significant in all four models, indicating that sample selection bias was not problematic in these four models. However, the Heckman models produce more efficient parameter estimates than single-equation models of intake. The squared correlations (R^2_c) between actual and predicted intakes range from 0.0130 (pork roasts) to 0.0402 (pork chops), reasonable with individual based data. The Wald χ^2 test statistics are statistically significant in all four models, indicating that the coefficients Heckman models are statistically different from zero at 0.05 level.

Table 21. Second Stage Heckman Model Results for At-Home Fresh Pork Cuts (Pork Chops, Pork Ribs, Pork Roasts, and Pork Tenderloin)

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Loin
income	-2.88E-04	2.32E-04	2.15E-04	3.89E-06
	(0.001)	(0.165)	(0.411)	(0.989)
inc_2	1.31E-09	-1.48E-09	6.65E-11	1.48E-09
	(0.027)	(0.126)	(0.969)	(0.294)
ETHNICITY				
Hispanic	1.8312	5.5485	-3.2888	-2.2748
	(0.698)	(0.529)	(0.816)	(0.882)
SEASON				
summer	6.5924	-9.6923	-6.9161	14.2768
	(0.022)	(0.093)	(0.494)	(0.088)
fall	4.2133	3.5923	-5.8766	7.1861
	(0.136)	(0.513)	(0.470)	(0.374)
winter	1.7891	-2.4612	-19.4778	4.8833
	(0.559)	(0.699)	(0.012)	(0.554)
GENDER				
femaleet	-58.3416	-38.9199	-57.0417	-15.3469
	(0.000)	(0.000)	(0.000)	(0.005)
MARKET SIZE				
smsa	1.6594	1.9087	-4.5769	11.9668
	(0.504)	(0.700)	(0.507)	(0.105)
RACE				
black	5.7023	9.0295	-8.3971	-14.1431
	(0.143)	(0.275)	(0.487)	(0.405)
Oriental	9.2835	34.8660	14.4144	30.6610
	(0.355)	(0.015)	(0.559)	(0.194)
other	13.7152	-18.3712	-32.6462	-5.0771
	(0.042)	(0.214)	(0.183)	(0.820)
REGION				
midatl	0.0162	16.8647	15.7230	-7.0586
	(0.998)	(0.121)	(0.301)	(0.606)
enc	4.0765	22.2410	8.3791	-2.5589
	(0.452)	(0.038)	(0.550)	(0.836)
wnc	3.5937	26.5871	46.5100	29.8828
	(0.556)	(0.029)	(0.003)	(0.055)
satl	3.0275	16.5530	22.5154	26.1520
	(0.581)	(0.126)	(0.138)	(0.039)
esc	2.7051	37.3572	21.0365	12.0501
	(0.661)	(0.005)	(0.243)	(0.429)

Table 21. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
wsc	17.8306	21.7027	26.1767	-16.0187
	(0.002)	(0.058)	(0.086)	(0.313)
mount	-12.8634	31.0672	32.1358	-3.8321
	(0.053)	(0.014)	(0.066)	(0.813)
pacific	-9.7720	27.3143	32.1878	5.5359
	(0.105)	(0.014)	(0.036)	(0.669)
AGE OF EATER				
age18_24	-5.4586	-19.8874	3.2638	10.5182
	(0.242)	(0.034)	(0.837)	(0.523)
age25_29	7.3304	-8.0484	21.6572	4.2329
	(0.134)	(0.484)	(0.322)	(0.786)
age40_49	-9.6306	0.5229	-6.4406	17.4104
	(0.002)	(0.939)	(0.486)	(0.075)
age50_59	-15.2106	-7.4964	1.4763	11.3821
	(0.000)	(0.309)	(0.888)	(0.310)
age60_64	-34.2029	11.5593	-6.1476	27.9986
	(0.000)	(0.246)	(0.677)	(0.048)
age65up	-49.9932	8.2818	-3.1114	19.4923
	(0.000)	(0.279)	(0.822)	(0.106)
HOUSEHOLD SIZE				
memb_1	7.0687	2.0544	-8.5963	-2.2831
	(0.206)	(0.808)	(0.517)	(0.845)
memb_3up	-10.4962	-10.2901	-18.0738	-1.5454
	(0.000)	(0.027)	(0.017)	(0.838)
_cons	215.8057	44.7839	137.7558	-11.5721
	(0.000)	(0.362)	(0.046)	(0.859)
mills lambda	-16.7768	41.9314	14.8137	43.5665
	(0.146)	(0.051)	(0.639)	(0.077)

Table 21. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Tenderloin
Number of obs	17,585	17,601	17,602	17,605
Censored obs	12,960	16,619	16,787	17,075
Uncensored obs	4,625	982	815	530
Wald chi2(52)	1480.53	284.89	313.58	193.03
Prob > chi2	(0.000)	(0.000)	(0.000)	(0.000)
R^2_c	0.0402	0.0113	0.0130	0.0116

Notes: The p-values are presented in parentheses below the parameter estimates.
R2c represents the squared correlation between actual and predicted intakes for all individuals.
Variable names and definitions are exhibited In Table A.1 in Appendix A.

The marginal effects for all individuals and for individuals who ate the selected products are presented in Tables 22 and 23, respectively. Both conditional and unconditional measures of marginal intake are presented based on two consecutive weeks of consumption. Key drivers of the absolute amount of at-home fresh pork products are as follows: income, season, gender of eater, race of eater, region, age of eater, and household size for pork chops; gender of eater, race of eater, region, age of eater, and household size for pork ribs; season, gender of eater, region, and household size for pork roasts; and gender of eater, region, and age of eater for pork tenderloin.

Table 22. Marginal Effects for All Individuals Associated with the Second Stage of the Heckman Models for At-Home Fresh Pork Cuts (Pork Chops, Pork Ribs, Pork Roasts, and Pork Tenderloin)

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Loin
income	-8.97E-06	2.56E-05	1.82E-05	6.88E-06
income (elasticity)	-0.01	0.17	0.13	0.09
ETHNICITY				
Hispanic*	3.4851	1.6899	0.5432	0.0566
SEASON				
summer*	1.2723	-1.2659	-2.4961	0.3910
fall*	2.5503	0.0130	-1.0369	0.9243
winter*	-3.9174	-1.8610	-0.8399	-0.1427
GENDER				
femaleet*	-14.1938	-1.6912	-2.3301	-0.4640
MARKET SIZE				
smsa*	-0.8680	0.2397	-0.7100	0.6484
RACE				
black*	11.2967	3.8823	-0.6900	-1.5870
Oriental*	2.5091	11.4739	2.7741	0.6036
other*	8.6351	-2.0388	-2.3504	0.1650
REGION				
midatl*	10.2386	1.3400	-0.9611	-1.3240
enc*	4.5042	2.1343	1.6554	-0.1160
wnc*	3.0169	2.8357	4.0492	-0.2077
satl*	5.2477	2.0472	-1.2108	-0.0391
esc*	8.3950	0.8685	-1.2551	0.3019
wsc*	8.3299	3.4367	0.8656	-1.5586
mount*	-6.4587	6.3888	0.0216	-1.0864
pacific*	-9.3186	2.7937	-0.4254	-0.3840

Table 22. Continued

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Loin
AGE OF INDIVIDUAL				
age18_24*	-5.8642	-0.5757	-1.6426	-0.0049
age25_29*	-4.5424	-2.3540	-3.2675	0.1528
age40_49*	-2.1788	1.6313	-0.0029	1.4901
age50_59*	3.7125	1.4264	1.8169	2.2323
age60_64*	-1.9805	5.2343	4.2172	4.3252
age65up*	-5.7030	1.9593	5.5294	2.3849
HOUSEHOLD SIZE				
memb_1*	-15.2848	-1.8312	-2.7377	-0.8787
memb_3up*	2.4372	-0.0467	1.0504	-2.0798

Notes: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1

Variable names and definitions are exhibited In Table A.1 in Appendix A.

Table 23. Marginal Effects for Eaters Only Associated with the Second Stage of the Heckman Models for At-Home Fresh Pork Cuts (Pork Chops, Pork Ribs, Pork Roasts, and Pork Tenderloin)

Variable	Pork Chops	Pork Ribs	Pork Roasts	Pork Loin
income	-2.69E-04	9.41E-05	1.98E-04	-5.83E-04
income (elasticity)	-0.09	0.04	0.07	-0.29
ETHNICITY				
Hispanic*	2.5906	1.7955	-3.9750	-3.0135
SEASON				
summer*	6.4866	-7.2714	-4.3815	14.0596
fall*	4.5899	4.1022	-5.0158	2.7286
winter*	0.6287	3.0133	-19.4346	6.5878
GENDER				
femaleet*	-58.1576	-39.8740	-57.0571	-14.8189
MARKET SIZE				
smsa*	1.3224	1.4856	-4.0556	9.5019
RACE				
black*	8.0168	0.6935	-8.0145	-3.2141
Oriental*	9.3168	18.4634	12.5955	31.4731
other*	14.8970	-14.2851	-31.1888	-6.9886
REGION				
midatl*	2.5225	15.6293	17.3880	1.7838
enc*	4.9459	19.7347	7.1457	-2.2120
wnc*	4.1216	23.1658	44.9345	35.3727
satl*	4.1482	13.4553	24.7184	30.2184
esc*	4.5714	39.9556	23.2402	12.0373
wsc*	18.7080	16.2109	26.3684	-5.9853
mount*	-13.7861	21.3637	33.3366	3.8154
pacific*	-11.7486	23.9982	33.8710	8.9706
AGE OF INDIVIDUAL				
age18_24*	-6.7138	-21.4455	5.2823	12.1548
age25_29*	5.6295	-1.2073	26.7355	3.9370
age40_49*	-9.5542	-4.0254	-6.7149	11.5514
age50_59*	-13.1894	-12.7985	-0.2000	1.1183
age60_64*	-32.1500	0.8862	-9.9944	13.5192
age65up*	-47.7557	4.1589	-7.9057	9.9651
HOUSEHOLD SIZE				
memb_1*	2.0783	8.2590	-5.6247	3.6568
memb_3up*	-9.1592	-11.7370	-19.9285	11.5288

Note: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1

Variable names and definitions are exhibited In Table A.1 in Appendix A.

Income does not play a role in the consumption of at-home fresh pork cuts except pork chops. The income elasticity for pork chops for all individuals and for eaters of pork chops are, respectively, -0.01 and -0.09. A 10 percent increase in income will result in 0.1 percent decrease in demand for all individuals and a 0.9 percent decrease in demand of individuals of at-home pork chops. These negative relationships may be due to the fact that as income increases, the consumption of pork chops is diverted from at-home to away-from-home.

Seasonality affects the intake of at-home fresh pork chops and pork roasts, but does not affect the consumption of at-home pork ribs and pork tenderloin. Relative to the spring, summer is the only different season in terms of the consumption of at-home pork chops. For eaters of at-home pork chops, intake is higher by 6.49 grams in the summer relative to the spring. For all individuals however, the consumption of at-home pork chops is higher by 1.27 grams in the summer relative to the spring. Winter is the only important determinant in the consumption of at-home pork roasts. Conditional on eating at-home pork roasts, individuals have a lower consumption of 19.43 grams of at-home pork roasts in the winter relative to the spring. For all individuals however, the consumption of pork roasts is lower by 0.84 grams in the winter relative to the spring.

Gender of individual plays a role in the intake of any of the four at-home fresh pork products. Both conditional and unconditional intakes of the four selected at-home fresh meats are lower for female eaters relative to male eaters. For those who eat the selected products, female eaters on average consume 58.16 less grams of at-home pork chops, 39.87 less grams of at-home pork ribs, 57.06 less grams of at-home pork roasts, and 14.82 less grams of at-home pork tenderloin over a two-week period relative to male eaters. For all individuals, however, female eaters have a lower intake of 14.19, 1.69, 2.33, and 0.46 grams of at-home pork chops, pork ribs, pork roasts, and pork tenderloin, respectively, relative to male eaters.

Race is an important determinant in the consumption of the at-home pork chops and pork ribs but does not affect the actual intake of at-home pork roasts and pork tenderloin. Further, there is no statistically significant difference between blacks and whites in consumption of at-home fresh pork products. The consumption of at-home pork chops is higher for other races (not blacks and not Orientals) by 8.63 grams for all individuals and by 14.90 grams for those who eat at-home pork chops relative to whites. Conditional on eating at-home pork ribs, Orientals consume 18.46 more grams of at-home pork ribs relative to whites. Further, for all individuals, Orientals consume 11.47 more grams of at-home pork ribs over a two-week period relative to whites.

Region plays a role in the consumption stage of at-home fresh pork products. For eaters of pork ribs and pork roasts, individuals residing in the New England region have the lowest average intake. The consumption of at-home pork ribs for eaters is 19.73 grams to 39.96 grams higher in the East North Central, the West North Central, the East South Central, the Mountain and the Pacific regions than in the New England region. The consumption of at-home pork roasts for eaters is higher by 33.87 grams in the Pacific region and higher by 44.93 grams in the West North Central region relative to the New England region. Except the West South Central region, all other regions are not statistically different effect on the consumption of at-home pork chops. Conditional on eating at-home pork chops, individuals living in the West South Central region consume 18.71 more grams of at-home pork chops relative to those from the New England region. For all individuals, those residing in the West South Central region consume about 8.33 more grams of at-home pork chops than those from the New England region. The South Atlantic region is the only region which is statistically different form the base region of New England in terms of intake of at-home pork tenderloin. For eaters of at-home pork tenderloin, intake is 30.22 grams lower in the South Atlantic region than in the New England region. For all individuals, those living in the South Atlantic region consume about 0.0391 less grams of at-home pork tenderloin relative to those residing in the New England.

Age of individual is a key determinant in the consumption of at-home fresh pork products, except for pork roasts. Individuals between 18 and 24 years of age are the only significantly different segment in terms of at-home pork ribs consumption relative those between 30 and 39 years of age. For eaters of at-home pork ribs, intake is lower by 21.45 grams for individuals between 18 and 24 years of age relative to those between 30 and 39 years of age. For all individuals, those between 18 and 24 years of age have a lower intake of 0.58 grams relative to individuals between 30 and 39 years of age. Individuals between 60 and 64 years of age are the only significantly different segment of population in terms of at-home pork tenderloin intake relative those between 30 and 39 years of age. For eaters of at-home pork tenderloin, individuals between 60 and 64 years of age have a higher intake of 13.52 grams of at-home pork tenderloin relative to those between 30 and 39 years of age. For all individuals, those between 60 and 64 years of age have a lower intake of 4.32 grams of at-home pork tenderloin relative to those between 30 and 39 years of age. Individuals 65 and older have the lowest intake of at-home pork chops, lower by 47.76 grams for eaters and lower by 5.70 grams for all individuals relative to those between 30 and 39 years of age. For eaters, consumption of pork chops is lower by 9.55 grams for those between 40 and 49 years of age and lower by 13.19 grams for those between 50 and 59 years of age relative to individuals between 30 and 39 years of age.

Household size plays a role in the consumption of at-home pork cuts except pork tenderloin. The volume of intake for individuals from one-member households is statistically the same as the volume of intake for individuals from two-member households for all fresh cuts of pork. For all individuals, those from at least three-member households have a higher intake of 2.44 grams and 1.05 grams of at-home pork chops and pork roasts, respectively, but a lower intake of 0.05 grams of at-home pork ribs than those from two-member households. For eaters of at-home fresh pork products, individuals from at least three-member households have lower intakes of 9.16, 11.74, and 19.93 grams of at-home pork chops, pork ribs, and pork roasts, respectively, relative to those from two-member households.

Disaggregated At-Home Processed Pork Products (Processed Pork, Pork Sausage, Ham, Bacon, Smoked Ham, Canned Ham, Lunchmeats, Pork Hotdogs)

Selection Stage Results

This part of the study discusses the profile of individuals who are likely to eat the selected at-home processed pork, pork sausage, ham, bacon, smoked ham, canned ham, lunchmeats, pork hotdogs. The parameter estimates and their associated p-values are presented in Table 24, and the marginal effects are presented in Table 25. The likelihood-ratio (χ^2) test statistics indicate that the coefficients are statistically different from zero at 0.05 level. The Pseudo R2 ranges from 0.0280 (ham) to 0.0708 (processed pork). All hypothesized factors are important determinants of the decision to eat at-home processed pork products.

Table 24 shows that income is a statistically significant factor affecting the decision to eat at-home processed pork products. Table 25 shows that income is negatively associated with the likelihood of eating at-home processed pork products except for ham (2.12E-07), bacon (4.78E-07), and smoked ham (6.60E-07). The magnitude of the impact in all models is very small though. This result is in agreement with the findings of Briggeman.

Ethnicity plays a role in the probability of eating at-home smoked ham only. This result is in agreement with the finding of Briggeman. Hispanics have a lower likelihood of 0.0366 basis points of eating at-home smoked ham relative to non-Hispanics.

Table 24. First Stage Heckman Model Results for At-Home Processed Pork Products (Processed Pork, Lunchmeat, Pork Sausage, Ham, Bacon, Canned Ham, Smoked Ham, and Hotdogs)

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
income	-2.52E-07	-4.98E-06	-1.79E-06	5.48E-07	1.44E-06	-4.17E-06	2.78E-06	-4.81E-06
	(0.806)	(0.000)	(0.044)	(0.521)	(0.119)	(0.015)	(0.008)	(0.000)
inc_2	-1.33E-11	1.97E-11	-3.57E-13	-1.12E-11	-1.45E-11	1.75E-11	-2.09E-11	3.14E-12
	(0.021)	(0.000)	(0.947)	(0.026)	(0.009)	(0.090)	(0.001)	(0.625)
ETHNICITY								
Hispanic	-0.0393	-0.0144	0.0160	-0.0342	-0.0616	0.1189	-0.1669	-0.0153
	(0.475)	(0.769)	(0.732)	(0.447)	(0.205)	(0.186)	(0.005)	(0.763)
SEASON								
summer	0.0020	-0.0382	0.0218	-0.1158	-0.0138	-0.1098	-0.2123	0.1597
	(0.953)	(0.197)	(0.440)	(0.000)	(0.636)	(0.041)	(0.000)	(0.000)
fall	-0.0244	-0.0223	0.0485	-0.0494	0.0840	-0.1266	-0.1636	-0.0194
	(0.472)	(0.447)	(0.084)	(0.070)	(0.004)	(0.019)	(0.000)	(0.523)
winter	-0.0062	-0.0450	-0.0065	0.0002	-0.0232	-0.0352	0.1172	-0.1416
	(0.857)	(0.127)	(0.817)	(0.993)	(0.424)	(0.501)	(0.000)	(0.000)
GENDER								
femaleet	-0.0570	-0.1201	-0.0755	-0.0344	0.0108	-0.0139	0.0031	-0.0330
	(0.020)	(0.000)	(0.000)	(0.078)	(0.602)	(0.720)	(0.893)	(0.128)
EMPLOYMENT OF FEMALE HEAD								
u35hrs	0.0361	0.0333	0.0561	-0.0154	0.0215	-0.0670	0.0425	0.0321
	(0.286)	(0.266)	(0.048)	(0.575)	(0.465)	(0.251)	(0.202)	(0.303)
nefp	0.0956	0.0857	0.0048	0.0490	0.0729	0.0157	0.0133	0.1205
	(0.002)	(0.001)	(0.850)	(0.046)	(0.005)	(0.747)	(0.654)	(0.000)

Table 24. Continued

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
EDUCATION OF FEMALE HEAD								
somecol	-0.1295	-0.0943	-0.0293	-0.0850	-0.0720	-0.0885	-0.0386	-0.0194
	(0.000)	(0.000)	(0.198)	(0.000)	(0.002)	(0.040)	(0.145)	(0.424)
postgcol	-0.2985	-0.1403	-0.1352	-0.1858	-0.1670	-0.2344	-0.0408	-0.1613
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.003)	(0.351)	(0.000)
MARKET SIZE								
smsa	-0.1150	-0.0788	-0.0897	-0.0871	-0.1258	0.0051	-0.1344	-0.0694
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.912)	(0.000)	(0.006)
RACE								
black	0.0625	-0.0300	0.3422	-0.0003	0.5079	0.2612	0.0338	-0.0520
	(0.198)	(0.461)	(0.000)	(0.993)	(0.000)	(0.000)	(0.452)	(0.207)
Oriental	-0.1864	-0.4003	-0.3244	0.1875	-0.3413	0.1281	-0.5967	-0.2990
	(0.041)	(0.000)	(0.001)	(0.026)	(0.001)	(0.474)	0.000	(0.010)
other	-0.2248	-0.0782	-0.1517	-0.1147	0.0524	-0.0444	-0.2603	-0.0332
	(0.003)	(0.280)	(0.029)	(0.080)	(0.453)	(0.749)	(0.006)	(0.650)
REGION								
midatl	-0.0140	0.1112	0.0844	0.0433	0.0077	-0.0142	0.1113	-0.2174
	(0.807)	(0.040)	(0.112)	(0.383)	(0.890)	(0.886)	(0.064)	(0.000)
enc	0.3035	0.1653	0.4750	0.0788	0.2394	-0.0669	0.0718	-0.0952
	(0.000)	(0.002)	(0.000)	(0.107)	(0.000)	(0.492)	(0.225)	(0.071)
wnc	0.2146	0.0616	0.4200	0.0322	0.2700	-0.1086	-0.0017	-0.2492
	(0.001)	(0.305)	(0.000)	(0.560)	(0.000)	(0.336)	(0.980)	(0.000)

Table 24. Continued

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
satl	0.1162	-0.0544	0.1038	0.0831	0.2928	0.0008	0.0690	-0.1835
	(0.045)	(0.316)	(0.049)	(0.091)	(0.000)	(0.993)	(0.248)	(0.001)
esc	0.3590	0.0582	0.3205	0.1647	0.4835	0.2057	0.0430	0.0310
	(0.000)	(0.343)	(0.000)	(0.004)	(0.000)	(0.051)	(0.529)	(0.607)
wsc	0.3105	-0.1762	0.4172	0.1498	0.4263	-0.0412	0.0271	-0.3038
	(0.000)	(0.003)	(0.000)	(0.005)	(0.000)	(0.691)	(0.673)	(0.000)
mount	0.2430	0.0583	0.2170	0.0031	0.2567	-0.0411	0.0827	-0.3815
	(0.001)	(0.359)	(0.000)	(0.958)	(0.000)	(0.726)	(0.241)	(0.000)
pacific	-0.0482	-0.1007	0.0755	-0.1175	0.1195	-0.2318	-0.1217	-0.5270
	(0.410)	(0.074)	(0.165)	(0.021)	(0.035)	(0.028)	(0.054)	(0.000)
DIET								
dietchc	-0.1621	-0.0625	-0.0226	-0.1741	-0.0698	-0.0588	-0.0838	-0.0786
	(0.000)	(0.142)	(0.571)	(0.000)	(0.091)	(0.412)	(0.068)	(0.072)
nodiet	0.1003	0.0675	0.0161	-0.0375	0.1083	-0.0195	-0.0041	0.0473
	(0.015)	(0.060)	(0.636)	(0.260)	(0.002)	(0.745)	(0.915)	(0.198)
ATTITUDE/LIFESTYLE								
chk_labels	-0.0618	-0.0200	-0.0423	-0.0250	-0.0334	0.0055	-0.0285	-0.0281
	(0.000)	(0.017)	(0.000)	(0.001)	(0.000)	(0.723)	(0.002)	(0.001)
plan_meals	0.0075	-0.0238	0.0405	0.0543	0.0386	0.0349	0.0655	-0.0096
	(0.509)	(0.015)	(0.000)	(0.000)	(0.000)	(0.050)	(0.000)	(0.344)
cholest	0.0176	0.0164	0.0001	0.0219	-0.0132	0.0566	-0.0027	0.0029
	(0.294)	(0.261)	(0.992)	(0.105)	(0.352)	(0.036)	(0.867)	(0.850)

Table 24. Continued

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
additives	0.0100	0.0100	0.0131	-0.0062	0.0890	-0.0154	0.0043	-0.0480
	(0.597)	(0.543)	(0.402)	(0.685)	(0.000)	(0.608)	(0.812)	(0.005)
fat	-0.0435	-0.0449	0.0011	-0.0654	-0.0574	-0.0532	-0.0200	0.0471
	(0.022)	(0.007)	(0.944)	(0.000)	(0.000)	(0.088)	(0.279)	(0.006)
salt	0.0143	0.0284	-0.0003	0.0400	-0.0050	0.0278	0.0193	-0.0200
	(0.382)	(0.051)	(0.983)	(0.003)	(0.726)	(0.321)	(0.238)	(0.185)
preserv	-0.0432	-0.0382	-0.0123	-0.0007	-0.0390	0.0256	-0.0257	0.0172
	(0.019)	(0.017)	(0.419)	(0.964)	(0.013)	(0.382)	(0.147)	(0.301)
good_taste	0.0170	0.0059	0.0238	-0.0001	0.0296	0.0328	0.0033	0.0244
	(0.040)	(0.413)	(0.001)	(0.984)	(0.000)	(0.012)	(0.680)	(0.001)
AGE OF INDIVIDUAL								
age18_24	-0.1382	-0.1332	0.0230	-0.0357	0.0079	-0.2910	0.0012	-0.0455
	(0.011)	(0.005)	(0.602)	(0.407)	(0.865)	(0.008)	(0.983)	(0.337)
age25_29	-0.1299	-0.1186	-0.1404	0.0007	-0.0705	0.0345	0.0149	-0.0134
	(0.014)	(0.011)	(0.002)	(0.987)	(0.133)	(0.701)	(0.784)	(0.776)
age40_49	-0.0266	0.0520	0.0753	0.0324	0.1275	0.0280	0.0591	0.0554
	(0.470)	(0.099)	(0.013)	(0.269)	(0.000)	(0.658)	(0.110)	(0.088)
age50_59	0.1372	0.0487	0.1228	0.2180	0.3383	0.2332	0.2238	0.0482
	(0.001)	(0.179)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.203)
age60_64	0.1998	0.1455	0.0934	0.2696	0.3623	0.1460	0.3765	0.1353
	(0.001)	(0.003)	(0.047)	(0.000)	(0.000)	(0.103)	(0.000)	(0.008)
age65up	0.2122	0.0514	0.1382	0.3803	0.3838	0.2502	0.4544	0.0978
	(0.000)	(0.203)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.019)

Table 24. Continued

Variable	Processed Pork	Lunchmeat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Hotdog
PRESENCE OF CHILDREN								
nochun18	-0.0443	0.0343	0.0575	0.0204	-0.0241	0.1092	0.1231	-0.0018
	(0.271)	(0.301)	(0.072)	(0.514)	(0.461)	(0.073)	(0.001)	(0.958)
HOUSEHOLD SIZE								
memb_1	-0.3973	-0.1424	-0.2767	-0.2575	-0.3940	0.0711	-0.3063	-0.1859
	0.000	(0.000)	(0.000)	(0.000)	(0.000)	(0.252)	(0.000)	(0.000)
memb_3up	0.1579	0.1505	0.0819	0.1213	0.0592	0.0632	0.2005	0.2083
	(0.000)	(0.000)	(0.009)	(0.000)	(0.064)	(0.272)	(0.000)	(0.000)
BODY MASS INDEX								
bmilow	-0.0715	-0.0649	-0.0192	-0.0259	-0.0241	0.2105	-0.0294	0.0333
	(0.029)	(0.028)	(0.492)	(0.335)	(0.401)	(0.000)	(0.369)	(0.271)
bmihigh	0.0760	0.0431	0.0844	0.0728	0.0637	0.0910	0.0230	0.0931
	(0.005)	(0.065)	(0.000)	(0.001)	(0.006)	(0.040)	(0.377)	(0.000)
_cons	1.4285	-0.1994	-0.6690	-0.0317	-0.9496	-2.3415	-1.2460	-0.4200
	(0.000)	(0.056)	(0.000)	(0.743)	(0.000)	(0.000)	(0.000)	(0.000)
Number of obs	17,581	17,591	17,580	17,578	17,586	17,601	17,596	17,585
LR chi2(44)	1069.90	581.27	844.91	682.43	1125.18	233.42	624.57	957.32
Prob > chi2	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R2	0.0708	0.0289	0.0368	0.0280	0.0519	0.0464	0.0398	0.0501

Notes: The p-values are presented in parentheses below the parameter estimates.
Variable names and definitions are exhibited In Table A.1 in Appendix A.

Table 25. Marginal Effects after First Stage Heckman Models for At-Home Processed Pork Products (Processed Pork, Lunchmeat, Pork Sausage, Ham, Bacon, Canned Ham, Smoked Ham, and Hotdogs)

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
income	-5.57E-08	-1.56E-06	-6.40E-07	2.12E-07	4.78E-07	-2.90E-07	6.60E-07	-1.40E-06
ETHNICITY								
Hispanic*	-0.0088	-0.0046	0.0060	-0.0137	-0.0210	0.0083	-0.0366	-0.0045
SEASON								
summer*	0.0004	-0.0121	0.0081	-0.0462	-0.0048	-0.0066	-0.0476	0.0488
fall*	-0.0054	-0.0071	0.0181	-0.0197	0.0294	-0.0075	-0.0372	-0.0057
winter*	-0.0014	-0.0143	-0.0024	0.0001	-0.0080	-0.0022	0.0286	-0.0408
GENDER								
femaleet*	-0.0125	-0.0384	-0.0281	-0.0137	0.0037	-0.0009	0.0007	-0.0098
MARKET SIZE								
smsa*	-0.0246	-0.0255	-0.0336	-0.0347	-0.0442	0.0003	-0.0329	-0.0208
RACE								
black*	0.0134	-0.0095	0.1323	-0.0001	0.1908	0.0204	0.0081	-0.0151
Oriental*	-0.0451	-0.1099	-0.1118	0.0742	-0.1063	0.0091	-0.1018	-0.0784
other*	-0.0553	-0.0243	-0.0547	-0.0457	0.0184	-0.0027	-0.0540	-0.0097
REGION								
midatl*	-0.0031	0.0364	0.0317	0.0173	0.0027	-0.0009	0.0274	-0.0606
enc*	0.0598	0.0546	0.1832	0.0314	0.0859	-0.0040	0.0174	-0.0275
wnc*	0.0427	0.0200	0.1631	0.0128	0.0984	-0.0063	-0.0004	-0.0677
satl*	0.0245	-0.0171	0.0390	0.0331	0.1059	0.0001	0.0167	-0.0518
esc*	0.0662	0.0189	0.1237	0.0653	0.1813	0.0153	0.0104	0.0093
wsc*	0.0595	-0.0535	0.1616	0.0595	0.1580	-0.0025	0.0065	-0.0815
mount*	0.0473	0.0189	0.0830	0.0012	0.0935	-0.0025	0.0203	-0.0979

Table 25. Continued

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
pacific*	-0.0108	-0.0313	0.0283	-0.0468	0.0423	-0.0124	-0.0275	-0.1320
AGE OF INDIVIDUAL								
age18_24*	-0.0324	-0.0408	0.0086	-0.0142	0.0027	-0.0144	0.0003	-0.0133
age25_29*	-0.0303	-0.0365	-0.0508	0.0003	-0.0240	0.0022	0.0036	-0.0040
age40_49*	-0.0059	0.0168	0.0282	0.0129	0.0449	0.0018	0.0142	0.0166
age50_59*	0.0288	0.0157	0.0462	0.0864	0.1227	0.0170	0.0568	0.0145
age60_64*	0.0399	0.0483	0.0352	0.1062	0.1340	0.0104	0.1038	0.0419
age65up*	0.0432	0.0166	0.0521	0.1492	0.1402	0.0185	0.1237	0.0297
HOUSEHOLD SIZE								
memb_1*	-0.1015	-0.0438	-0.0981	-0.1022	-0.1243	0.0047	-0.0643	-0.0521
memb_3up*	0.0348	0.0480	0.0304	0.0483	0.0205	0.0040	0.0474	0.0616
EMPLOYMENT OF FEMALE HEAD								
u35hrs*	0.0078	0.0107	0.0210	-0.0062	0.0075	-0.0041	0.0102	0.0096
nefp*	0.0209	0.0274	0.0018	0.0195	0.0253	0.0010	0.0032	0.0359
EDUCATION OF FEMALE HEAD								
somecol*	-0.0285	-0.0301	-0.0109	-0.0339	-0.0249	-0.0056	-0.0092	-0.0058
postgcol*	-0.0739	-0.0431	-0.0491	-0.0739	-0.0557	-0.0124	-0.0095	-0.0455
DIET								
dietchc*	-0.0378	-0.0197	-0.0084	-0.0693	-0.0238	-0.0036	-0.0193	-0.0228
nodiet*	0.0226	0.0213	0.0060	-0.0149	0.0369	-0.0012	-0.0010	0.0139

Table 25. Continued

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
ATTITUDE/LIFESTYLE								
chk_labels	-0.0136	-0.0064	-0.0157	-0.0100	-0.0116	0.0003	-0.0068	-0.0083
plan_meals	0.0016	-0.0076	0.0151	0.0217	0.0134	0.0022	0.0155	-0.0028
cholest	0.0039	0.0052	0.0001	0.0087	-0.0046	0.0036	-0.0006	0.0008
additives	0.0022	0.0032	0.0049	-0.0025	0.0308	-0.0010	0.0010	-0.0142
fat	-0.0096	-0.0143	0.0004	-0.0261	-0.0199	-0.0033	-0.0047	0.0140
salt	0.0031	0.0091	-0.0001	0.0160	-0.0017	0.0017	0.0046	-0.0059
preserv	-0.0095	-0.0122	-0.0046	-0.0003	-0.0135	0.0016	-0.0061	0.0051
good_taste	0.0037	0.0019	0.0088	-0.0001	0.0103	0.0021	0.0008	0.0072
PRESENCE OF CHILDREN								
nochun18*	-0.0097	0.0109	0.0213	0.0081	-0.0083	0.0067	0.0288	-0.0005
BODY MASS INDEX								
bmilow*	-0.0161	-0.0204	-0.0071	-0.0103	-0.0083	0.0151	-0.0069	0.0100
bmihigh*	0.0166	0.0138	0.0314	0.0290	0.0221	0.0058	0.0055	0.0278

Notes: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1.
Variable names and definitions are exhibited In Table A.1 in Appendix A.

Seasonality affects the likelihood of eating at-home processed pork products, except for processed pork, pork lunchmeats, and pork sausage. This result is in contrast with the finding of Briggeman. Briggeman reported that individuals have a higher likelihood of 0.055 basis points of eating at-home processed pork in September relative to February. The likelihood of eating at-home ham is 0.0462 basis points lower in the summer relative to the spring. Individuals in the fall have a higher likelihood of 0.0294 basis points of eating at-home bacon than in spring. The probability of eating at-home canned ham is 0.0066 to 0.0075 basis points lower in the summer and fall relative to the spring. In the spring the likelihood of eating at-home smoked ham is 0.0372 to 0.0476 basis points higher relative to the summer and fall and is 0.0286 basis points lower relative to the winter. Individuals have a higher probability of 0.0488 basis points of eating at-home pork hotdogs in the summer and have a lower probability of 0.0408 basis points of eating at-home pork hotdogs in the winter relative to the spring.

Gender is a driver for the decision to eat at-home processed pork, lunchmeats, and pork sausage but does not affect the decision to eat at-home ham, bacon, canned ham, smoked ham, and hotdogs. Female eaters have a lower likelihood of 0.0125, 0.0384, and 0.0281 basis points of eating at-home processed pork, lunchmeats, and pork sausage, respectively, relative to male eaters. This result is in agreement with the findings of Briggeman.

Characteristics of the female head play a role in the decision to eat at-home processed pork products, except smoked ham. Employment of the female head does not have a statistically significant impact on the decision to eat at-home canned ham.

Individuals in households wherein the female head is not employed for pay have a higher likelihood of 0.0195 to 0.0359 basis points of eating at-home processed pork, lunchmeats, ham, bacon, and pork hotdogs, respectively, relative to those employed 35 hours or more per week. Relative to individuals in households wherein the female head is employed 35 hours or more per week, those in households wherein the female head is employed less than 35 hours per week have a higher likelihood of 0.0210 basis points of eating at-home pork sausage. These results are in contrast with the findings of Briggeman. Briggeman found that employment of female head does not play a role in the decision to eat at-home processed pork.

In general, individuals from households wherein the female heads are more educated are less likely to eat at-home pork products relative to the others. These results are in agreement with the findings of Briggeman. Briggeman also found that the education of female head has a negative association with the likelihood of eating at-home processed pork. Individuals in households wherein the female head has some college education or has graduated from college have a lower probability of 0.0056 to 0.0339 basis points of eating at-home processed pork, lunchmeats, ham, bacon, and canned ham relative to those in households wherein the female head has at most high school education. Individuals in households wherein the female head has a post-college education have a lower probability of 0.0124 to 0.0739 basis points of eating at-home processed pork cuts relative to those in households wherein the female head has grade school; some high school education; or has graduated high school.

Market size is an important factor affecting the selection of at-home processed pork products except canned ham. Individuals from SMSAs have a lower likelihood of 0.0208 to 0.0442 basis points of consuming at-home processed pork products relative those from non-SMSAs. These results are in contrast with the findings of Briggeman. Briggeman reported that SMSA population has the highest likelihood of eating at-home processed pork.

Race plays a role in the likelihood of eating at-home pork products. Relative to whites, blacks have a higher the probability of 0.01908 to 0.1323 basis points of eating at-home pork sausage, bacon, and canned ham, respectively. Orientals have a lower likelihood of 0.0451 to 0.1118 basis points of eating at-home processed pork, lunchmeats, pork sausage, bacon, smoked ham, and pork hotdogs, but have a higher likelihood of 0.0742 basis points of eating at-home ham relative to whites. The likelihood of eating at-home processed pork, pork sausage, and smoked ham is by 0.0540 to 0.0553 basis points lower for other individuals relative to whites. Briggeman also found that race is an important determinant in the decision to eat at-home processed pork.

There are regional differences in the consumption of at-home processed pork products, except for at-home smoked ham. The Pacific is the only region where individuals have a significantly different likelihood of eating at-home canned ham relative to those residing in the New England region. Individuals from the East North Central, West North Central, South Atlantic, East South Central, West South Central, and Mountain regions have higher probabilities ranging from 0.0245 (South Atlantic) to

0.0662 (East South Central) of eating at-home processed pork and higher probabilities ranging from 0.0390 (South Atlantic) to 0.1832 (East North Central) of eating at-home processed pork relative to those living in the New England. The likelihood of eating at-home lunchmeats is 0.0364 to 0.0546 basis points higher in the Middle Atlantic and East North Central region and 0.0535 basis points lower in the West South Central region relative to the New England region. The likelihood of consumption of at-home ham is 0.0595 to 0.0653 basis points higher in the East South Central and West South Central regions and 0.0468 basis points lower in the Pacific region relative to the New England region. Individuals living in the New England region have a lower probability of 0.0423 to 0.1813 basis points of eating at-home bacon relative to the other regions except Middle Atlantic. The likelihood of eating at-home canned ham is by 0.0124 basis points lower in the Pacific region relative to the New England region. Individuals from the Middle Atlantic, West North Central, South Atlantic, West South Central, Mountain, and Pacific regions have lower probabilities of 0.0606 (Middle Atlantic) to 0.1320 (Pacific) of eating at-home pork hotdogs relative to from the New England. These results are in agreement with the finding of Briggeman. Briggeman also found that individuals residing in the East North Central, South Atlantic, East South Central, West South Central, and Mountain regions have higher likelihood of eating at-home processed pork that those from the Middle Atlantic, Pacific, and New England regions.

Attitudinal/lifestyle factors are key drivers of the decision to eat at-home processed pork products. Concern about serving foods with salt is positively associated with the likelihood of eating at-home ham, but does not affect the probability of consuming other at-home processed pork products. For each one-unit increase in the level of concern about serving foods with salt, the likelihood of eating at-home ham increases by 0.0160 basis points. Concern about serving foods with cholesterol is positively associated with the likelihood of eating at-home canned ham, but does not affect the probability of consuming other at-home processed pork products. For each unit increase in the concern about serving foods with cholesterol, the likelihood of eating at-home canned ham increases by 0.0036 basis points. Further, for each unit increase in individual's concern about serving foods with preservatives, the likelihood of eating at-home processed pork, lunchmeats, and bacon decreases by 0.0095, 0.0122, and 0.0135 basis points, respectively. Concern about serving foods with preservatives however, does not affect the probability of consuming at-home pork sausage, ham, canned ham, smoked ham, and pork hotdogs. Concern about serving foods with additives affects the likelihood of eating at-home bacon and pork hotdogs, but does not affect the probability of consuming other at-home processed pork products. For each unit increase in the concern about serving foods with additives, the likelihood of eating at-home bacon increases by 0.0308 basis points and the likelihood of eating at-home pork hotdogs decreases by 0.0142 basis points. Concern about serving foods with fat affects the likelihood of eating at-home processed pork, lunchmeats, ham, bacon, and pork hotdogs, but does not affect the probability of consuming at-home pork sausage, canned ham, and smoked ham. For each unit increase in the concern about serving foods with fat, the likelihood of eating at-home processed pork, lunchmeats, ham, and bacon decreases by

0.0096, 0.0143, 0.0261, and 0.0199 basis points, respectively, and the likelihood of eating at-home pork hotdogs increases by 0.0140 basis points.

Individuals who frequently check labels to determine whether foods they buy contain anything they are trying to avoid have a lower likelihood of eating at-home processed pork, lunchmeats, pork sausage, ham, bacon, smoked ham, and pork hotdogs. The marginal effects related to these products are 0.0136, 0.0064, 0.0157, 0.0100, 0.0116, 0.0068, and 0.0083 basis points, respectively. Checking labels however, does not affect the probability of consuming at-home canned ham. Individuals who stress the importance of planning meals to make sure they are nutritious have a higher probability of eating at-home pork sausage, ham, bacon, canned ham, and smoked ham. A one-unit increase in the level of the importance of planning meals to make sure they are nutritious increases the probability of eating these at-home products by 0.0151, 0.0217, 0.0134, 0.0022, and 0.0155 basis points, respectively. These individuals however, have a lower probability of at-home lunchmeats. A unit increase in the level of the importance of planning meals to make sure they are nutritious decreases the probability of eating these at-home lunchmeats by 0.0076 basis points. Individuals who believe how food tastes is more important than how nutritious it is have a higher probability of consuming at-home processed pork, pork sausage, bacon, canned ham, and pork hotdogs. The marginal effects related to these products are 0.0037, 0.0088, 0.0103, 0.0021, and 0.0072 basis points, respectively

Age of individual is an important factor in the decision to eat any of the at-home processed pork products. In general, as individuals get older their likelihood of eating at-home processed pork products increases. Individuals 65 and more have the highest likelihood of eating at-home processed pork, pork sausage, ham, bacon, canned ham and smoked ham. These individuals have higher probabilities of 0.0185 to 0.1492 basis points of eating these goods relative to those between 30 and 39 years of age. Individuals between 18 and 24 years of age have the lowest likelihood of eating at-home processed pork, lunchmeats, and canned ham. These individuals have lower probabilities of 0.0144 to 0.0408 basis points of eating these goods relative to those between 30 and 39 years of age.

The presence of children under 18 is an important factor in the decision to consume at-home smoked ham only. Individuals in households wherein there are no children under 18 have a higher probability of 0.0288 basis points of eating at-home smoked ham relative to individuals in households wherein there are children under 18.

Household size plays a role in the decision to eat at-home processed pork products, except for canned ham. Individuals from larger families have higher likelihood of eating these products. These results are in agreement with the findings of Briggeman. Individuals from one-member households have a lower likelihood of 0.0438 to 0.1243 basis points of eating at-home processed pork, lunchmeats, pork sausage, ham, bacon, smoked ham, and pork hotdogs relative to those from two-member households. Individuals from households with at least three members have a higher likelihood of 0.0304 to 0.0616 basis points of eating at-home processed pork, lunchmeat, pork sausage, ham, smoked ham, and pork hotdogs, respectively, relative to those from two-member households.

Health factors are important in the decision to eat at-home processed pork products. Dieting affects the decision to eat at-home processed pork, ham, and bacon only. Individuals who are on a diet by choice have lower probabilities of 0.0378 and 0.0693 of eating at-home processed pork and ham, respectively, relative to individuals who are on a doctor prescribed diet. Individuals who are not on diet have higher likelihoods of 0.0226 and 0.0369 basis points of eating at-home processed pork and bacon, respectively, relative to individuals who are on a doctor prescribed diet. These results are in agreement with the findings of Briggeman.

Body Mass Index plays a role in the decision to eat at-home processed pork products, except for smoked ham. Individuals with higher than recommended BMI have higher probabilities of 0.0058 to 0.0314 of eating at-home processed pork, pork sausage, ham, bacon, canned ham, and pork hotdogs relative to those who are within recommended standards of BMI. These results are in agreement with the findings of Briggeman. Briggeman also shows that BMI is positively associated with the likelihood of eating at-home processed pork. Individuals with lower than recommended BMI have lower probabilities of 0.0161 and 0.0204 of eating at-home processed pork and pork sausage, respectively, but a higher probability of 0.0151 basis points of eating at-home canned ham relative to those who are within recommended standards of BMI.

Intake Stage Results

This part of the study discusses the key factors affecting the volume of intake of the selected at-home processed pork, bacon, ham, pork sausage, canned ham, smoked ham, lunchmeat, and pork hotdogs. The parameter estimates and associated p-values of the second stage of the Heckman sample selection models are presented in Table 26. Key drivers of the absolute amount of intake of at-home processed pork products are income, season, gender of eater, race of eater, region, age of eater, and household size. The mills ratio is statistically significant in models for processed pork, bacon, and hotdogs. This finding emphasizes the importance of adjusting for sample selection in those models. The squared correlations (R^2_c) between actual and predicted intakes range from 0.1124 (processed pork) to 0.0175 (canned ham), reasonable with individual based data. The Wald χ^2 test statistics are statistically significant in all four models, indicating that the coefficients Heckman models are statistically different from zero at 0.05 level.

Table 26. Second Stage Heckman Model Results for At-Home Processed Pork Products (Processed Pork, Lunchmeat, Pork Sausage, Ham, Bacon, Canned Ham, Smoked Ham, and Hotdogs)

Variable	Processed Pork	Lunch meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
income	-7.56E-04	-1.40E-04	-2.82E-05	1.18E-04	-1.94E-04	-2.36E-04	2.20E-04	1.61E-04
	0.000	(0.345)	(0.786)	(0.302)	0.000	(0.634)	(0.132)	(0.204)
inc_2	2.41E-09	9.86E-11	-1.57E-10	-1.27E-09	9.52E-10	9.35E-10	-1.76E-09	-8.79E-10
	(0.007)	(0.908)	(0.808)	(0.079)	(0.001)	(0.751)	(0.064)	(0.266)
ETHNICITY								
Hispanic	-18.4540	-10.3323	-11.3171	-5.3134	-3.0594	36.7355	-14.2622	-2.2339
	(0.018)	(0.135)	(0.036)	(0.399)	(0.221)	(0.136)	(0.120)	(0.684)
SEASON								
summer	-3.2505	-3.7991	-9.3152	-6.7794	0.9652	30.9668	-6.4380	8.6247
	(0.490)	(0.359)	(0.004)	(0.090)	(0.505)	(0.040)	(0.276)	(0.013)
fall	3.6338	3.9170	-8.2198	0.5678	1.3453	2.9939	-16.2329	12.7335
	(0.438)	(0.332)	(0.011)	(0.878)	(0.348)	(0.846)	(0.002)	(0.000)
winter	-7.5411	-4.3533	-13.0635	4.9034	2.5316	23.8672	0.0061	4.3089
	(0.108)	(0.286)	(0.000)	(0.178)	(0.080)	(0.089)	(0.999)	(0.240)
GENDER								
femaleet	-97.4448	-52.1615	-30.8253	-58.4835	-9.6843	-20.9529	-42.0990	-39.0577
	0.000	0.000	0.000	0.000	0.000	(0.041)	0.000	0.000
MARKET SIZE								
smsa	-16.3747	-0.2011	-11.5408	1.1126	1.0690	-12.5496	1.4725	-4.4876
	(0.000)	(0.954)	(0.000)	(0.734)	(0.392)	(0.331)	(0.732)	(0.101)
RACE								
black	34.5634	-11.1973	26.6707	2.7539	8.7017	127.1920	1.6243	-0.8908
	0.000	(0.051)	0.000	(0.582)	(0.000)	0.000	(0.781)	(0.838)

Table 26. Continued

Variable	Processed Pork	Lunch meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
Oriental	-25.2056	-4.6993	3.6987	-23.7022	7.2854	-13.5100	7.8614	17.7925
	(0.106)	(0.809)	(0.797)	(0.042)	(0.254)	(0.792)	(0.773)	(0.246)
other	23.8029	-5.8802	33.2084	-11.3483	13.3171	-54.4728	-30.6823	-10.1138
	(0.043)	(0.571)	(0.000)	(0.237)	(0.000)	(0.166)	(0.046)	(0.192)
REGION								
midatl	3.6614	6.0800	-8.6591	1.7263	8.1945	-23.7973	-10.3074	5.6453
	(0.676)	(0.430)	(0.210)	(0.803)	(0.008)	(0.364)	(0.215)	(0.345)
enc	10.9962	16.6614	-1.3858	-5.8792	7.0728	-43.4026	-9.8690	5.3131
	(0.219)	(0.030)	(0.874)	(0.389)	(0.022)	(0.098)	(0.214)	(0.328)
wnc	2.7808	25.6313	-4.3704	-9.6467	5.3498	-109.1650	-0.4935	9.9983
	(0.777)	(0.002)	(0.616)	(0.206)	(0.113)	(0.001)	(0.956)	(0.132)
satl	-9.3878	5.5503	2.4674	-7.1322	5.6241	-54.5196	-7.9525	1.9328
	(0.280)	(0.471)	(0.719)	(0.298)	(0.073)	(0.032)	(0.320)	(0.734)
esc	35.8635	12.0306	6.7251	14.2244	15.1803	-78.2316	17.2036	0.6629
	(0.000)	(0.160)	(0.412)	(0.071)	0.000	(0.008)	(0.058)	(0.912)
wsc	9.1821	16.7339	13.2826	1.5154	10.3942	1.5256	0.1001	10.1698
	(0.334)	(0.053)	(0.115)	(0.838)	(0.002)	(0.956)	(0.991)	(0.121)
mount	-23.5995	6.2186	-12.2985	2.9911	14.2663	-55.6587	7.6912	2.7618
	(0.023)	(0.483)	(0.129)	(0.711)	0.000	(0.083)	(0.410)	(0.724)
pacific	-31.5007	23.2145	-12.1557	-14.3750	8.0444	-38.7179	-10.8008	19.4094
	(0.001)	(0.005)	(0.084)	(0.050)	(0.010)	(0.202)	(0.222)	(0.017)
AGE OF INDIVIDUAL								
age18_24	6.1652	-1.3041	-7.3363	-3.1529	2.5354	7.0920	-19.1233	8.2787
	(0.403)	(0.843)	(0.139)	(0.597)	(0.274)	(0.828)	(0.009)	(0.094)

Table 26. Continued

Variable	Processed Pork	Lunch meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
age25_29	4.5054	-13.4964	-3.2160	8.8690	-6.6759	-7.8828	2.6477	6.1457
	(0.542)	(0.043)	(0.565)	(0.138)	(0.007)	(0.749)	(0.727)	(0.211)
age40_49	12.7792	-2.0097	-1.1930	1.8882	0.9026	-10.5385	4.7091	-7.4822
	(0.011)	(0.641)	(0.735)	(0.645)	(0.579)	(0.560)	(0.364)	(0.028)
age50_59	12.6287	2.3637	-2.7182	-5.1272	-0.4049	-25.4065	-4.2056	-3.6364
	(0.022)	(0.623)	(0.499)	(0.314)	(0.839)	(0.210)	(0.537)	(0.350)
age60_64	15.0649	10.2970	-0.3259	-16.3565	0.2143	-41.0551	-10.3997	-12.7383
	(0.049)	(0.122)	(0.952)	(0.016)	(0.933)	(0.089)	(0.283)	(0.020)
age65up	0.6162	-19.2735	-5.1942	-18.4375	-4.6521	-24.5104	-8.4704	-11.9483
	(0.918)	(0.000)	(0.225)	(0.005)	(0.033)	(0.247)	(0.394)	(0.004)
HOUSEHOLD SIZE								
memb_1	5.8606	26.4993	4.1341	12.0996	4.6439	9.4654	-1.8347	16.9339
	(0.401)	0.000	(0.457)	(0.041)	(0.061)	(0.560)	(0.824)	(0.001)
memb_3up	5.3107	-13.5626	-1.6216	0.9353	-1.4883	-7.1122	5.4069	-6.1904
	(0.232)	(0.001)	(0.575)	(0.794)	(0.246)	(0.566)	(0.229)	(0.100)
_cons	352.2037	161.6534	163.6272	212.2447	52.4548	169.8379	145.4081	182.7498
	0.000	0.000	0.000	0.000	0.000	(0.057)	0.000	0.000
mills lambda	-131.0120	-19.9291	-14.0152	-31.1528	-12.1421	-0.4016	-4.0252	-35.8919
	0.000	(0.206)	(0.409)	(0.091)	(0.014)	(0.992)	(0.849)	(0.006)

Table 26. Continued

Variable	Processed Pork	Lunch meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
Number of obs	17,581	17,591	17,580	17,578	17,586	17,601	17,596	17,585
Censored obs	2,709	13,039	11,282	8,630	12,184	17,031	14,709	13,479
Uncensored obs	14,872	4,552	6,298	8,948	5,402	570	2,887	4,106
Wald chi2(52)	1461.34	722.52	883.75	947.19	1019.36	216.93	731.54	808.75
Prob > chi2	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2_c	0.1124	0.0409	0.0534	0.0429	0.0574	0.0175	0.0312	0.0526

Notes: The p-values are presented in parentheses below the parameter estimates.
R^2_c represents the squared correlation between actual and predicted intakes for all individuals.
Variable names and definitions are exhibited In Table A.1 in Appendix A.

The marginal effects for all individuals and for individuals who ate the selected products are presented in Table 27 and Table 28, respectively. Both conditional and unconditional measures of marginal effects are presented based on two consecutive weeks of consumption.

Income does not play a role in the consumption of at-home processed pork products except for processed pork and bacon. The income elasticity for processed pork is the same (-0.15) for all individuals and for eaters of at-home processed pork. A 10 percent increase in the income will result in 1.5 percent decrease in consumption of at-home processed pork. For bacon, the income elasticity is about -0.13 for all individuals and -0.21 for those who consumed bacon. These negative relationships may be explained by the fact that as income increases they divert their processed pork and bacon consumption from at-home to away-from-home. But it does not necessarily mean that processed pork or bacon in aggregate are inferior goods.

Ethnicity does not affect the actual intake of at-home processed pork products except for processed pork and pork sausage. For all individuals, Hispanics have a lower intake of 19.39 grams of at-home processed pork relative to non-Hispanics. Conditional on eating at-home processed pork, Hispanics eat 20.25 less grams of at-home processed pork relative to non-Hispanics. Further, for all individuals, Hispanics have a lower intake of 3.33 grams of at-home pork sausage relative to non-Hispanics. For eaters of at-home pork sausage, intake is 11.16 grams lower for Hispanics than non-Hispanics.

Table 27. Marginal Effects for All Individuals Associated with the Second Stage of Heckman Models for At-Home Processed Pork Products (Processed Pork, Lunchmeat, Pork Sausage, Ham, Bacon, Canned Ham, Smoked Ham, and Hotdogs)

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
income	-6.48E-04	-2.49E-04	-9.50E-05	9.81E-05	-3.32E-05	-3.56E-05	1.13E-04	-2.14E-04
income (elasticity)	-0.15	-0.42	-0.11	0.06	-0.13	-0.47	0.29	-0.35
ETHNICITY								
Hispanic*	-19.3909	-3.0993	-3.3290	-5.0518	-1.7844	2.1524	-5.8232	-1.1283
SEASON								
summer*	-2.6207	-2.3502	-2.3395	-11.4238	0.0710	0.0561	-6.1765	9.1751
fall*	0.8917	0.1432	-0.7752	-3.1940	1.7412	-0.7226	-6.3771	1.9514
winter*	-7.0583	-2.7338	-4.8852	2.5130	0.3832	0.3972	3.2149	-4.9336
GENDER								
femaleet*	-89.2816	-17.8087	-14.3402	-32.2527	-2.7044	-0.6664	-6.3837	-10.0479
MARKET SIZE								
smsa*	-24.5396	-3.0434	-8.3387	-5.5799	-1.6556	-0.3071	-3.4453	-4.0332
RACE								
black*	35.7614	-3.8422	28.7263	1.3769	13.0585	7.8626	1.1749	-2.3431
Oriental*	-38.7164	-13.1482	-12.4131	-0.4297	-3.1470	0.4711	-10.8961	-8.2670
other*	-2.7603	-4.1770	3.4136	-13.3000	5.0135	-1.6333	-9.1822	-3.5248
REGION								
midatl*	1.8685	5.9723	0.6125	3.9616	2.5662	-0.7292	1.3015	-7.5185
enc*	35.2978	11.2460	21.9668	2.4674	6.4292	-1.5008	0.3270	-2.8386
wnc*	20.6044	9.2447	18.0445	-2.7356	6.5782	-3.0744	-0.1207	-7.8191
satl*	1.9976	-0.6646	5.6858	2.1021	6.9385	-1.4864	0.5700	-6.9529
esc*	61.5065	5.4489	18.3329	19.7428	15.4660	-1.5596	3.9640	1.4870
wsc*	33.7886	-2.6767	26.3635	11.4826	11.8037	-0.2268	0.7436	-9.7434

Table 27. Continued

Variable	Processed Pork	Lunch Meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
mount*	-1.1294	3.8974	4.9449	1.7464	9.7334	-1.6627	3.6054	-13.1051
pacific*	-31.3578	1.6754	-1.0965	-15.0515	4.5544	-2.0294	-4.5285	-15.6231
AGE OF INDIVIDUAL								
age18_24*	-7.9867	-5.0176	-1.5989	-4.0790	0.8806	-1.4160	-2.9122	-0.1650
age25_29*	-8.5473	-7.2187	-7.1154	4.5674	-2.9082	0.0050	0.8143	0.7671
age40_49*	8.5523	1.4424	2.9856	3.2654	2.3177	-0.1093	2.3587	0.6726
age50_59*	23.1664	2.4621	4.5920	12.5921	5.5080	0.8116	5.5979	1.2429
age60_64*	30.4208	8.7442	4.1634	9.3588	6.3509	-0.3976	9.1820	2.8176
age65up*	18.7766	-3.1227	4.3477	15.7998	4.6843	0.9715	11.9526	1.4206
HOUSEHOLD SIZE								
memb_1*	-35.2141	0.7431	-10.6037	-12.5424	-4.4028	0.7897	-7.3875	-4.2557
memb_3up*	18.9430	2.2021	3.1178	9.0281	0.4760	0.2256	6.1560	7.4634

Notes: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1.
Variable names and definitions are exhibited In Table A.1 in Appendix A.

Table 28. Marginal Effects for Eaters Only Associated with the Second Stage of Heckman Models for At-Home Processed Pork Products (Processed Pork, Lunchmeat, Pork Sausage, Ham, Bacon, Canned Ham, Smoked Ham, and Hotdogs)

Variable	Processed Pork	Lunch meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
income	-7.67E-04	-2.15E-04	-4.60E-05	1.28E-04	-1.81E-04	-2.38E-04	2.29E-04	2.83E-05
income (elasticity)	-0.15	-0.09	-0.02	0.04	-0.21	-0.08	0.10	-0.01
ETHNICITY								
Hispanic*	-20.2491	-10.5506	-11.1580	-5.9908	-3.6140	36.7774	-14.8073	-2.6577
SEASON								
summer*	-3.1599	-4.3764	-9.0985	-9.0801	0.8417	30.9279	-7.1294	13.0158
fall*	2.5287	3.5796	-7.7380	-0.4075	2.0933	2.9490	-16.7649	12.1946
winter*	-7.8183	-5.0342	-13.1283	4.9080	2.3236	23.8548	0.3836	0.3639
GENDER								
femaleet*	-100.0053	-53.9724	-31.5770	-59.1594	-9.5878	-20.9578	-42.0888	-39.9728
MARKET SIZE								
smsa*	-21.4283	-1.3859	-12.4297	-0.5886	-0.0494	-12.5478	1.0401	-6.4049
RACE								
black*	37.3117	-11.6514	29.9504	2.7471	13.0130	127.2836	1.7335	-2.3361
Oriental*	-34.2491	-10.9491	0.3487	-20.1336	4.1295	-13.4649	5.8614	9.3109
other*	12.7589	-7.0688	31.6705	-13.6483	13.7838	-54.4885	-31.5381	-11.0359
REGION								
midatl*	3.0272	7.7457	-7.8240	2.5737	8.2633	-23.8023	-9.9494	-0.4524
enc*	23.5102	19.1299	3.1512	-4.3431	9.1778	-43.4263	-9.6377	2.6618
wnc*	11.6954	26.5561	-0.3831	-9.0156	7.7035	-109.2035	-0.4990	2.9737
satl*	-4.3328	4.7269	3.4926	-5.5125	8.1861	-54.5193	-7.7301	-3.2039
esc*	49.9212	12.9052	9.8035	17.3826	19.2938	-78.1593	17.3423	1.5202
wsc*	21.7055	14.0405	17.2569	4.4003	14.0587	1.5110	0.1874	1.5869

Table 28. Continued

Variable	Processed Pork	Lunch meat	Pork Sausage	Ham	Bacon	Canned Ham	Smoked Ham	Pork Hotdogs
mount*	-13.6619	7.0944	-10.1896	3.0525	16.5046	-55.6733	7.9573	-8.0976
pacific*	-33.7035	21.6841	-11.4091	-16.7217	9.1034	-38.8004	-11.1967	4.3589
AGE OF INDIVIDUAL								
age18_24*	-0.3725	-3.3363	-7.1073	-3.8588	2.6058	6.9881	-19.1195	7.0125
age25_29*	-1.6233	-15.3044	-4.6348	8.8831	-7.3108	-7.8706	2.6958	5.7731
age40_49*	11.5772	-1.2264	-0.4466	2.5242	2.0349	-10.5287	4.8998	-5.9510
age50_59*	18.5748	3.0964	-1.5069	-0.9445	2.5478	-25.3244	-3.4894	-2.3053
age60_64*	23.3931	12.4655	0.5954	-11.2758	3.3388	-41.0037	-9.2130	-9.0293
age65up*	9.6000	-18.5009	-3.8326	-11.2984	-1.3183	-24.4224	-7.0354	-9.2542
HOUSEHOLD SIZE								
memb_1*	-14.2762	24.3287	1.3107	6.8696	1.0149	9.4906	-2.8403	11.7228
memb_3up*	12.4267	-11.2905	-0.8052	3.3219	-0.9584	-7.0899	6.0554	-0.4189

Notes: * indicates the marginal effect is for discrete change of dummy variable from 0 to 1,
Variable names and definitions are exhibited In Table A.1 in Appendix A.

Seasonality affects the intake of at-home pork sausage, canned ham, smoked ham, and pork hotdogs only. For all individuals, the consumption of at-home pork sausage is higher in the spring by 0.77 to 4.88 grams relative to the summer, fall, and winter. Conditional on eating at-home pork sausage, intake is higher in the spring by 7.74 to 13.13 grams relative to the summer, fall, and winter. Further, for all individuals, the consumption of canned ham is higher by 0.06 grams in the summer than in the spring. For eaters of canned ham, it is higher by 30.93 grams in the summer relative to the spring. For all individuals, the consumption of at-home smoked ham is lower by 6.38 grams in the fall relative to the spring. Conditional on eating at-home smoked ham, individuals consume 16.76 less grams of at-home smoked ham in the fall relative to the spring. For all individuals, the consumption of at-home pork hotdogs is higher by 1.95 to 9.17 grams in the fall and summer relative to spring. For eaters of at-home pork hotdogs, intake is lower in the spring by 12.19 to 13.02 grams relative to the summer and fall.

Gender of individual plays a role in the intake of any of the eight at-home processed pork products. Females eat less processed pork products relative to males. For all individuals, females consume 0.67 (canned ham) to 89.28 (processed pork) less grams of at-home processed pork products relative to males. For eaters of at-home processed pork products, intake is lower for females by 9.59 (bacon) to 100.01 grams (processed pork) than for males.

Market size plays a role in the consumption of at-home processed pork and pork sausage. For all individuals, those located in SMSA areas consume 8.34 to 24.54 less grams of at-home processed pork and pork sausage than those from non-SMSA areas.

Conditional on eating at-home processed pork and pork sausage, individuals located in SMSA areas consume 12.43 to 21.43 less grams of at-home processed pork and pork sausage than those from non-SMSA areas.

Race is an important determinant in the consumption of the at-home processed pork products except lunchmeat, canned ham, and pork hotdogs. For all individuals, the consumption of processed pork is higher by 35.76 grams for blacks and lower by 2.76 grams for other races (not blacks, not Orientals) relative to whites. When consumption of at-home processed pork products occurs, intake is lower by 37.31 grams for blacks and 12.76 grams for others than for whites. Further, for all individuals, blacks and other races consume 3.41 to 28.73 more grams of pork sausage and 5.01 to 13.06 more grams of bacon relative to whites. Conditional on eating pork sausage, blacks and others consume 29.95 to 31.67 more grams of pork sausage and, conditional on eating bacon, they eat 13.01 to 13.78 more grams of bacon than whites. For all individuals, Orientals consume 0.43 less grams of ham than whites. When ham consumption occurs, intake is lower by 20.13 grams for Orientals relative to whites. For all individuals, blacks consume 7.86 more grams of canned ham than whites. Conditional on consuming canned ham, blacks eat 127.28 more grams of canned ham relative to whites. Further, for all individuals, others consume 9.18 less grams of smoked ham than whites. When smoked ham consumption occurs, intake is lower by 31.54 grams for others relative to whites.

Region plays a role in the consumption stage of at-home processed pork products except for pork sausage and smoked ham. For all individuals, individuals residing in the

Mountain and Pacific regions consume 1.13 to 31.36 less grams of processed pork but individuals residing in the East South Central region consume 61.51 grams more processed pork relative to those from the New England region. When processed pork consumption occurs, intake is 13.66 to 33.70 grams lower in the Mountain and Pacific regions and 49.92 grams higher in the East South Central region than in the New England region.

For all individuals, those living in the East North Central, West North Central, and Pacific regions consume 1.67 to 11.25 more grams of lunchmeat than those residing in the New England region. Conditional on consuming lunchmeats, individuals residing in the East North Central, West North Central, and Pacific regions consume 19.13 to 26.56 more grams of lunchmeat than those from the New England region. For all individuals, individuals residing in the Pacific region consume 15.05 less grams of ham relative to those from the New England region. When ham consumption occurs, intake is 16.72 grams lower in Pacific region relative to the New England region. For all individuals, those from the New England region consume 2.57 to 15.47 less grams of bacon than those from the Middle Atlantic, East North Central, East South Central, West South Central, Mountain, and Pacific regions. Conditional on consuming bacon, individuals from the New England region consume 8.26 to 19.29 less grams of bacon than those from the Middle Atlantic, East North Central, East South Central, West South Central, Mountain, and Pacific regions.

For all individuals, the consumption of canned ham is lower by 1.49 to 3.07 grams in the West North Central, South Atlantic, and East South Central regions relative to the New England region. When canned ham consumption occurs, intake is lower by 54.52 to 109.20 grams in the West North Central, South Atlantic, and East South Central regions than in the New England region. For all individuals, individuals residing in the Pacific region consume 15.62 less grams of pork hotdogs than those from the New England region. Conditional on eating pork hotdogs, individuals living in the Pacific region consume 4.36 more grams of pork hotdogs than those from the New England region.

Age of individual is an important determinant in the consumption of at-home processed pork products except for pork sausage and canned ham. For all individuals, individuals between 40 and 49, 50 and 59, and 60 and 64 years of age consume 8.55 to 30.42 more grams of processed pork than those between 30 and 39 years of age. When processed pork consumption occurs, intake is 11.58 to 23.39 grams higher for individuals between 40 and 49, 50 and 59, and 60 and 64 years of age relative to those between 30 and 39 years of age. For all individuals, those 65 and older consume 3.12 less grams of lunchmeat than those between 30 and 39 years of age. Conditional on eating lunchmeats, individuals 65 and older consume 18.50 less grams of lunchmeat than those between 30 and 39 years of age. For all individuals, individuals between 60 and 64 and 65 and older consume 9.36 to 15.80 more grams of ham relative to those between 30 and 39 years of age. When ham consumption occurs, intake is lower for individuals between 60 and 64 and 65 and older by roughly 11.00 grams relative to those between 30 and 39 years of age. For all individuals, bacon consumption is lower by 2.91 grams for individuals between 25 and 29 years of age and higher by 4.68 grams for individuals

65 and more relative to those between 30 and 39 years of age. For bacon eaters, individuals between 25 and 29 years of age and those 65 and older consume 1.32 to 7.31 less grams of bacon than those between 30 and 39 years of age. For all individuals, individuals between 18 and 24 years of age consume 2.91 less grams of smoked ham than those between 30 and 39 years of age. When smoked ham consumption occurs, intake is 19.12 grams lower for individuals between 18 and 24 years of age than those between 30 and 39 years of age. For all individuals, those between 30 and 39 years of age consume 0.67 to 2.82 more grams of pork hotdogs than those between 40 and 49, 60 and 64, and 65 and older. Conditional on eating hotdogs, this difference is 5.95 to 9.25 grams.

Household size plays a role in the consumption of at-home lunchmeats, ham, and hotdogs. For all individuals, those from one-member households have lower intakes of 4.26 and 12.54 grams of pork hotdogs and ham, respectively, but have a higher intake of 0.74 grams of lunchmeats relative to those from two-member households. Individuals from one member households have a higher intake of 24.33 grams of lunchmeats conditional on eating lunchmeats, a higher intake of 6.86 grams of ham conditional on eating ham, and a higher intake of 11.73 grams of pork hotdogs conditional on eating hotdogs relative to those from two-member households. For all individuals, those with at least three members in the household have a higher intake of 2.20 grams of lunchmeats than those two-member households. When lunchmeat consumption occurs, intake is higher by 11.29 grams for individuals from two-member households relative to those from least three members in the household.

CHAPTER VI

VALIDATION OF THE HECKMAN SAMPLE SELECTION MODELS

Introduction

This chapter examines the predictive power of the sixteen Heckman sample selection models in terms of: (1) their ability to identify eaters and non-eaters, (2) their ability to predict the penetration of the selected products, and (3) their ability to predict the volume of intake of the selected products.

Pindyck and Rubinfeld suggest that the predictive power of models should be based on out-of-sample evaluations. Following their recommendation, we constructed the out-of-sample data by taking 20% (or 3,522 observations) of the total sample using a uniform distribution (to give each observation an equal chance of being selected). Then, outliers corresponding to each product were dropped from the within- and out-of-sample data. The last column of Table 29 shows that sample sizes of the out-of-sample data range from 3,511 (ham) to 3,522 (pork roasts).

Parameters of the respective Heckman models are re-estimated using the in-sample data only. Then, we use these estimated parameters to generate predictions based on out-of-sample data. Out-of-sample predictions include probability of consumption and volume of intake. (See Figure 5.)

Table 29. Two-by-Two Classification Table of Eaters and Non-Eaters

Classified	**True** T	~T	**Total**
+	A	B	A + B
-	C	D	C + D
Total	A + C	B + D	A+B+C+D

Sensitivity	≡ **Pr(+| T)**	=	A / (A+C)
Specificity	≡ **Pr(-|~T)**	=	D / (B+D)
Positive predictive value	≡ **Pr(T| +)**	=	A / (A+B)
Negative predictive value	≡ **Pr(~T| -)**	=	D / (C+D)
False + rate for true ~T	≡ **Pr(+|~T)**	=	B / (B+D)
False - rate for true T	≡ **Pr(-| T)**	=	C / (A+C)
False + rate for classified +	≡ **Pr(~T| +)**	=	B / (A+B)
False - rate for classified -	≡ **Pr(T| -)**	=	C / (C+D)

Correctly classified (weighted average)	= (A+D)/ (A+B+C+D)
Correctly classified (sum)	= Sensitivity + Specificity

Notes: In-sample penetration is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed the product;
~T An individual has not consumed the product;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

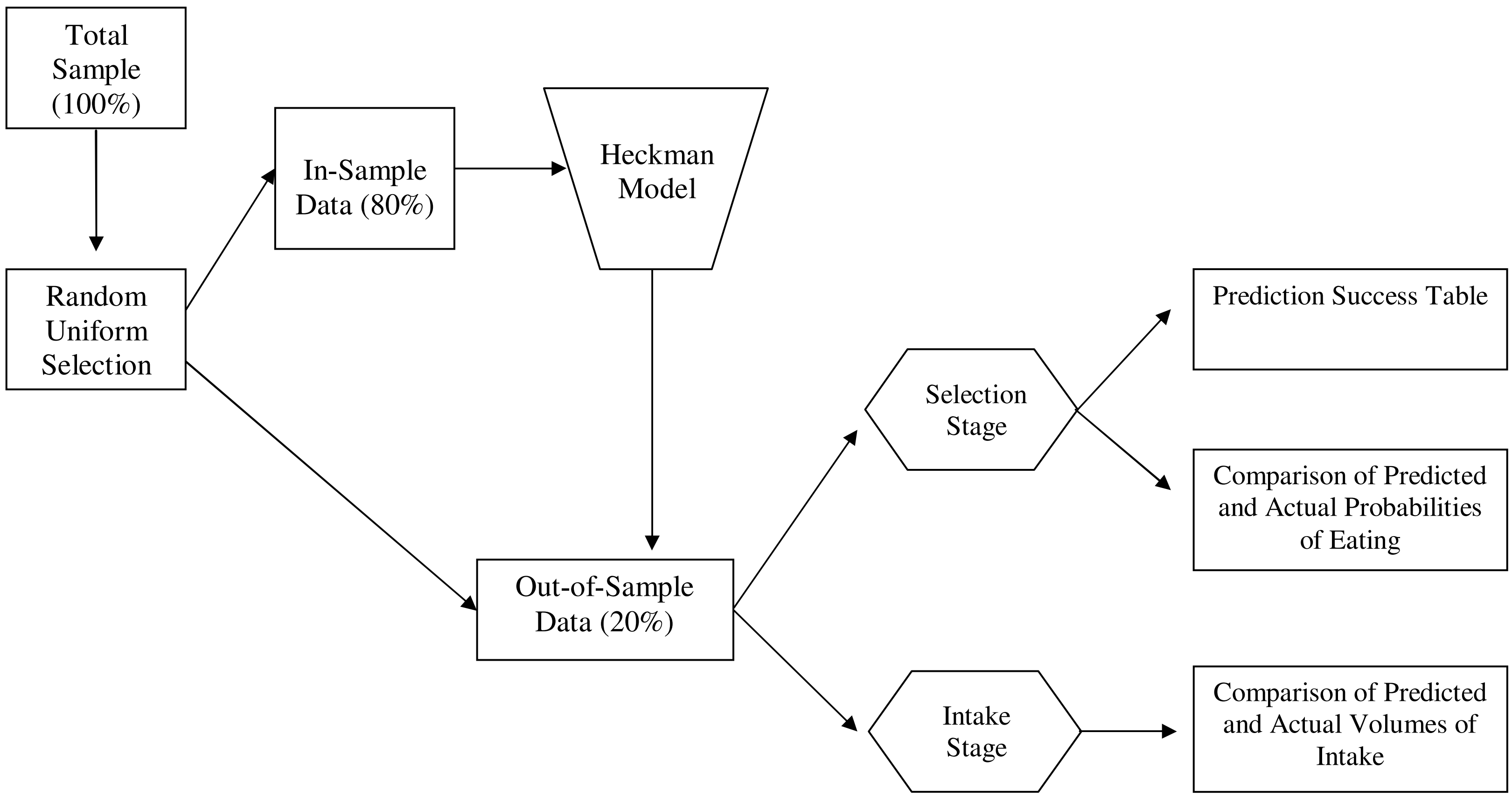


Figure 5. Diagram for the validation of the Heckman models

The predictive power of the selection stage of the two-stage Heckman sample selection models (i.e., probit models) is examined through prediction success tables and comparison of average predicted probability of consumption and average actual probability of consumption of the selected products. The predictive power of the intake stage of the Heckman models is examined by comparing average predicted volume of intake and average actual volume of intake of the selected products. Through this analysis, the predictive power of the Heckman sample selection models is addressed for the out-of-sample data.

Prediction Success Tables

Prediction success tables can be used in binary choice models to measure their predictive power. We, therefore, apply this procedure to study the predictive power of the selection stage of the Heckman models. Table 29 shows that a prediction success table is basically a two-way table of predicted (or classified) results versus actual results (STATA). For example, an individual is considered correctly classified if the predicted probability of the model is higher than or equal to the cutoff value. The percentage of individuals who consumed (i.e., penetration) a specific product based on out-of-sample data is considered as a cutoff value for this study. An individual is further sorted into cells based on information about whether he/she actually consumed the corresponding product over a two-week period. If an individual consumed the product, then he/she is sorted to the cell A (a correctly identified individual who ate). Otherwise, an individual is sorted to the cell B (an individual was identified as an eater, but actually he/she did consume the product).

Based on this two-way relationship, STATA reports set of ratios measuring the accuracy of prediction of the models. For example, sensitivity represents the percentage of correctly identified individuals who ate. It is calculated by dividing the number of correctly identified individuals who ate (i.e., A) on the total number of eaters (i.e., A+C). Specificity represents the percentage of correctly identified individuals who did not eat. It is calculated by dividing the number of correctly identified individuals who did not eat (i.e., D) on the total number of non-eaters (i.e., B+D). Correctly classified (weighted average) represents the weighted average of sensitivity and specificity (i.e., (A+D)/(A+B+C+D)). Correctly classified (sum) represents the sum of sensitivity and specificity.

Usually a goal of maximizing sensitivity, specificity, their sum, or their weighted average is set up a priori. The cutoff values maximizing those objectives are, then, calculated. For example, Briggeman's (2002) goal was to maximize the percentage of correctly identified individuals who did not eat pork (i.e., specificity). He considered four cutoff values: toss of a fair coin, penetration, average of the probabilities of those that ate and complete enumeration. Briggeman found that, in his example, there is not much difference between penetration and average of the probabilities of those that ate.

We have chosen penetration as a cutoff point, because this information is readily available from the out-of-sample data. With this information on hand, marketers have some power to filter eaters and non-eaters. Table 30 shows that the out-of-sample penetration values range from 2.88 (pork tenderloin) to 84.57 percent (processed pork).

Table 30. Probability of Eating of the Selected Products: Actual versus Predicted

Product	Average Probability of Eating (in %) Actual (A)	Predicted (P)	MAE ABS(P-A) (in %)	Number of Individuals (out of sample)
Fresh Pork	41.21	41.00	0.21	3,516
Fresh Beef	79.74	79.86	0.12	3,515
Fresh Chicken	73.23	72.61	0.63	3,512
Fresh Seafood	32.40	33.39	0.99	3,518
Pork Chops	26.32	26.53	0.21	3,518
Pork Ribs	5.51	5.58	0.07	3,521
Pork Roasts	4.43	4.66	0.23	3,522
Pork Tenderloin	3.52	2.87	0.65	3,521
Porcessed Pork	84.67	84.66	0.01	3,517
Bacon	31.11	30.76	0.35	3,517
Ham	50.56	51.18	0.62	3,511
Canned Ham	3.13	3.35	0.22	3,520
Smoked Ham	16.73	16.53	0.19	3,521
Pork Hotdogs	23.70	23.33	0.37	3,519
Luncheon Meats	25.90	25.91	0.01	3,521
Pork Sausage	35.41	35.97	0.56	3,513
Average over Sixteen Products			0.34	3,518

Note: MAE stands for Mean Absolute Error. ABS stands for absolute value.

Hence, knowing that the penetration of processed pork is 84.57 percent and assuming that everybody is a processed pork eater, the marketer has about 85 percent chance of detecting eaters of processed pork. However, he/she is not able to filter non-eaters in this case. Hence, the overall ability of correctly predicting eaters and non-eaters in terms of sensitivity versus specificity is (85, 0). The marketer could also assume that everybody is non-eater. However, in this case, he/she would be right only 15 percent of the time, but would not be able to correctly detect any of the eaters. In this case, the overall ability of correctly predicting eaters and non-eaters in terms of sensitivity versus specificity is (0, 15).

As it was mentioned in the beginning of the chapter we are equally interested in the models' ability to filter both eaters and non-eaters. Our models may have lower predictive power in terms of correctly classifying eaters (non-eaters), but they compensate this weakness by being able to correctly detect large number of non-eaters (eaters) as well. We therefore think that our models could predict those eaters and non-eaters better than just the knowledge about penetration.

The sixteen at-home products prediction success tables are presented in Tables D.1 to D.16 in Appendix D. The sensitivity values range from 52.58 (pork ribs) to 68.21 percent (fresh beef) and the specificity values range from 50.46 (pork chops) to 61.97 percent (processed pork). Continuing the example of processed pork, we learn from Table D.14 in Appendix D that our models simultaneously can correctly identify about 63 percent eaters and about 62 percent of non eaters. If one is interested in the overall predictive power of the model then (63, 62) relationship is better than (85, 0) in case of assuming that everybody is eater and (0, 15) in case of assuming that every body is non-eater.

The weighted average of sensitivity and specificity is another measure representing the overall predictive power of the model. The values of "correctly classified (weighted average)" range from 53.92 (pork chops) to 66.23 percent (fresh beef). Briggeman argues that if the combined percentage of those correctly identified (i.e., sensitivity plus specificity) should exceed 100 percent, then the binary choice model has a valuable predictive power. The sum those correctly identified cells (“correctly classified (sum)” raw) ranges from 111 (pork ribs) to 126.5 percent (fresh beef) in our models. Hence, all our models are valuable in terms of predicting individual’s decision to eat or not to eat the selected products.

Predicted versus Actual Probability of Eating of the Selected Products

The comparison of the average predicted probabilities of eating and the actual penetrations (frequencies) of the selected products is another way to study the predictive power of the selection stage of the Heckman models. Table 31 shows that the average absolute value of the difference between those average and predicted probabilities is rather small (0.34 percent), ranging from 0.01 (luncheon meats) to 0.99 percent (fresh seafood). We, therefore, can state that the selection stage of the Heckman models can serve as a powerful tool in predicting average penetrations.

Volume of Intake of the Selected Products: Actual versus Predicted

The predictive power of the intake stage of the Heckman models are analyzed by comparing average predicted volume of intake with the average actual volume of intake of the selected products. Table 31 shows that the mean absolute values of the difference between the average and predicted probabilities are rather small ranging from 0.06 grams (smoked ham) to 3.29 grams per two-weeks (ham). Table 31also shows that the absolute difference standardized by the volume of actual intake ranges from 0.34 percent (smoked ham) to 13.06 percent (pork tenderloin) with average over sixteen products being equal to 3.56 percent.

Table 31. Volume of Intake: Actual versus Predicted

Product	**Average Intake for all Individuals (in grams per two-weeks)**		**MAE ABS(P-A) (in grams)**	**MAPE ABS(P-A) / A (in %)**
	Actual (A)	**Predicted (P)**		
Fresh Pork	68.23	70.44	2.21	3.23
Fresh Beef	256.16	259.26	3.11	1.21
Fresh Chicken	146.39	145.13	1.25	0.86
Fresh Seafood	63.20	64.26	1.06	1.67
Pork Chops	36.41	37.25	0.83	2.29
Pork Ribs	7.07	7.25	0.18	2.61
Pork Roasts	6.35	6.73	0.38	6.00
Pork Tenderloin	4.08	3.55	0.53	13.06
Porcessed Pork	199.69	201.81	2.12	1.06
Bacon	12.25	11.89	0.37	2.99
Ham	74.72	78.01	3.29	4.41
Canned Ham	3.37	3.71	0.34	10.14
Smoked Ham	18.62	18.56	0.06	0.34
Pork Hotdogs	28.95	29.14	0.19	0.65
Luncheon Meats	29.11	27.85	1.26	4.31
Pork Sausage	40.40	41.26	0.86	2.13
Average (over sixteen products)			1.13	3.56

Note: MAE and MAPE stand for Mean Absolute Error and Mean Absolute Percent Error, respectively. ABS stands for absolute value.

The large percentage of deviation in terms of pork tenderloin (13.06 percent), however, is due to the very small values of actual and predicted intakes. For pork tenderloin, the actual out-of-sample intake and the actual out-of-sample prediction of the intake are, respectively, 3.52 grams and 2.87 grams per two-weeks. The mean absolute difference between these values is 0.65 grams, which is twice as low as the average absolute value of the difference between those average and predicted intakes (1.13 grams per two-weeks). Therefore, it can be concluded that the intake stage Heckman sample selection models is a powerful tool in terms of forecasting the volume of consumption of the selected products.

Conclusion

In summary, we used prediction success tables and comparison of the average actual versus average predicted probabilities to test the predictive power of the selection stage of the sixteen Heckman models. The predictive accuracy of the intake stage of the models was studied by comparing the actual values of average intakes with the predicted values of average intakes. The results allow us to conclude that all sixteen Heckman models used in this study adds significant value in the forecasting ability of marketers.

CHAPTER VII

EMPIRICAL RESULTS ASSOCIATED WITH THE SELECTIVITY-ADJUSTED CENSORED LA/AIDS MODELS

Introduction

In this part of the study we discuss demand-price relationships estimated using the two selectivity-adjusted censored LA/AIDS models. As mentioned previously, the first model estimates the demand-price relationships among four aggregate fresh meats (pork, beef, chicken, and seafood). The second model models the demand-price relationships among nine disaggregated fresh and processed pork cuts (pork chops, pork ribs, pork roasts, pork tenderloin, pork sausage, bacon, canned ham, smoked ham, and lunchmeats). The market covered in this study is at-home, USA. The data used for the fresh meats model run from January 1998 to December 2001 and the data used for the pork cuts model run from April 1999 to December 2001. Unit of observation in the models is a representative individual over 18 years of age. Each individual is represented by two observations. The total numbers of observations are, therefore, 21,264 and 9,902 for the fresh meats model and pork cuts model, respectively. Measure of intake is presented in terms of kilograms in a 7-day period

As discussed previously, we introduced a three-stage procedure to adjust for sample selection (outside of a demand system) and censoring (within a demand system). The first two stages of this three-stage procedure are based on all observations. The third stage however, includes individuals with non-missing budget shares (i.e., positive total expenditures) only. The results of the last stage therefore, are conditional on consuming at least one commodity from the group of products in the system. In addition, there were a substantial number of individuals with zero intakes (or zero budget shares) within the demand system. Taking into account the fact that the consumption represents a seven-day intake, we assume that individuals had enough time to reveal their preferences and did not prefer to consume the selected product. The within demand system adjustment for censored observations is based procedure developed by Shonkwiler and Yen. In essence, our three-step adjustment for sample selection and censoring can be considered as an extension of their model. The three-stage procedure developed and applied to LA/AIDS model is described in detail in Chapter II.

The parameters of the LA/AIDS model for at-home fresh meats are estimated by dropping the equation of fresh seafood. The homogeneity and symmetry conditions are imposed in the estimation. We apply the seemingly unrelated regression procedure (SUR) in STATA for estimation. The parameter estimates of the demand models are presented in Appendix C.1. Our goal is to find the effects of prices and expenditures on the consumption of the selected products. We therefore, focus our attention on the results of the third stage only, which include own-price, cross-price, and expenditure elasticities.

This chapter consists of two sections. The first section discusses the results from the demand system for the four at-home fresh meat products, and the second section discusses the results from the demand system for the nine at-home fresh and processed pork cuts.

Price and Expenditure Effects on the Consumption of At-Home Fresh Meats

The usable data from the joining FreshLook scanner data with NET Survey consist of 23,534 observations for the first (probit) and second (probit with sample selection) stages of the selectivity -adjusted censored LA/AIDS model. The third stage however, is conditional on having a positive total expenditure on the four at-home fresh meats (21,264 observations). When the LA/AIDS model is estimated with the price data constructed above, each individual is presented by two observations. There are therefore, 10,632 individuals represented in the final stage. In addition, individuals are assumed to be facing the prices for the particular geographic location and week.

Tables 32 and 33 show the elasticity estimates from the selectivity-adjusted censored LA/AIDS model for at-home fresh pork, beef, chicken, and seafood. Own-price elasticities of demand for the four at-home fresh meats are shown in the main diagonals of the tables.

Table 32. Uncompensated Price and Expenditure Elasticities for At-Home Fresh Meats

	Price Effects				
Meat Items	**Fresh Pork**	**Fresh Beef**	**Fresh Chicken**	**Fresh Seafood**	**Expenditure Elasticity**
Fresh Pork	-0.295	-0.485	-0.126	-0.165	1.071
Fresh Beef	-0.128	-0.733	-0.154	-0.052	1.067
Fresh Chicken	0.023	0.031	-0.478	0.033	0.391
Fresh Seafood	-0.215	-0.472	-0.284	-0.763	1.735

Table 33. Compensated Price Elasticities for At-Home Fresh Meats

	Price Effects			
Meat Items	**Fresh Pork**	**Fresh Beef**	**Fresh Chicken**	**Fresh Seafood**
Fresh Pork	-0.1623	0.0177	0.1443	0.0003
Fresh Beef	0.0047	-0.2326	0.1153	0.1126
Fresh Chicken	0.0711	0.2147	-0.3795	0.0937
Fresh Seafood	0.0003	0.3424	0.1530	-0.4957

Table 32 shows the uncompensated own- and cross-price elasticities as well as expenditure elasticities. The expenditure elasticities (the last column in Table 32) for all at-home fresh meat items are positive indicating that these commodities are normal goods. The estimated expenditure elasticities are about 1.1 for pork and beef, 0.4 for chicken, and 1.7 for seafood. This means that for a 10 percent increase (decrease) in expenditure on at-home fresh meats pork and beef will increase (decrease) by 11 percent, chicken intake will increase (decrease) by 4 percent, and seafood intake will increase (decrease) by 17 percent. This analysis suggests that, as expenditure on at-home fresh meats increases, major consumption gains are expected to come to seafood at the expense of chicken. The consumption of pork and beef will increase slightly more than proportionally.

Estimated (uncompensated) price elasticities show that all of the own-price elasticities are negative and less than unity as is expected for aggregate food commodities. The own-price elasticity of fresh pork, beef, chicken, and seafood are, respectively, -0.295, -0.733, -0.478, and -0.763. A one percent increase in the price of pork will decrease the quantity of pork demanded by 0.295 percent, a one percent increase in the price of beef will decrease the quantity of beef demanded by 0.733 percent, a one percent increase in the price of chicken will decrease the quantity of chicken demanded by 0.478 percent, and a one percent increase in the price of seafood will decrease the quantity of seafood demanded by 0.763 percent. All fresh meat products are price inelastic.

Let's look at the relationship between of own-prices and cross-prices elasticities and the total revenue. Total revenue (TR) is calculated by

$$\text{(51)} \qquad \text{TR} = \sum_{i=1}^{n} p_i q_i \left(p_1, p_2, ..., p_n \right)$$

where $i = 1,...,n$ is the index of goods in the n-good system, p_i and q_i are the price and quantity of good i, respectively. The marginal revenue (MR) with respect to the change in the price of good j is

$$\text{(52)} \qquad \begin{aligned} \text{MR}_\text{j} &= \frac{\partial \text{TR}(\cdot)}{\partial p_j} = \frac{\partial \left(\sum_{i=1}^{n} p_i q_i \left(p_1, p_2, ..., p_n \right) \right)}{\partial p_j} \\ &= q_j(\cdot) + \sum_{i=1}^{n} p_i \frac{\partial q_i}{\partial p_j} \\ &= q_j(\cdot) + \sum_{i=1}^{n} p_i \left(\frac{\partial q_i}{\partial p_j} * \frac{p_j}{q_i} \right) * \frac{q_i}{p_j} \\ &= q_j(\cdot) + \frac{\sum_{i=1}^{n} p_i q_i \eta_{ij}}{p_j} \end{aligned}$$

(52) shows that the changes in own-prices and cross-prices have direct impact on the marginal revenue. Knowledge about demand-price effects is, therefore, vital in the

policies, which maximize the total revenue. This can be easily shown for one product. In this case, the marginal revenue can be easily simplified to

(53) $$\text{MR} = p*\left(1-\frac{1}{\varepsilon_p}\right),$$

where ε_p is the own-price elasticity.

Hence, if the own-price elasticity is negative and above unity, strategies directed towards decreasing (increasing) the price of the corresponding product would bring about an increase (decrease) of total revenues, *ceteris paribus*.

Further, these elasticities together with cost information are vital in designing policies that maximize profit. This can be shown by deriving price from (53)

(54) $$p = \frac{\text{MR}}{1-\frac{1}{\varepsilon_p}}.$$

Replacing MR=MC in (54) (based first order condition of profit maximization) we get

(55) $$p = \frac{\text{MC}}{1-\frac{1}{\varepsilon_p}}.$$

(55) shows that the profit maximizing price level for one product depends on own-price elasticity and the marginal cost.

Further, if it is planned to increase the consumption level of at-home fresh pork by a certain level (for example, 2%), then the required adjustment in the price level of at-home fresh pork can be calculated from the own-price elasticity of at-home fresh pork. In this case, knowing that the own-price elasticity of at-home fresh pork is negative

0.295 percent, then about 6.8 percent decrease in the price of at-home fresh pork is necessary to achieve this goal, *ceteris paribus*.

Table 33 shows that fresh chicken (0.1443) is the main competitor (substitute) for fresh pork in at-home markets. A ten-percent increase in the price of fresh chicken will result in 1.443 percent increase in the quantity demanded for fresh pork. Further, the cross price elasticities of beef (0.0177) and seafood (0.0003) related to the quantity of pork demand are numerically small suggesting that these products are substitutes for pork. Further, Table 33 shows that the demand for pork has almost equal response to the changes related to its own-price and the price of chicken.

Price and Expenditure Effects on the Consumption of At-Home Fresh and Processed Pork Products

The usable data from the joining FreshLook scanner data with A.C. Nielsen data and NET Survey cover consist of 15,672 observations for the first (probit) and second (probit with sample selection) stages. The third stage (i.e., selectivity-adjusted censored LA/AIDS model) is conditional on having a positive total expenditure on the nine at-home pork products (9,902 observations). In this model, again, there are two observations per individual and individuals are assumed to be facing the prices for the particular geographic location and week. The parameter estimates of the demand models are presented in Tables E1 and E2 in Appendix E.

Tables 34 and 35 show the elasticity estimates from the selectivity-adjusted censored LA/AIDS model for at-home pork cuts. Own-price elasticities of demand for these products are shown in the main diagonals of the tables. The expenditure elasticities (the last column in Table 34) for all pork products (except bacon (-0.0329)) are positive indicating that these commodities are normal goods. As expenditure on at-home pork increases, more that proportional gains are expected to come in the fresh pork products group as well as canned ham (1.0883) and luncheon meats (1.3662) (from the processed pork group). Further, less than proportional gains are expected in the consumption of pork sausage (0.8836) and smoked ham (0.8821). As mentioned previously, these gains will be accompanied by relatively small losses in the consumption of bacon (-0.0329).

Estimated (uncompensated) price elasticities show that all of the own-price elasticities are negative, consistent with economic theory. They range from -0.9189 (pork chop) to -1.5101 (pork roasts) for the at-home fresh pork group and from -0.3866 (bacon) to -1.8247 (canned ham) for the at-home processed pork group. Similar to Capps (1993) findings, the results show same own-price elasticities are in the elastic (above unity) range. Higher elasticities may be due to more disaggregation of products.

The cross-price effects are examined using the income-compensated (Hicksian) cross-price elasticities. Table 35 shows that half of the compensated cross-price elasticities are negative (in contrast with 100% positive cross price elasticities in the aggregate at-home fresh meats model). This diversity of relationships emphasis the importance of focusing our study on disaggregated pork products. Further, about 96% of the cross-price effects are less than unity, meaning that we would expect less than proportional responses to the cross-price changes for most of the cases within this category. Pork chops is the strongest complement for pork ribs, pork tenderloin, and smoked ham.

Table 34. Uncompensated Price and Expenditure Elasticities for At-Home Fresh and Processed Pork Products

	Price Effects of Fresh Pork Cuts				Price Effects of Processed Pork Cuts					
Pork Items	**Pork Chops**	**Pork Ribs**	**Pork Roasts**	**Pork Tenderloin**	**Bacon**	**Pork Sausage**	**Smoked Ham**	**Canned Ham**	**Lunchmeats**	**Expenditure Elasticity**
Pork Chops	-0.9189	-0.3168	0.0796	-0.0946	0.2331	-0.2193	-0.2050	0.0875	-0.0854	1.4397
Pork Ribs	-1.7024	-1.2467	-0.0799	0.1621	-0.2996	-0.4515	0.4231	0.5113	1.5062	1.1773
Pork Roasts	0.5901	-0.1040	-1.5101	-0.0847	-0.4276	0.4862	0.2428	-0.2509	-0.2077	1.2659
Pork Tenderloin	-0.9359	0.2658	-0.1253	-1.3077	0.1533	0.2679	0.3404	0.2491	-0.4999	1.5923
Bacon	0.5825	-0.0255	-0.0408	0.0534	-0.3866	0.1827	0.0840	-0.0786	-0.3382	-0.0329
Pork Sausage	-0.0757	-0.0583	0.0693	0.0380	-0.0204	-1.1380	-0.0128	0.0306	0.2836	0.8836
Smoked Ham	-0.3715	0.1897	0.0922	0.0978	0.0141	-0.0354	-0.7699	0.1045	-0.2036	0.8821
Canned Ham	0.8764	0.8553	-0.3263	0.2502	-0.7491	0.2877	0.3937	-1.8247	-0.8517	1.0883
Lunchmeats	-0.0590	0.2271	-0.0284	-0.0402	-0.4475	0.1773	-0.1150	-0.0852	-0.9953	1.3662

Table 35. Compensated Price Elasticities for At-Home Fresh and Processed Pork Products

	Price Effects of Fresh Pork Cuts				Price Effects of Processed Pork Cuts				
Pork Items	**Pork Chops**	**Pork Ribs**	**Pork Roasts**	**Pork Tenderloin**	**Bacon**	**Pork Sausage**	**Smoked Ham**	**Canned Ham**	**Lunchmeats**
Pork Chops	-0.6370	-0.2659	0.1199	-0.0651	0.4566	0.1157	-0.0848	0.1181	0.2426
Pork Ribs	-1.4718	-1.2050	-0.0469	0.1861	-0.1169	-0.1776	0.5214	0.5363	1.7744
Pork Roasts	0.8380	-0.0592	-1.4746	-0.0588	-0.2312	0.7807	0.3485	-0.2241	0.0807
Pork Tenderloin	-0.6241	0.3222	-0.0807	-1.2751	0.4004	0.6383	0.4733	0.2829	-0.1372
Bacon	0.5761	-0.0266	-0.0417	0.0527	-0.3917	0.1750	0.0813	-0.0793	-0.3457
Pork Sausage	0.0974	-0.0270	0.0940	0.0561	0.1168	-0.9325	0.0609	0.0493	0.4849
Smoked Ham	-0.1988	0.2209	0.1169	0.1159	0.1510	0.1698	-0.6962	0.1232	-0.0026
Canned Ham	1.0896	0.8938	-0.2958	0.2724	-0.5802	0.5409	0.4846	-1.8016	-0.6037
Lunchmeats	0.2085	0.2755	0.0099	-0.0123	-0.2355	0.4952	-0.0010	-0.0562	-0.6840

For the discussion of the cross price effects, the nine pork cuts are separated into two groups: (1) fresh pork cuts (pork chops, pork ribs, pork roasts, and pork tenderloin) and (2) processed pork cuts (bacon, pork sausage, smoked ham, canned ham, and lunchmeat). The cross-price relationships within each group are further referred as intra-group effects and the cross-price relationships between these groups are further referred as inter-group effects. Table 36 reports the major inter- and intra-group competitors and complements of the nine pork cuts. For example the table shows that pork sausage is the major intra-group competitor for the processed products. Pork sausage also is a major inter-group competitor for pork roasts and pork tenderloin, but a major inter-group complement for pork ribs. These elasticities together with cost information are vital in models optimizing profit.

Table 36. Inter- and Intra-Group Relationships of At-Home Fresh and Processed Pork Products

	Among Fresh Pork Cuts		Among Processed Pork Cuts	
Pork Items	**Major Competitor**	**Major Complement**	**Major Competitor**	**Major Complement**
Pork Chops	Pork Roasts	Pork Ribs	Bacon	Smoked Ham
Pork Ribs	Pork Tenderloin	Pork Chops	Lunchmeat	Pork Sausage
Pork Roasts	Pork Chops	Pork Ribs and Pork Tenderloin	Pork Sausage	Bacon and Ham
Pork Tenderloin	Pork Ribs	Pork Chops	Pork Sausage	Lunchmeat
Bacon	Pork Chops	Pork Roasts	Pork Sausage	Lunchmeat
Pork Sausage	Pork Chops and Pork Roasts	Pork Ribs	Lunchmeat	-
Smoked Ham	Pork Ribs	Pork Chops	Pork Sausage	Lunchmeat
Canned Ham	Pork Chops	Pork Roasts	Pork Sausage	Lunchmeat
Lunchmeat	Pork Ribs	Pork Tenderloin	Pork Sausage	Bacon

Note: - sign means that no intra-group complementary relationship was detected for at-home pork sausage.

CHAPTER VIII

SUMMARY, CONCLUDING REMARKS, AND IMPLICATION FOR FUTURE RESEACH

In this study, we found the key factors related to the demand of pork products by mining a database obtained by NPB. Specifically, this study found the key economic and demographic factors affecting individuals' decisions to eat pork product and their volume of intake. The purpose is to develop and demonstrate methods for improving marketing decisions of the National Pork Board.

This study also has two methodological contributions to econometrics. First, this study has extended the works of Byrne, Capps, and Saha and by Saha, Capps, and Byrne by deriving and applying the exact expression of the unconditional marginal effects for Heckman models. Second, the study's stronger methodological contribution is that it has extended the work of Shonkwiler and Yen by presenting a three-step procedure to correct for selectivity and censoring problems within the demand systems.

Summary of the Results

This study identified the key factors affecting the consumption of fresh and processed pork products as well as fresh beef, fresh chicken, and fresh seafood. Fresh pork cuts include: pork chops, pork ribs, pork roasts, and pork tenderloin and processed pork products include: processed pork, bacon, ham, smoked ham, canned ham, pork sausage, pork hotdogs, and lunchmeat.

Two-step Heckman models are applied to identify the key socio-demographic, attitudinal/lifestyle, and health factors affecting individuals' decision to eat pork product and their actual volume of intake. Data from NPD NET is used in this analysis. We also examined the predictive power of the Heckman models in terms of: (1) their ability to accurately predict the average likelihood of eating, (2) their ability to filter eaters and non-eaters, and (3) their ability to accurately predict average volume of intake of the corresponding products. The results show that our models can be used as accurate forecasting tools.

The micro-level analysis shows that income plays a role in the decision to eat the selected at-home products, except for fresh pork and pork roasts. Further, income is negatively associated with the consumption of fresh pork, beef, chicken, pork chops, processed pork, and bacon. This may mean that as individuals' income increases they divert their consumption of these products from at-home to away-from-home. But it does not necessarily mean that they consume less of these products.

Gender plays a role in the decision to eat at-home fresh chicken, lunchmeat, and bacon. The results show that females have a higher likelihood of eating at-home fresh chicken, but a lower likelihood of eating at-home lunchmeat and pork sausage relative to males. Further, this factor plays a key role in the volume of intake of all sixteen products. Both conditional and unconditional marginal effects show that females have lower intake of the selected at-home products.

There are seasonal differences in the probability and intake of the selected products. Individuals in the winter have a lower likelihood of eating at-home fresh pork, chicken, seafood, pork chops, pork ribs, and pork hotdogs, but have a higher likelihood of eating smoked ham relative to the spring. In the fall, individuals have a higher probability of eating beef, chicken, pork tenderloin, and bacon, but a lower probability of eating fresh seafood, canned ham, and smoked ham relative to the spring. Individuals in the summer are less likely to eat fresh pork, seafood, pork roasts, ham, canned ham, and smoked ham, but are more likely to eat pork hotdogs relative to the spring.

Season plays a role in the consumption of fresh chicken, pork chops, pork roasts, pork sausage, canned ham, and pork hotdogs. The intake of pork chops is higher in the summer relative to the spring. The intake of pork roasts is lower in the winter relative to the spring. Individuals in the spring have a higher intake of pork sausage relative to the other seasons. The average consumption of the smoked ham is lower in the fall relative to the spring. Individuals in the summer have a higher intake of canned ham relative to the spring. The volume of intake of pork hotdogs is lower in the spring relative to the summer and fall.

Employment of female head plays a role in the decision to eat at-home beef, chicken, seafood, pork chops, pork tenderloin, processed pork, lunchmeat, pork sausage, ham, bacon, and pork hotdogs, but does not affect the decision to eat at-home fresh pork, pork ribs, pork roasts, canned ham, and smoked ham. Individuals from households wherein the female head is not employed for pay have a higher likelihood of eating at-home beef, chicken, seafood, pork tenderloin, processed pork, lunchmeat, ham, bacon, and pork hotdogs than those from households wherein the female head is employed 35 hours and more per week. Relative to individuals from households wherein the female head is employed 35 hours and more per week, those in households wherein the female head is employed less than 35 hours per week have a lower likelihood of eating pork chops, but a higher likelihood of eating pork sausage.

Employment of female head plays a role in the decision to eat at-home products, except for pork roasts and smoked ham. In general, individuals from households wherein the female head is more educated have a lower likelihood of eating at-home fresh pork, beef, chicken, as well as fresh and processed pork cuts, but a higher likelihood of eating seafood.

Market size is an important factor affecting the selection of at-home products, except for chicken, seafood, and canned ham. Individuals from SMSAs have a lower likelihood of consuming at-home products relative to those from non-SMSAs. This factor, however, plays a role in the consumption processed pork and pork sausage only. Individuals from SMSAs have a lower intake of at-home processed pork and pork sausage relative to those from non-SMSAs.

Race plays a role in the likelihood of eating the selected products except pork roasts. Blacks have a higher likelihood of eating pork, chicken, seafood, pork chops, pork ribs, pork sausage, bacon, and canned ham, but a lower likelihood of eating pork tenderloin relative to whites. Orientals have a higher likelihood of eating pork, chicken, seafood, pork ribs, and ham, but a lower likelihood of eating beef, lunchmeat, pork sausage, bacon, smoked ham, and pork hotdogs relative to whites. Other races have a lower probability of eating processed pork, pork sausage, and smoked ham.

Race also plays a role in the consumption of the selected products, except for seafood, pork roasts, pork tenderloin, lunchmeat, and pork hotdogs. Blacks, on average, eat more pork, chicken, processed pork, pork sausage, bacon, and canned ham but less beef relative to whites. Oriental have a higher intake of fresh pork, chicken, pork ribs, but a lower intake of ham relative to whites. The other races have a higher intake of chicken, pork chops, pork sausage, and bacon, and a lower intake of smoked ham. The directions of the conditional and unconditional marginal affects of other races concerning the consumption of at-home processed pork are opposite. For all individuals, other races consume less processed pork relative to whites. However, for eaters of processed pork, intake of processed pork is higher for other races relative to whites.

There are regional differences in the likelihood of eating the selected products, except for at-home smoked ham. Individuals residing in the New England region have the highest likelihood of eating fresh pork, beef, chicken, seafood, pork roasts, pork tenderloin, and pork hotdogs. These individuals, however, have the lowest probability of consuming processed pork, pork sausage, ham, and bacon. The likelihood of eating pork chops is the highest in the Middle Atlantic region. Individuals living in the Mountain region have the highest likelihood of eating pork ribs. The likelihood of eating lunchmeat is highest in the East North Central region and lowest in the West South Central region.

Region also plays a role in the consumption of the selected products, except for chicken, pork sausage and smoked ham. Individuals residing in the West North Central region have the highest intake of fresh pork and beef. For all individuals, those located in the Pacific region have the lowest intake of fresh pork. Individuals from the East South Central region have the lowest intake of seafood. Individuals residing in the West North Central region have the highest consumption of pork chops. For all individuals, Mountain region has the highest average intake of pork ribs. However, for eaters of pork ribs, the highest intake is detected in the East South Central region. For all individuals, those from the New England region have the highest intake of pork roasts. For eaters of pork roasts, the highest consumption is found in the Pacific region. Individuals residing in the West South Central region have the lowest intake of pork tenderloin. Individuals residing in the East South Central region have the highest intake of processed pork and bacon. For all individuals, those from East North Central and West North Central regions have the highest intake of lunchmeat. For eaters of lunchmeat, those from East North Central, West North Central, and Pacific regions have the highest intake of lunchmeat. Individuals residing in the Pacific region have the lowest consumption of ham. West North Central region has the lowest average consumption of canned ham. The unconditional and conditional marginal effects on the consumption of pork hotdogs have opposite signs for the Pacific region. For all individuals, those living in the Pacific region have the lowest intake of pork hotdogs. For eaters of pork hotdogs, however, Pacific region has the highest intake of pork hotdogs.

Age of eater is an important factor in the decision to eat the selected products except chicken. In general, age of eater is positively associated with the likelihood of eating at-home fresh pork, beef, seafood, as well as fresh and processed pork cuts.

Age of eater also plays a role in the consumption of the selected products, except for pork roasts, pork sausage, and canned ham. For all individuals, age of eater is positively associated with the consumption of fresh pork, seafood, pork tenderloin, processed pork, ham, bacon, and pork hotdogs. For these individuals, this factor has a negative relationship with the consumption of beef, chicken, and pork chops. For eaters of the corresponding products, age of eater is negatively associated with the consumption of fresh pork, beef, chicken, pork chops, ham, and pork hotdogs. For these individuals, age of eater is positively related with the consumption of processed pork.

Dieting plays a role in the decision to eat beef, chicken, seafood, pork chops, pork ribs, processed pork, ham, and bacon. Individuals who are on diet by choice have a lower likelihood of eating beef, chicken, pork chops, processed pork, and ham relative to those on doctor prescribed diet. Individuals who are not on a diet have a lower probability of consuming beef, seafood, but a higher probability of consuming processed pork and bacon relative to those on a doctor prescribed diet.

Individuals from household wherein there are no children under 18 have a lower probability of eating chicken, pork tenderloin, but these individuals have a higher likelihood of eating seafood, pork ribs, and smoked ham relative to those from household wherein there are children under 18.

Body mass index plays a role in the decision to eat the selected products. Individuals with lower than recommended BMI have a higher likelihood of eating fresh pork, and canned ham, but these individuals have a lower likelihood of eating seafood, processed pork, and ham relative to those who are within recommended standards of

BMI. Individuals with higher than recommended BMI have a higher probability of consuming fresh pork, beef, chicken, pork ribs, pork roasts, processed pork, pork sausage, ham, bacon, canned ham, and pork hotdogs.

Attitudinal/lifestyle factors are important determinants of the decision to eat the selected products. Checking labels is negatively associated with the likelihood of consuming fresh pork, beef, pork chops, pork roasts, as well as with the processed pork products, except for canned ham. This factor, however, is positively related with the decision to consume seafood. Individuals who stress the importance of planning meals to make sure they are nutritious have a higher probability of eating the selected products, except for pork chops, processed pork, lunchmeat, and pork hotdogs. These individuals have a lower probability of consuming lunchmeat. The belief about how food tastes is more important than how nutritious it is does not affect the decision to eat the selected fresh products as well as lunchmeat, ham, and smoked ham. This belief is positively related with the likelihood of consuming processed pork, pork sausage, bacon, canned ham, and pork hotdogs. Concerns about serving food with cholesterol, fat, salt, preservatives do not significantly affect the likelihood of eating aggregate fresh meats. Concern about serving food with additives, however, is positively associated with the likelihood of eating beef. Concerns about serving food with cholesterol, additive, salt, preservatives do not significantly affect the likelihood of eating fresh pork cuts. Concerns about serving food with fat, however, is positively associated with the likelihood of eating pork ribs. Concern about serving food with cholesterol is positively associated with the probability of eating canned ham. Concern about serving food with additive is positively related with the likelihood of eating bacon and negatively related with the likelihood of eating pork hotdogs. Concern about serving food with fat is negatively related with the likelihood of eating processed pork, lunchmeat, ham, and bacon, but it is positively related with the likelihood of eating pork hotdogs.

Household size plays a role in the decision to eat the selected products except canned ham. Individuals from larger households, in general, have a higher likelihood of eating the selected products, except for seafood, pork tenderloin, and canned ham. For all individuals, household size is also positively related to the consumption of fresh pork, beef, pork chops, pork roasts, ham, and pork hotdogs. For eaters of the selected products, household size is negatively associated with the consumption of pork chops, pork ribs, pork roasts, lunchmeat, and pork hotdogs.

This study also shed light on the demand-price relationships among fresh meats as well as among pork cuts using two selectivity-adjusted censored LA/AIDS models. Specifically, this study estimated the own-price and cross-price elastisticities of the corresponding products. The analysis shows that aggregate fresh meats have relatively lower own-price elasticities than disaggregate pork cuts. Lower substitution possibilities among fresh meats, relative to pork cuts, are likely to be the reason behind this finding. Further, aggregate fresh meats are substitutes for each other in at-home market. However, there are substantial complementarities between pork cuts.

Concluding Remarks

The information about the key factors affecting individuals' decisions to select pork products and their actual intake is vital in NPB's marketing strategy. Most importantly, this information can save substantial unnecessary expenses in terms of targeting and promotion. Using this information, marketing strategists can target narrow segments of population in promoting disaggregate pork products.

The results show that it is possible for the same factor to have different directional effects on the decision to eat pork products and on the actual volume of intake. This means that for some market segments promotions which are designed to increase market penetration of specific pork product may not be as effective as those designed to increase the consumption of those products. For example, individuals 64 and more have a higher likelihood of eating pork chops, but their actual intake is lower relative to those between 30 and 39 years of age. If marketing strategists want to increase the penetration of pork chops (i.e., bring in new consumers), then they can use these findings to target their messages to individuals 64 and more.

The results also show that there are many cases when groups of individuals with the similar profiles have different consumption patterns relative to pork products. For example, we report that blacks have both higher likelihood of eating and higher volume of intake of pork sausage, bacon, and canned ham relative to whites. This information shows that it can be feasible to find different market segments for these processed pork products. Hence, one would target pork sausage, bacon, and canned ham separately to the blacks.

NPB's marketing specialists can easily find the profiles of individuals who are most (least) likely to select specific pork products as well as the profiles of individuals who have the highest (lowest) volume of intake to select specific pork products. Putting together the factors with highest (lowest) marginal effects in the selection stage as well as in the intake stage can do this. For example, the results show that for all individuals, Orientals age 50 and more from three and more member households residing in West North Central have the highest intake of fresh pork.

NPB's marketing specialist can also use these findings to evaluate the intake potential of different market segments based on their profile. Hence, they will be able to evaluate (or score) communities around major grocery stores in terms of their likelihood of selecting pork products and their actual intake. In addition the models can be used as forecasting tools in terms of future penetration and volume of intake of specific products due to changes in demographic patterns of the population.

This study also found substantial information on demand-price relationships among fresh pork, beef, chicken, and seafood as well as among nine pork cuts. This study found that there is very week substitutability between pork and beef, and relatively strong substitutability between pork and chicken and between beef and chicken. "Pork: the other white meat" may have been successful in placing pork as a direct competitor (substitute) for chicken, but not a strong substitute for beef. This could suggest opportunities for some joint marketing efforts between pork and beef commodity interests.

Moreover, the own-price and cross-price elasticities calculated in this research, along with cost information, can be used in profit optimizing models.

Recommendations for Future Analysis

There are several limitations related to this study. This research was not able to study the factors affecting the consumption of the selected products at away-from-home market due to two major reasons. First, data on away-from-home consumption with linked socio-demographic variables are not generally available for such research. Data available for this study are mainly focused on at-home consumption and do not fully reflect away-from-home consumption patterns. Second, available price series are limited to commodities and products consumed in the at-home market.

The price information concerning at-home processed pork, pork hotdogs, and ham was not available for analysis. This situation did not allow the inclusion of information on pork hotdogs into the demand system for pork cuts. Further research also needs to incorporate generic advertising information into the models.

Despite the limitations, this study is a genuine addition to the literature in terms of investigating the key socio-demographic, attitudinal/lifestyle, health and economic factors affecting the consumption of at-home disaggregate pork products. This was possible thanks to the major methodological developments as well as unique micro-level NET data and price information obtained by NPB.

Another product of this study is the development of a unique database, which includes the key socio-demographic, attitudinal/lifestyle, health factors as well as actual and predicted penetration and actual and predicted intakes. An automated process can be further developed to get forecasts of the penetration and intake of the selected products for different market segments. Further, this data would also allow identifying the profile of consumers having certain level of penetration or volume of intake.

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APPENDIX A

VARIABLE NAMES AND DEFINITIONS

Table A.1. Variable Names and Definitions

Variable	Definition
EAT SELECTED PRODUCT?	
psprk	individual actually consumed processed pork in a two-week period? (1 = yes, 0 = no)
fshpk	individual actually consumed fresh pork in a two-week period? (1 = yes, 0 = no)
chfsh	individual actually consumed fresh chicken in a two-week period? (1 = yes, 0 = no)
bffsh	individual actually consumed fresh beef in a two-week period? (1 = yes, 0 = no)
sffsh	individual actually consumed fresh seafood in a two-week period? (1 = yes, 0 = no)
pkch	individual actually consumed pork chops in a two-week period? (1 = yes, 0 = no)
pkrb	individual actually consumed pork ribs in a two-week period? (1 = yes, 0 = no)
pkrst	individual actually consumed pork roasts in a two-week period? (1 = yes, 0 = no)
pkltd	individual actually consumed pork tenderloin in a two-week otherwise;
smkh	individual actually consumed smoked ham in a two-week period? (1 = yes, 0 = no)
canh	individual actually consumed canned ham in a two-week period? (1 = yes, 0 = no)
ham	individual actually consumed ham in a two-week period? (1 = yes, 0 = no)
pkhtd	individual actually consumed pork hotdogs in a two-week period? (1 = yes, 0 = no)
bacon	individual actually consumed bacon in a two-week period? (1 = yes, 0 = no)
sausg	individual actually consumed pork sausage in a two-week period? (1 = yes, 0 = no)
lchmt	individual actually consumed lunchmeat in a two-week period? (1 = yes, 0 = no)

Table A.1. Continued

Variable	Definition
INCOME OF HOUSEHOLD	
Income	annual household income in dollars
inc_2	annual household income squared in dollars
SEASON	
summer	diary entry is in summer? (1 = yes, 0 = no)
fall	diary entry is in fall? (1 = yes, 0 = no)
winter	diary entry is in winter? (1 = yes, 0 = no)
spring	diary entry is in spring? (1 = yes, 0 = no)
DIET	
dietchc	respondent is on a diet by individual choice? (1 = yes, 0 = no)
nodiet	respondent is not on a diet? (1 = yes, 0 = no)
presdiet	respondent is on a doctor prescribed diet? (1 = yes, 0 = no)
HISPANIC	
Hispanic	respondent is Hispanic? (1 = yes, 0 = no)
nonhisp	respondent is not Hispanic? (1 = yes, 0 = no)
GENDER OF INDIVIDUAL	
femaleet	respondent is female? (1 = yes, 0 = no)
maleet	respondent is male? (1 = yes, 0 = no)
AGE OF INDIVIDUAL	
age18_24	the age of the female head is between 18 and 24? (1 = yes, 0 = no)
age25_29	the age of the female head is between 25 and 29 (1 = yes, 0 = no)
age30_39	the age of the female head is between 30 and 39? (1 = yes, 0 = no)
age40_49	the age of the female head is between 40 and 49? (1 = yes, 0 = no)
age50_59	the age of the female head is between 50 and 59? (1 = yes, 0 = no)
age60_64	the age of the female head is between 60 and 64? (1 = yes, 0 = no)
age65up	the age of the female head is over the age of 65? (1 = yes, 0 = no)
EMPLOYMENT OF FEMALE HEAD	
u35hrs	the female head works under 35 hours per week? (1 = yes, 0 = no)
nefp	the female head is not employed for pay? (1 = yes, 0 = no)
o35uphrs	the female head works 35 hours and more per week? (1 = yes, 0 = no)
EDUCATION OF FEMALE HEAD	
postgcol	the female head has graduated post college? (1 = yes, 0 = no)
somecol	the female head has some college education or has graduated college? (1 = yes, 0 = no)
somehs	the female head has grade school; some high school education; or has graduated high school? (1 = yes, 0 = no)

Table A.1. Continued

Variable	**Definition**
MARKET SIZE	
smsa	the household is located in SMSA? (1 = yes, 0 = no)
nonsmsa	the household is located in non SMSA? (1 = yes, 0 = no)
RACE	
black	the respondent is black? (1 = yes, 0 = no)
Oriental	the respondent is Oriental? (1 = yes, 0 = no)
other	the respondent is of another race? (1 = yes, 0 = no)
white	the respondent is white? (1 = yes, 0 = no)
REGION	
midatl	the household is located in the Middle Atlantic region? (1 = yes, 0 = no)
enc	the household is located in the East North Central region? (1 = yes, 0 = no)
wnc	the household is located in the West North Central region? (1 = yes, 0 = no)
satl	the household is located in the South Atlantic region? (1 = yes, 0 = no)
esc	the household is located in the East South Central region? (1 = yes, 0 = no)
wsc	the household is located in the West South Central region? (1 = yes, 0 = no)
mount	the household is located in the Mountain region? (1 = yes, 0 = no)
pacific	the household is located in the Pacific region? (1 = yes, 0 = no)
neweng	the household is located in the New England region? (1 = yes, 0 = no)
PRESENCE OF CHILDREN UNDER 18	
nochun18	there are no children under 18 in the household? (1 = yes, 0 = no)
chun18	there are children under 18 in the household? (1 = yes, 0 = no)
SIZE OF THE HOUSEHOLD	
memb_1	it is a single-member household? (1 = yes, 0 = no)
memb_2	there are 2 members household? (1 = yes, 0 = no)
memb_3up	there are 3 members or more in household? (1 = yes, 0 = no)
BODY MASS INDEX (BMI)	
bmilow	respondent's BMI is lower than acceptable value? (1 = yes, 0 = no)
bmihigh	respondent's BMI is higher than acceptable value? (1 = yes, 0 = no)
bmiaccept	respondent's BMI is in range of acceptable value? (1 = yes, 0 = no)

Table A.1. Continued

Variable	Definition
chk_labels	Response to the following statement: I frequently check labels to determine whether foods I buy contain anything I'm trying to avoid.
plan_meals	Response to the following statement: I carefully plan my household meals to be sure they are nutritious.
good_taste	Response to the following statement: The most important things about food are that it looks good, smells good, and tastes good.
fat	Response to the following statement: A person should be very cautious in serving food with fat.
cholest	Response to the following statement: A person should be very cautious in serving food with cholesterol.
salt	Response to the following statement: A person should be very cautious in serving food with salt.
additives	Response to the following statement: A person should be very cautious in serving food with additives.
preserv	Response to the following statement: A person should be very cautious in serving food with preservatives.
m_ratio	Mills Ratio
_cons	Intercept
VOLUME OF INTAKE	
psprkvol	two-week individual intake of processed pork in grams
fshpkvol	two-week individual intake of fresh pork in grams
chfshvol	two-week individual intake of fresh chicken in grams
bffshvol	two-week individual intake of fresh beef in grams
sffshvol	two-week individual intake of processed fresh seafood in grams
pkchvol	two-week individual intake of pork chops in grams
pkrbvol	two-week individual intake of pork ribs in grams
pkrstvol	two-week individual intake of pork roasts in grams
pkltdvol	two-week individual intake of pork tenderloin in grams
smkhamvol	two-week individual intake of smoked ham in grams
canhamvol	two-week individual intake of canned ham in grams
hamvol	two-week individual intake of ham in grams
pkhtdvol	two-week individual intake of pork hotdogs in grams
baconvol	two-week individual intake of bacon in grams
sausgvol	two-week individual intake of pork sausage in grams
lchmtvol	two-week individual intake of lunchmeat in grams

Table A.1. Continued

Variable	Definition
PRICES	
pcpork	price of at-home fresh pork;
pcbeef	price of at-home fresh beef;
pcchick	price of at-home fresh chicken; and
pcseafd	price of at-home fresh seafood.
pcpkchop	price of at-home pork chops;
pcpkrib	price of at-home pork ribs;
pcpkrost	price of at-home pork roasts;
pcpktend	price of at-home pork tenderloin;
pcbacon	price of at-home bacon;
pcsausge	price of at-home pork sausage;
pcsmkham	price of at-home smoked ham;
pccanham	price of at-home canned ham; and
pclnchmt	price of at-home pork lunchmeat
AVERAGE BUDGET SHARES	
w_fshpk	average budget share of at-home fresh pork
w_bffsh	average budget share of at-home fresh beef;
w_chfsh	average budget share of at-home fresh chicken; and
w_sffsh	average budget share of at-home fresh seafood.
w_ch	average budget share of at-home pork chops;
w_rb	average budget share of at-home pork ribs;
w_rs	average budget share of at-home pork roasts;
w_td	average budget share of at-home pork tenderloin;
w_bn	average budget share of at-home bacon;
w_ssg	average budget share of at-home pork sausage;
w_sh	average budget share of at-home smoked ham;
w_cndh	average budget share of at-home canned ham; and
w_lmt	average budget share of at-home pork lunchmeat.
OTHER VARIABLES	
tot_exp	total expenditure on group of products
p_star	Stone's Price Index.

APPENDIX B

COMPARATIVE DESCRIPTIVE STATISTICS OF THE DATA OVER MARCH 1996 TO FEBRUARY 2002 AFTER EACH CLEANING STAGE

Table B.1. Comparative Descriptive Statistics of the Data over March 1996 to February 2002 after Each Cleaning Stage

Variable	After First Stage (aggregation of intake) All Individuals mean	After Second Stage Individuals who are above 18 mean	After Third Stage Individuals who are above 18 with no missing observations mean
income	$45,269	$46,565	$47,543
Hispanic	0.067	0.056	0.055
nonhisp	0.933	0.944	0.945
spring	0.248	0.248	0.242
summer	0.252	0.25	0.25
fall	0.252	0.253	0.255
winter	0.248	0.249	0.254
femaleet	0.514	0.534	0.534
maleet	0.486	0.466	0.466
u35hrs	0.226	0.209	0.21
o35uphrs	0.322	0.342	0.341
nefp	0.452	0.449	0.449
somehs	0.381	0.377	0.377
somecol	0.517	0.508	0.508
postgcol	0.103	0.114	0.115
smsa	0.737	0.744	0.738
nonsmsa	0.263	0.256	0.262
white	0.872	0.88	0.886
black	0.085	0.08	0.076
Oriental	0.013	0.013	0.014
other	0.03	0.026	0.025
neweng	0.044	0.047	0.049
midatl	0.156	0.155	0.156
enc	0.18	0.175	0.176

Table B.1. Continued

	After First Stage (aggregation of intake)	After Second Stage	After Third Stage
Variable	**All Individuals mean**	**Individuals who are above 18 mean**	**Individuals who are above 18 with no missing observations mean**
wnc	0.081	0.077	0.079
satl	0.166	0.17	0.169
esc	0.074	0.072	0.072
wsc	0.109	0.109	0.106
mount	0.062	0.059	0.06
pacific	0.128	0.135	0.132
dietchc	0.121	0.156	0.156
presdiet	0.08	0.105	0.106
nodiet	0.8	0.739	0.738
chk_labels	4.316	4.408	4.376
plan_meals	3.989	4.007	3.998
cholest	4.635	4.677	4.658
additives	4.466	4.495	4.48
fat	4.765	4.801	4.762
salt	4.559	4.585	4.568
preserv	4.366	4.388	4.379
good_taste	4.114	4.099	4.121
age18_24	0.051	0.069	0.068
age25_29	0.054	0.073	0.068
age30_39	0.159	0.215	0.204
age40_49	0.169	0.229	0.235
age50_59	0.133	0.18	0.185
age60_64	0.05	0.067	0.068
age65up	0.124	0.168	0.172
nochun18	0.449	0.601	0.609

Table B.1. Continued

Variable	After First Stage (aggregation of intake) All Individuals mean	After Second Stage Individuals who are above 18 mean	After Third Stage Individuals who are above 18 with no missing observations mean
chun18	0.551	0.399	0.391
memb_1	0.097	0.13	0.129
memb_2	0.27	0.354	0.36
memb_3up	0.633	0.516	0.51
bmilow	0.147	0.197	0.19
bmiaccept	0.293	0.395	0.4
bmihigh	0.303	0.407	0.41

Notes: The number of observations for each stage are 31,946 (after aggregating intake); 23,648 (after dropping individuals who are 18 years of age and under); and 17,607 (after dropping missing observations of the explanatory variables).
Variable names and definitions are exhibited In Table A.1 in Appendix A.

APPENDIX C

RECONCILIATION OF IRI DATA

Table C.1. Breakdown of IRI Regions by States

GREAT LAKES	PLAINS	NORTHEAST	WEST
Ohio	Minnesota	Maine	Montana
Indiana	Iowa	New Hampshire	Wyoming
Illinois	Missouri	Vermont	Colorado
Michigan	Nebraska	Massachusetts	Idaho
Wisconsin	Kansas	Rhode Island	New Mexico
	North Dakota	Connecticut	Nevada
	South Dakota	New York	Arizona
		New Jersey	Utah
		Pennsylvania	Washington
			Oregon
SOUTHEAST	**CALIFORNIA**	**SOUTH CENTRAL**	**MID-SOUTH**
Alabama	California	Arkansas	Meryland
Mississippi		Louisiana	Delaware
Georgia		Oklohoma	Virginia
South Carolina		Texas	West Virginia
			North Carolina
			Kentucky
			Tennessee

Table C.2. Prescription for Action

1.	PRICE FOR NEW ENGLAND	=	FRESH LOOK PRICE IN NORTHEAST
2.	PRICE FOR MIDDLE ATLANTIC	=	FRESH LOOK PRICE IN NORTHEAST
3.	PRICE FOR EAST NORTH CENTRAL	=	FRESH LOOK PRICE IN GREAT LAKES
4.	PRICE FOR WEST NORTH CENTRA	=	FRESH LOOK PRICE IN PLAINS
5.	PRICE FOR SOUTH ATLANTIC	=	COMBINATION OF FRESH LOOK PRICES IN MID-SOUTH AND IN SOUTHEAST
6.	PRICE FOR EAST SOUTH CENTRAL	=	COMBINATION OF FRESH LOOK PRICES IN MID-SOUTH AND IN SOUTHEAST
7.	PRICE IN WEST SOUTH CENTRAL	=	FRESH LOOK PRICE IN SOUTH CENTRAL
8.	PRICE IN MOUNTAIN	=	FRESH LOOK PRICE IN WEST
9.	PRICE IN SOUTH ATLANTIC	=	0.5428*FRESH LOOK PRICE IN MID-SOUTH+0.4572*FRESH LOOK PRICE IN SOUTHEAST
10.	PRICE IN EAST SOUTH CENTRAL	=	0.3865*FRESH LOOK PRICE IN MID-SOUTH+0.6135*FRESH LOOK PRICE IN SOUTHEAST
11.	PRICE IN PACIFIC	=	0.2152*FRESH LOOK PRICE IN WEST+0.7848*FRESH LOOK PRICE IN CALIFORNIA
12.	PRICE IN PACIFIC	=	COMBINATION OF FRESH LOOK PRICES IN WEST AND IN CALIFORNIA

Table C.3. Weights of Combinations to be based on State Population

STATE	POPULATION IN 1998	1999	2000	2001	WEIGHTS
MARYLAND	5130.07	5171.63	5310.91	5375.16	1
DELAWARE	744.07	753.54	786.23	796.16	1
WASHINGTON DC	521.43	519	571.07	571.82	1
VIRGINIA	6789.23	6872.91	7104.02	7187.73	1
WEST VIRGINIA	1811.69	1806.93	1807.1	1801.92	1
NORTH CAROLINA	7545.83	7650.79	8077.37	8186.27	1
SOUTH CAROLINA	3829.58	3885.74	4023.44	4063.01	1
FLORIDA	14908.23	15111.24	16054.33	16396.52	1
SOUTH ATLANTIC	41280.13	41771.78	43734.47	44378.59	1
MID-SOUTH WEIGHT	0.5461	0.5452	0.5409	0.5390	0.5428
SOUTHEAST WEIGHT	0.4539	0.4548	0.4591	0.4610	0.4572
KENTUCKY	3934.31	3960.82	4047.42	4065.86	1
TENNESSEE	5432.68	5483.54	5702.03	5740.02	1
ALABAMA	4351.04	4369.86	4451.49	4464.36	1
MISSISSIPPI	2751.33	2768.62	2849.1	2858.03	1
GEORGIA	7636.52	7788.24	8229.82	8383.92	1
EAST SOUTH CENTRAL	24105.88	24371.08	25279.86	25512.19	1
MID-SOUTH WEIGHT	0.3886	0.3875	0.3857	0.3844	0.3865
SOUTHEAST WEIGHT	0.6114	0.6125	0.6143	0.6156	0.6135
WASHINGTON	5687.83	5756.36	5908.37	5987.97	1
OREGON	3282.05	3316.15	3429.29	3472.87	1
CALIFORNIA	32682.79	33145.12	34000.45	34501.13	1
PACIFIC	41652.67	42217.63	43338.11	43961.97	1
WEST WEIGHT	0.2153	0.2149	0.2155	0.2152	0.2152
CALIFORNIA WEIGHT	0.7847	0.7851	0.7845	0.7848	0.7848

APPENDIX D

OUT-OF-SAMPLE CLASSIFICATION TABLE

Table D.1. Out-of-Sample Classification Table for At-Home Fresh Pork

Classified	True T	True ~T	Total
+	894	973	1867
-	555	1094	1649
Total	1449	2067	3516

Sensitivity	Pr(+| T)	61.70%
Specificity	Pr(-|~T)	52.93%
Positive predictive value	Pr(T| +)	47.88%
Negative predictive value	Pr(~T| -)	66.34%
False + rate for true ~T	Pr(+|~T)	47.07%
False - rate for true T	Pr(-| T)	38.30%
False + rate for classified +	Pr(~T| +)	52.12%
False - rate for classified -	Pr(T| -)	33.66%
Correctly classified (weighted average)		56.54%
Correctly classified (sum)		114.63%

Notes: In-sample penetration for fresh pork (.4081763) is used as a cutoff point.
The signs used in the tables have the following meanings:
T An individual consumed at-home fresh pork;
~T An individual has not consumed at-home fresh pork;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

Table D.2. Out-of-Sample Classification Table for At-Home Fresh Beef

Classified	True T	True ~T	Total
+	1912	296	2208
-	891	416	1307
Total	2803	712	3515

Sensitivity	Pr(+| T)	68.21%
Specificity	Pr(-|~T)	58.43%
Positive predictive value	Pr(T| +)	86.59%
Negative predictive value	Pr(~T| -)	31.83%
False + rate for true ~T	Pr(+|~T)	41.57%
False - rate for true T	Pr(-| T)	31.79%
False + rate for classified +	Pr(~T| +)	13.41%
False - rate for classified -	Pr(T| -)	68.17%
Correctly classified (weighted average)		66.23%
Correctly classified (sum)		126.64%

Notes: In-sample penetration for fresh beef (.7959605) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home fresh beef;

~T An individual has not consumed at-home fresh beef;

\+ The model’s predicted probability is greater than or equal to the cutoff point;

\- The model’s predicted probability is less than the cutoff point.

Table D.3. Out-of-Sample Classification Table for At-Home Fresh Chicken

Classified	True T	True ~T	Total
+	1578	404	1982
-	994	536	1530
Total	2572	940	3512

Sensitivity	Pr(+| T)	61.35%
Specificity	Pr(-|~T)	57.02%
Positive predictive value	Pr(T| +)	79.62%
Negative predictive value	Pr(~T| -)	35.03%
False + rate for true ~T	Pr(+|~T)	42.98%
False - rate for true T	Pr(-| T)	38.65%
False + rate for classified +	Pr(~T| +)	20.38%
False - rate for classified -	Pr(T| -)	64.97%
Correctly classified (weighted average)		60.19%
Correctly classified (sum)		118.37%

Notes: In-sample penetration for fresh chicken (.7248079) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home fresh chicken;

~T An individual has not consumed at-home fresh chicken;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.4. Out-of-Sample Classification Table for At-Home Fresh Seafood

Classified	True T	True ~T	Total
+	712	922	1634
-	428	1456	1884
Total	1140	2378	3518

Sensitivity	Pr(+| T)	62.46%
Specificity	Pr(-|~T)	61.23%
Positive predictive value	Pr(T| +)	43.57%
Negative predictive value	Pr(~T| -)	77.28%
False + rate for true ~T	Pr(+|~T)	38.77%
False - rate for true T	Pr(-| T)	37.54%
False + rate for classified +	Pr(~T| +)	56.43%
False - rate for classified -	Pr(T| -)	22.72%
Correctly classified (weighted average)		61.63%
Correctly classified (sum)		123.69%

Notes: In-sample penetration for fresh seafood (.3303958) is used as a cutoff point.
The signs used in the tables have the following meanings:
T An individual consumed at-home fresh seafood;
~T An individual has not consumed at-home fresh seafood;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

Table D.5. Out-of-Sample Classification Table for At-Home Pork Chops

Classified	True T	True ~T	Total
+	16	23	39
-	910	2569	3479
Total	926	2592	3518

Sensitivity	Pr(+| T)	1.73%
Specificity	Pr(-|~T)	99.11%
Positive predictive value	Pr(T| +)	41.03%
Negative predictive value	Pr(~T| -)	73.84%
False + rate for true ~T	Pr(+|~T)	0.89%
False - rate for true T	Pr(-| T)	98.27%
False + rate for classified +	Pr(~T| +)	58.97%
False - rate for classified -	Pr(T| -)	26.16%
Correctly classified (weighted average)		73.48%
Correctly classified (sum)		100.84%

Notes: In-sample penetration for pork chops (.4402543) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home pork chops;
~T An individual has not consumed at-home pork chops;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

Table D.6. Out-of-Sample Classification Table for At-Home Pork Ribs

Classified	True T	True ~T	Total
+	102	1374	1476
-	92	1953	2045
Total	194	3327	3521

Sensitivity	Pr(+| T)	52.58%
Specificity	Pr(-|~T)	58.70%
Positive predictive value	Pr(T| +)	6.91%
Negative predictive value	Pr(~T| -)	95.50%
False + rate for true ~T	Pr(+|~T)	41.30%
False - rate for true T	Pr(-| T)	47.42%
False + rate for classified +	Pr(~T| +)	93.09%
False - rate for classified -	Pr(T| -)	4.50%
Correctly classified (weighted average)		58.36%
Correctly classified (sum)		111.28%

Notes: In-sample penetration for pork ribs (.0559659) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home pork ribs;
~T An individual has not consumed at-home pork ribs;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

Table D.7. Out-of-Sample Classification Table for At-Home Pork Roasts

Classified	True T	True ~T	Total
+	93	1382	1475
-	63	1984	2047
Total	156	3366	3522

Sensitivity	Pr(+| T)	59.62%
Specificity	Pr(-|~T)	58.94%
Positive predictive value	Pr(T| +)	6.31%
Negative predictive value	Pr(~T| -)	96.92%
False + rate for true ~T	Pr(+|~T)	41.06%
False - rate for true T	Pr(-| T)	40.38%
False + rate for classified +	Pr(~T| +)	93.69%
False - rate for classified -	Pr(T| -)	3.08%
Correctly classified (weighted average)		58.97%
Correctly classified (sum)		118.76%

Notes: In-sample penetration for pork roasts (.046804) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home pork roasts;

~T An individual has not consumed at-home pork roasts;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.8. Out-of-Sample Classification Table for At-Home Pork Tenderloin

Classified	True T	True ~T	Total
+	76	1315	1391
-	48	2082	2130
Total	124	3397	3521

Sensitivity	Pr(+| T)	61.29%
Specificity	Pr(-|~T)	61.29%
Positive predictive value	Pr(T| +)	5.46%
Negative predictive value	Pr(~T| -)	97.75%
False + rate for true ~T	Pr(+|~T)	38.71%
False - rate for true T	Pr(-| T)	38.71%
False + rate for classified +	Pr(~T| +)	94.54%
False - rate for classified -	Pr(T| -)	2.25%
Correctly classified (weighted average)		61.29%
Correctly classified (sum)		122.58%

Notes: In-sample penetration for pork tenderloin (.028827) is used as a cutoff point. The signs used in the tables have the following meanings:

T An individual consumed at-home pork tenderloin;

~T An individual has not consumed at-home pork tenderloin;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.9. Out-of-Sample Classification Table for At-Home Bacon

Classified	True T	True ~T	Total
+	691	985	1676
-	403	1438	1841
Total	1094	2423	3517

Sensitivity	Pr(+| T)	63.16%
Specificity	Pr(-|~T)	59.35%
Positive predictive value	Pr(T| +)	41.23%
Negative predictive value	Pr(~T| -)	78.11%
False + rate for true ~T	Pr(+|~T)	40.65%
False - rate for true T	Pr(-| T)	36.84%
False + rate for classified +	Pr(~T| +)	58.77%
False - rate for classified -	Pr(T| -)	21.89%
Correctly classified (weighted average)		60.53%
Correctly classified (sum)		122.51%

Notes: In-sample penetration for bacon (.3062051) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home bacon;

~T An individual has not consumed at-home bacon;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.10. Out-of-Sample Classification Table for At-Home Canned Ham

Classified	True T	True ~T	Total
+	62	1341	1403
-	48	2069	2117
Total	110	3410	3520

Sensitivity	Pr(+| T)	56.36%
Specificity	Pr(-|~T)	60.67%
Positive predictive value	Pr(T| +)	4.42%
Negative predictive value	Pr(~T| -)	97.73%
False + rate for true ~T	Pr(+|~T)	39.33%
False - rate for true T	Pr(-| T)	43.64%
False + rate for classified +	Pr(~T| +)	95.58%
False - rate for classified -	Pr(T| -)	2.27%
Correctly classified (weighted average)		60.54%
Correctly classified (sum)		117.03%

Notes: In-sample penetration for canned ham (.0326681) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home canned ham;
~T An individual has not consumed at-home canned ham;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

Table D.11. Out-of-Sample Classification Table for At-Home Ham

Classified	True T	True ~T	Total
+	1060	776	1836
-	715	960	1675
Total	1775	1736	3511

Sensitivity	Pr(+| T)	59.72%
Specificity	Pr(-|~T)	55.30%
Positive predictive value	Pr(T| +)	57.73%
Negative predictive value	Pr(~T| -)	57.31%
False + rate for true ~T	Pr(+|~T)	44.70%
False - rate for true T	Pr(-| T)	40.28%
False + rate for classified +	Pr(~T| +)	42.27%
False - rate for classified -	Pr(T| -)	42.69%
Correctly classified (weighted average)		57.53%
Correctly classified (sum)		115.02%

Notes: In-sample penetration for ham (.5099168) is used as a cutoff point.
The signs used in the tables have the following meanings:
T An individual consumed at-home ham;
~T An individual has not consumed at-home ham;
\+ The model's predicted probability is greater than or equal to the cutoff point;
\- The model's predicted probability is less than the cutoff point.

Table D.12. Out-of-Sample Classification Table for At-Home Pork Hotdogs

Classified	True T	True ~T	Total
+	538	1141	1679
-	296	1544	1840
Total	834	2685	3519

Sensitivity	Pr(+| T)	64.51%
Specificity	Pr(-|~T)	57.50%
Positive predictive value	Pr(T| +)	32.04%
Negative predictive value	Pr(~T| -)	83.91%
False + rate for true ~T	Pr(+|~T)	42.50%
False - rate for true T	Pr(-| T)	35.49%
False + rate for classified +	Pr(~T| +)	67.96%
False - rate for classified -	Pr(T| -)	16.09%
Correctly classified (weighted average)		59.16%
Correctly classified (sum)		122.01%

Notes: In-sample penetration for pork hotdogs (.2326177) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home pork hotdogs;

~T An individual has not consumed at-home pork hotdogs;

\+ The model’s predicted probability is greater than or equal to the cutoff point;

\- The model’s predicted probability is less than the cutoff point.

Table D.13. Out-of-Sample Classification Table for At-Home Pork Lunchmeats

Classified	True T	True ~T	Total
+	531	1141	1672
-	381	1468	1849
Total	912	2609	3521

Sensitivity	Pr(+| T)	58.22%
Specificity	Pr(-|~T)	56.27%
Positive predictive value	Pr(T| +)	31.76%
Negative predictive value	Pr(~T| -)	79.39%
False + rate for true ~T	Pr(+|~T)	43.73%
False - rate for true T	Pr(-| T)	41.78%
False + rate for classified +	Pr(~T| +)	68.24%
False - rate for classified -	Pr(T| -)	20.61%
Correctly classified (weighted average)		56.77%
Correctly classified (sum)		114.49%

Notes: In-sample penetration for lunchmeat (.2587065) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home lunchmeat;

~T An individual has not consumed at-home lunchmeat;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.14. Out-of-Sample Classification Table for At-Home Processed Pork

Classified	True T	True ~T	Total
+	1882	205	2087
-	1096	334	1430
Total	2978	539	3517

Sensitivity	Pr(+| T)	63.20%
Specificity	Pr(-|~T)	61.97%
Positive predictive value	Pr(T| +)	90.18%
Negative predictive value	Pr(~T| -)	23.36%
False + rate for true ~T	Pr(+|~T)	38.03%
False - rate for true T	Pr(-| T)	36.80%
False + rate for classified +	Pr(~T| +)	9.82%
False - rate for classified -	Pr(T| -)	76.64%
Correctly classified (weighted average)		63.01%
Correctly classified (sum)		225.17%

Notes: In-sample penetration for processed pork (.8457053) is used as a cutoff point. The signs used in the tables have the following meanings:

T An individual consumed at-home processed pork;

~T An individual has not consumed at-home processed pork;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.15. Out-of-Sample Classification Table for At-Home Pork Sausage

Classified	True T	True ~T	Total
+	715	928	1643
-	529	1341	1870
Total	1244	2269	3513

Sensitivity	Pr(+| T)	57.48%
Specificity	Pr(-|~T)	59.10%
Positive predictive value	Pr(T| +)	43.52%
Negative predictive value	Pr(~T| -)	71.71%
False + rate for true ~T	Pr(+|~T)	40.90%
False - rate for true T	Pr(-| T)	42.52%
False + rate for classified +	Pr(~T| +)	56.48%
False - rate for classified -	Pr(T| -)	28.29%
Correctly classified (weighted average)		58.53%
Correctly classified (sum)		116.58%

Notes: In-sample penetration for pork sausage (.3592806) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home pork sausage;

~T An individual has not consumed at-home pork sausage;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

Table D.16. Out-of-Sample Classification Table for At-Home Smoked Ham

Classified	True T	True ~T	Total
+	365	1271	1636
-	224	1661	1885
Total	589	2932	3521

Sensitivity	Pr(+| T)	61.97%
Specificity	Pr(-|~T)	56.65%
Positive predictive value	Pr(T| +)	22.31%
Negative predictive value	Pr(~T| -)	88.12%
False + rate for true ~T	Pr(+|~T)	43.35%
False - rate for true T	Pr(-| T)	38.03%
False + rate for classified +	Pr(~T| +)	77.69%
False - rate for classified -	Pr(T| -)	11.88%
Correctly classified (weighted average)		57.54%
Correctly classified (sum)		117.64%

Notes: In-sample penetration for smoked ham (.1632682) is used as a cutoff point.
The signs used in the tables have the following meanings:

T An individual consumed at-home smoked ham;

~T An individual has not consumed at-home smoked ham;

\+ The model's predicted probability is greater than or equal to the cutoff point;

\- The model's predicted probability is less than the cutoff point.

APPENDIX E

STATA COMMAND AND ESTIMATION RESULTS FOR THE SELECTIVITY-ADJUSTED CENSORED LA/AIDS MODEL

Table E.1. STATA Command and Estimation Results for the Selectivity-Adjusted Censored LA/AIDS model for Fresh Pork, Beef, Chicken, and Seafood

STATA Command

```
sureg (w_fshpk ln_pk_pk ln_pk_bf ln_pk_ck ln_pk_sf ln_pk_yp  mrv_fshpk)
      (w_bffsh ln_bf_pk ln_bf_bf ln_bf_ck ln_bf_sf ln_bf_yp  mrv_bffsh)
      (w_chfsh ln_ck_pk ln_ck_bf ln_ck_ck ln_ck_sf ln_ck_yp  mrv_chfsh)
, corr c(1 2 3 4 5 6);
```

Constraints:

Symmetry Restrictions

```
 ( 1)  .3167956 [w_fshpk]ln_pk_bf - .7419404 [w_bffsh]ln_bf_pk = 0
 ( 2)  .3167956 [w_fshpk]ln_pk_ck - .6336302 [w_chfsh]ln_ck_pk = 0
 ( 3)  .7419404 [w_bffsh]ln_bf_ck - .6336302 [w_chfsh]ln_ck_bf = 0
```

Homogeneity Restrictions

```
( 4)  [w_fshpk]ln_pk_pk + [w_fshpk]ln_pk_bf + [w_fshpk]ln_pk_ck +
       [w_fshpk]ln_pk_sf = 0
 ( 5)  [w_bffsh]ln_bf_pk + [w_bffsh]ln_bf_bf + [w_bffsh]ln_bf_ck +
       [w_bffsh]ln_bf_sf = 0
 ( 6)  [w_chfsh]ln_ck_pk + [w_chfsh]ln_ck_bf + [w_chfsh]ln_ck_ck +
       [w_chfsh]ln_ck_sf = 0
```

Regression Information

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
w_fshpk	21264	5	.2286319	0.0038	63.76	0.0000
w_bffsh	21264	5	.3622073	0.0353	1032.24	0.0000
w_chfsh	21264	5	.2962803	0.1248	3114.79	0.0000

Table E.1. Continued

Parameter Estimates

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
w_fshpk						
ln_pk_pk	.2797612	.0463962	6.03	0.000	.1888264	.370696
ln_pk_bf	-.1770954	.0436599	-4.06	0.000	-.2626673	-.0915235
ln_pk_ck	-.0422793	.0347137	-1.22	0.223	-.1103168	.0257582
ln_pk_sf	-.0603865	.0245005	-2.46	0.014	-.1084065	-.0123665
ln_pk_yp	.0277012	.006742	4.11	0.000	.0144871	.0409152
mrv_fshpk	.2454512	.0682987	3.59	0.000	.1115881	.3793142
_cons	.0428822	.0235062	1.82	0.068	-.0031892	.0889536
w_bffsh						
ln_bf_pk	-.0756166	.018642	-4.06	0.000	-.1121544	-.0390789
ln_bf_bf	.1885376	.0331258	5.69	0.000	.1236122	.2534631
ln_bf_ck	-.0865184	.0222216	-3.89	0.000	-.1300719	-.0429648
ln_bf_sf	-.0264026	.0178108	-1.48	0.138	-.0613111	.0085059
ln_bf_yp	.0423246	.0045776	9.25	0.000	.0333528	.0512964
mrv_bffsh	-.8959426	.0357934	-25.03	0.000	-.9660964	-.8257888
_cons	.7509547	.0202101	37.16	0.000	.7113436	.7905657
w_chfsh						
ln_ck_pk	-.0211383	.0173558	-1.22	0.223	-.055155	.0128783
ln_ck_bf	-.1013075	.0260201	-3.89	0.000	-.1523059	-.0503091
ln_ck_ck	.1465797	.0280138	5.23	0.000	.0916738	.2014857
ln_ck_sf	-.0241339	.0168065	-1.44	0.151	-.057074	.0088063
ln_ck_yp	-.2423213	.0043501	-55.70	0.000	-.2508474	-.2337953
mrv_chfsh	-.3699646	.0672626	-5.50	0.000	-.5017969	-.2381323
_cons	.4257888	.0339765	12.53	0.000	.359196	.4923816

Note: The variables in this table are transformed according to as in the text equation (35). Specifically, prices and real expenditure are multiplied by Cumulative distribution functions as shown in equation (35). That model also includes conditional probability density function. We are reporting this equation for convenience.

(35) $$E\left[w_{ik} \mid y_{1k}=1\right]=\Phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right)*\left(\alpha_i+\sum_i \gamma_{ij}\ln p_{jk}+B_i\ln\left(y_k/P_k\right)\right) +\sigma_{\varepsilon_{1k}\varepsilon_{2ik}\varepsilon_{3ik}}*\phi_2\left(\boldsymbol{x}_{2ik}^{'}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{'}\boldsymbol{\beta}_1\right)$$

Table E.2. STATA Command and Estimation Results for the Selectivity-Adjusted Censored LA/AIDS model for Pork Cuts

STATA Command

```
sureg (w_ch ln_ch_ch ln_ch_rb ln_ch_rs ln_ch_td ln_ch_bn ln_ch_ssg ln_ch_sh
       ln_ch_cndh ln_ch_lmt ln_ch_yp  mrv_ch)
      (w_rb ln_rb_ch ln_rb_rb ln_rb_rs ln_rb_td ln_rb_bn ln_rb_ssg ln_rb_sh
       ln_rb_cndh ln_rb_lmt ln_rb_yp  mrv_rb)
      (w_rs ln_rs_ch ln_rs_rb ln_rs_rs ln_rs_td ln_rs_bn ln_rs_ssg ln_rs_sh
       ln_rs_cndh ln_rs_lmt ln_rs_yp  mrv_rs)
      (w_bn ln_bn_ch ln_bn_rb ln_bn_rs ln_bn_td ln_bn_bn ln_bn_ssg ln_bn_sh
       ln_bn_cndh ln_bn_lmt ln_bn_yp  mrv_ch)
      (w_ssg ln_ssg_ch ln_ssg_rb ln_ssg_rs ln_ssg_td ln_ssg_bn ln_ssg_ssg
       ln_ssg_sh ln_ssg_cndh ln_ssg_lmt ln_ssg_yp mrv_ch)
      (w_sh ln_sh_ch ln_sh_rb ln_sh_rs ln_sh_td ln_sh_bn ln_sh_ssg ln_sh_sh
       ln_sh_cndh ln_sh_lmt ln_sh_yp  mrv_sh)
      (w_cndh ln_cndh_ch ln_cndh_rb ln_cndh_rs ln_cndh_td ln_cndh_bn
       ln_cndh_ssg ln_cndh_sh ln_cndh_cndh ln_cndh_lmt ln_cndh_yp
       mrv_cndh)
      (w_lmt ln_lmt_ch ln_lmt_rb ln_lmt_rs ln_lmt_td ln_lmt_bn ln_lmt_ssg
       ln_lmt_sh ln_lmt_cndh ln_lmt_lmt ln_lmt_yp  mrv_lmt)
, corr c(1 2 4 5 6 7 8 9 11 12 13 14 15 17 18 19 20 21 27 28 29 30 31 32 3
3 34 35 36 37 38 39 40 41 42 43 44);
```

Constraints:

Symmetry Restrictions

```
 ( 1)  .2761938 [w_ch]ln_ch_rb - .0569503 [w_rb]ln_rb_ch = 0
 ( 2)  .2761938 [w_ch]ln_ch_rs - .0475707 [w_rs]ln_rs_ch = 0
 ( 3)  .2761938 [w_ch]ln_ch_bn - .3590074 [w_bn]ln_bn_ch = 0
 ( 4)  .2761938 [w_ch]ln_ch_ssg - .3835249 [w_ssg]ln_ssg_ch = 0
 ( 5)  .2761938 [w_ch]ln_ch_sh - .1486424 [w_sh]ln_sh_ch = 0
 ( 6)  .2761938 [w_ch]ln_ch_cndh - .035035 [w_cndh]ln_cndh_ch = 0
 ( 7)  .2761938 [w_ch]ln_ch_lmt - .2878357 [w_lmt]ln_lmt_ch = 0
 ( 8)  .0569503 [w_rb]ln_rb_rs - .0475707 [w_rs]ln_rs_rb = 0
 ( 9)  .0569503 [w_rb]ln_rb_bn - .3590074 [w_bn]ln_bn_rb = 0
 (10)  .0569503 [w_rb]ln_rb_ssg - .3835249 [w_ssg]ln_ssg_rb = 0
 (11)  .0569503 [w_rb]ln_rb_sh - .1486424 [w_sh]ln_sh_rb = 0
 (12)  .0569503 [w_rb]ln_rb_cndh - .035035 [w_cndh]ln_cndh_rb = 0
 (13)  .0569503 [w_rb]ln_rb_lmt - .2878357 [w_lmt]ln_lmt_rb = 0
 (14)  .0475707 [w_rs]ln_rs_bn - .3590074 [w_bn]ln_bn_rs = 0
 (15)  .0475707 [w_rs]ln_rs_ssg - .3835249 [w_ssg]ln_ssg_rs = 0
 (16)  .0475707 [w_rs]ln_rs_sh - .1486424 [w_sh]ln_sh_rs = 0
 (17)  .0475707 [w_rs]ln_rs_cndh - .035035 [w_cndh]ln_cndh_rs = 0
 (18)  .0475707 [w_rs]ln_rs_lmt - .2878357 [w_lmt]ln_lmt_rs = 0
 (19)  .3590074 [w_bn]ln_bn_ssg - .3835249 [w_ssg]ln_ssg_bn = 0
 (20)  .3590074 [w_bn]ln_bn_sh - .1486424 [w_sh]ln_sh_bn = 0
 (21)  .3590074 [w_bn]ln_bn_cndh - .035035 [w_cndh]ln_cndh_bn = 0
 (22)  .3590074 [w_bn]ln_bn_lmt - .2878357 [w_lmt]ln_lmt_bn = 0
 (23)  .3835249 [w_ssg]ln_ssg_sh - .1486424 [w_sh]ln_sh_ssg = 0
 (24)  .3835249 [w_ssg]ln_ssg_cndh - .035035 [w_cndh]ln_cndh_ssg = 0
 (25)  .3835249 [w_ssg]ln_ssg_lmt - .2878357 [w_lmt]ln_lmt_ssg = 0
 (26)  .1486424 [w_sh]ln_sh_cndh - .035035 [w_cndh]ln_cndh_sh = 0
 (27)  .1486424 [w_sh]ln_sh_lmt - .2878357 [w_lmt]ln_lmt_sh = 0
 (28)  .035035 [w_cndh]ln_cndh_lmt - .2878357 [w_lmt]ln_lmt_cndh = 0
```

Table E.2. Continued

STATA Command

Constraints:

Homogeneity Restrictions

```
(29)  [w_ch]ln_ch_ch + [w_ch]ln_ch_rb + [w_ch]ln_ch_rs + [w_ch]ln_ch_td
       + [w_ch]ln_ch_bn + [w_ch]ln_ch_ssg + [w_ch]ln_ch_sh + [w_ch]ln_ch_cndh
       + [w_ch]ln_ch_lmt = 0

(30)  [w_rb]ln_rb_ch + [w_rb]ln_rb_rb + [w_rb]ln_rb_rs + [w_rb]ln_rb_td
       + [w_rb]ln_rb_bn + [w_rb]ln_rb_ssg + [w_rb]ln_rb_sh + [w_rb]ln_rb_cndh
       + [w_rb]ln_rb_lmt = 0

(31)  [w_rs]ln_rs_ch + [w_rs]ln_rs_rb + [w_rs]ln_rs_rs + [w_rs]ln_rs_td
       + [w_rs]ln_rs_bn + [w_rs]ln_rs_ssg + [w_rs]ln_rs_sh + [w_rs]ln_rs_cndh
       + [w_rs]ln_rs_lmt = 0

(32)  [w_bn]ln_bn_ch + [w_bn]ln_bn_rb + [w_bn]ln_bn_rs + [w_bn]ln_bn_td
       + [w_bn]ln_bn_bn + [w_bn]ln_bn_ssg + [w_bn]ln_bn_sh + [w_bn]ln_bn_cndh
       + [w_bn]ln_bn_lmt = 0
(33)  [w_ssg]ln_ssg_ch + [w_ssg]ln_ssg_rb + [w_ssg]ln_ssg_rs
       + [w_ssg]ln_ssg_td + [w_ssg]ln_ssg_bn + [w_ssg]ln_ssg_ssg
       + [w_ssg]ln_ssg_sh + [w_ssg]ln_ssg_cndh + [w_ssg]ln_ssg_lmt = 0

(34)  [w_sh]ln_sh_ch + [w_sh]ln_sh_rb + [w_sh]ln_sh_rs + [w_sh]ln_sh_td
       + [w_sh]ln_sh_bn + [w_sh]ln_sh_ssg + [w_sh]ln_sh_sh + [w_sh]ln_sh_cndh
       + [w_sh]ln_sh_lmt = 0

(35)  [w_cndh]ln_cndh_ch + [w_cndh]ln_cndh_rb + [w_cndh]ln_cndh_rs
       + [w_cndh]ln_cndh_td + [w_cndh]ln_cndh_bn + [w_cndh]ln_cndh_ssg
       + [w_cndh]ln_cndh_sh + [w_cndh]ln_cndh_cndh + [w_cndh]ln_cndh_lmt = 0

(36)  [w_lmt]ln_lmt_ch + [w_lmt]ln_lmt_rb + [w_lmt]ln_lmt_rs + [w_lmt]ln_lmt_td
       + [w_lmt]ln_lmt_bn + [w_lmt]ln_lmt_ssg + [w_lmt]ln_lmt_sh
       + [w_lmt]ln_lmt_cndh + [w_lmt]ln_lmt_lmt = 0
```

Regression Information

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
w_ch	9902	10	.3344404	0.0762	1033.76	0.0000
w_rb	9902	10	.1583764	0.0248	191.99	0.0000
w_rs	9902	10	.1417859	0.0199	145.98	0.0000
w_bn	9902	10	.2545812	0.3543	4769.17	0.0000
w_ssg	9902	10	.3622833	0.0234	289.43	0.0000
w_sh	9902	10	.2406242	0.0136	120.45	0.0000
w_cndh	9902	10	.1279253	0.0147	155.32	0.0000
w_lmt	9902	10	.3559588	0.1117	1242.68	0.0000

Table E.2. Continued

Parameter Estimates

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
w_ch						
ln_ch_ch	.118506	.1087497	1.09	0.276	-.0946396	.3316515
ln_ch_rb	-.2135574	.0456332	-4.68	0.000	-.3029967	-.1241181
ln_ch_rs	.0651365	.0358717	1.82	0.069	-.0051707	.1354437
ln_ch_td	-.0606697	.0418327	-1.45	0.147	-.1426603	.0213209
ln_ch_bn	.2136655	.071756	2.98	0.003	.0730263	.3543046
ln_ch_ssg	-.0829238	.0842056	-0.98	0.325	-.2479637	.0821161
ln_ch_sh	-.1192889	.048635	-2.45	0.014	-.2146116	-.0239661
ln_ch_cndh	.0686753	.0340295	2.02	0.044	.0019788	.1353718
ln_ch_lmt	.0104565	.0466156	0.22	0.823	-.0809083	.1018214
ln_ch_yp	.3117463	.0111401	27.98	0.000	.2899122	.3335805
mrv_ch	1.086537	.0770554	14.10	0.000	.9355114	1.237563
_cons	-.2348542	.0303955	-7.73	0.000	-.2944282	-.1752802
w_rb						
ln_rb_ch	-1.035697	.2213087	-4.68	0.000	-1.469454	-.6019396
ln_rb_rb	-.1493034	.2100676	-0.71	0.477	-.5610284	.2624216
ln_rb_rs	-.0465203	.1215017	-0.38	0.702	-.2846592	.1916186
ln_rb_td	.1029128	.1121006	0.92	0.359	-.1168003	.3226258
ln_rb_bn	-.1689767	.2188218	-0.77	0.440	-.5978594	.2599061
ln_rb_ssg	-.2547697	.2661003	-0.96	0.338	-.7763168	.2667774
ln_rb_sh	.2719595	.1364963	1.99	0.046	.0044316	.5394874
ln_rb_cndh	.3198948	.1143773	2.80	0.005	.0957195	.5440701
ln_rb_lmt	.9604995	.1414345	6.79	0.000	.683293	1.237706
ln_rb_yp	.1101361	.0250046	4.40	0.000	.061128	.1591441
mrv_rb	-.2967536	.1124316	-2.64	0.008	-.5171155	-.0763918
_cons	.0210556	.005253	4.01	0.000	.0107598	.0313513
w_rs						
ln_rs_ch	.3781805	.2082697	1.82	0.069	-.0300207	.7863816
ln_rs_rb	-.0556928	.1454584	-0.38	0.702	-.340786	.2294004
ln_rs_rs	-.2960058	.157037	-1.88	0.059	-.6037927	.0117811
ln_rs_td	-.0466928	.1267797	-0.37	0.713	-.2951766	.2017909
ln_rs_bn	-.2275364	.2190778	-1.04	0.299	-.6569211	.2018482
ln_rs_ssg	.3227813	.2918147	1.11	0.269	-.2491651	.8947276
ln_rs_sh	.1560774	.1344299	1.16	0.246	-.1074005	.4195552
ln_rs_cndh	-.1444632	.1082827	-1.33	0.182	-.3566933	.067767
ln_rs_lmt	-.0866481	.1616542	-0.54	0.592	-.4034844	.2301883
ln_rs_yp	.1565697	.0251895	6.22	0.000	.1071991	.2059402
mrv_rs	.305154	.1080224	2.82	0.005	.0934341	.516874
_cons	.0032909	.0038376	0.86	0.391	-.0042306	.0108124
w_bn						
ln_bn_ch	.1643785	.0552038	2.98	0.003	.0561811	.2725758
ln_bn_rb	-.0268052	.0347123	-0.77	0.440	-.09484	.0412296
ln_bn_rs	-.03015	.0290292	-1.04	0.299	-.0870461	.0267461
ln_bn_td	.0139569	.029677	0.47	0.638	-.044209	.0721228
ln_bn_bn	.1958811	.0721686	2.71	0.007	.0544331	.337329
ln_bn_ssg	-.0248997	.0670885	-0.37	0.711	-.1563907	.1065912
ln_bn_sh	-.0009691	.0363262	-0.03	0.979	-.0721671	.0702288
ln_bn_cndh	-.0434744	.026415	-1.65	0.100	-.0952468	.0082981
ln_bn_lmt	-.247918	.0264923	-9.36	0.000	-.299842	-.195994
ln_bn_yp	-.4465202	.006618	-67.47	0.000	-.4594913	-.4335491
mrv_ch	.03037	.0507826	0.60	0.550	-.0691621	.1299021

Table E.2. Continued

Parameter Estimates

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
w_ssg						
ln_ssg_ch	-.0597172	.0606403	-0.98	0.325	-.17857	.0591355
ln_ssg_rb	-.0378312	.0395137	-0.96	0.338	-.1152767	.0396143
ln_ssg_rs	.0400363	.0361954	1.11	0.269	-.0309053	.110978
ln_ssg_td	.0216187	.0383926	0.56	0.573	-.0536294	.0968668
ln_ssg_bn	-.023308	.0627997	-0.37	0.711	-.1463931	.0997772
ln_ssg_ssg	-.1001246	.0950235	-1.05	0.292	-.2863672	.0861181
ln_ssg_sh	-.0136856	.0405252	-0.34	0.736	-.0931135	.0657423
ln_ssg_cndh	.017059	.0302594	0.56	0.573	-.0422484	.0763663
ln_ssg_lmt	.1559525	.0301391	5.17	0.000	.0968809	.215024
ln_ssg_yp	-.0706287	.0086645	-8.15	0.000	-.0876108	-.0536465
mrv_ch	-.4806543	.0677972	-7.09	0.000	-.6135344	-.3477742
_cons	.3555846	.0339373	10.48	0.000	.2890688	.4221004
w_sh						
ln_sh_ch	-.2216518	.0903691	-2.45	0.014	-.3987719	-.0445317
ln_sh_rb	.1041976	.0522967	1.99	0.046	.0016979	.2066972
ln_sh_rs	.0499501	.0430222	1.16	0.246	-.0343719	.1342721
ln_sh_td	.0535987	.0535125	1.00	0.317	-.051284	.1584813
ln_sh_bn	-.0023407	.0877365	-0.03	0.979	-.174301	.1696197
ln_sh_ssg	-.0353113	.1045625	-0.34	0.736	-.24025	.1696274
ln_sh_sh	.1237504	.081037	1.53	0.127	-.0350792	.2825799
ln_sh_cndh	.057271	.0405401	1.41	0.158	-.0221861	.1367281
ln_sh_lmt	-.129464	.072804	-1.78	0.075	-.2721572	.0132292
ln_sh_yp	-.0662051	.014145	-4.68	0.000	-.0939288	-.0384815
mrv_sh	.334437	.0762486	4.39	0.000	.1849926	.4838815
_cons	.0208273	.0090136	2.31	0.021	.003161	.0384936
w_cndh						
ln_cndh_ch	.5413926	.2682667	2.02	0.044	.0155995	1.067186
ln_cndh_rb	.5199973	.1859232	2.80	0.005	.1555946	.8844001
ln_cndh_rs	-.1961528	.1470268	-1.33	0.182	-.48432	.0920144
ln_cndh_td	.1526483	.1429386	1.07	0.286	-.1275062	.4328029
ln_cndh_bn	-.4454863	.2706771	-1.65	0.100	-.9760037	.0850311
ln_cndh_ssg	.1867432	.331247	0.56	0.573	-.4624889	.8359753
ln_cndh_sh	.2429827	.1719988	1.41	0.158	-.0941287	.5800942
ln_cndh_cndh	-.4984136	.1800165	-2.77	0.006	-.8512394	-.1455878
ln_cndh_lmt	-.5037115	.2291822	-2.20	0.028	-.9529004	-.0545226
ln_cndh_yp	.053511	.0314719	1.70	0.089	-.0081728	.1151947
mrv_cndh	.5732849	.1481233	3.87	0.000	.2829687	.8636012
_cons	-.0066182	.0033848	-1.96	0.051	-.0132523	.0000158
w_lmt						
ln_lmt_ch	.0100336	.0447302	0.22	0.823	-.0776359	.0977031
ln_lmt_rb	.1900415	.0279838	6.79	0.000	.1351943	.2448888
ln_lmt_rs	-.0143204	.0267166	-0.54	0.592	-.066684	.0380433
ln_lmt_td	-.0259164	.0413051	-0.63	0.530	-.1068728	.0550401
ln_lmt_bn	-.3092195	.0330429	-9.36	0.000	-.3739824	-.2444565
ln_lmt_ssg	.2077979	.0401587	5.17	0.000	.1290884	.2865074
ln_lmt_sh	-.066857	.037597	-1.78	0.075	-.1405458	.0068318
ln_lmt_cndh	-.0613111	.0278958	-2.20	0.028	-.1159858	-.0066364
ln_lmt_lmt	.0697512	.0500385	1.39	0.163	-.0283224	.1678249
ln_lmt_yp	.2898577	.0105581	27.45	0.000	.2691643	.3105511

Table E.2. Continued

Parameter Estimates

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
mrv_lmt	.9288945	.0882923	10.52	0.000	.7558447	1.101944
_cons	-.0339349	.0192088	-1.77	0.077	-.0715835	.0037137

Note:The variables in this table are transformed according to as in the text equation (35). Specifically, prices and real expenditure are multiplied by Cumulative distribution functions as shown in equation (35). That model also includes conditional probability density function. We are reporting this equation for convenience.

$$E\left[w_{ik} \mid y_{1k}=1\right]=\Phi_2\left(\boldsymbol{x}_{2ik}^{\prime}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{\prime}\boldsymbol{\beta}_1\right)*\left(\alpha_i+\sum_i \gamma_{ij}\ln p_{jk}+B_i\ln\left(y_k/P_k\right)\right) + \sigma_{\varepsilon_{1k}\varepsilon_{2ik}\varepsilon_{3ik}} * \phi_2\left(\boldsymbol{x}_{2ik}^{\prime}\boldsymbol{\beta}_{2i} \mid \boldsymbol{x}_{1k}^{\prime}\boldsymbol{\beta}_1\right) \qquad (35)$$

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